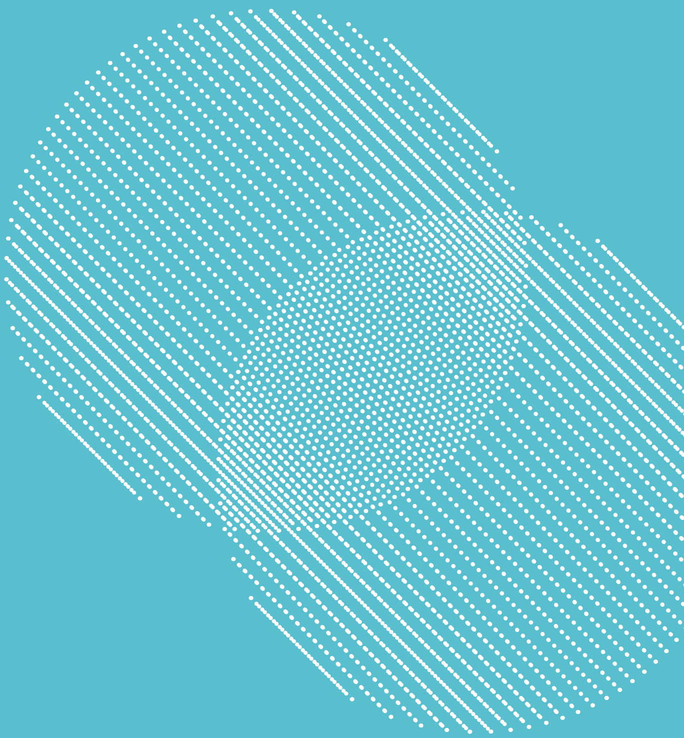

COLLECTION

02

ART+DESIGN \ PSYCHOLOGY

La revue *Collection* est une initiative de la Parsons **Paris** School of **Art + Design**.

Revue de recherche internationale en Art & Design, à caractère professionnel, Collection veut être un pont entre les théories et les pratiques, entre la recherche fondamentale et les acteurs du Design – les enseignants tout comme les professionnels. Elle cherche à diffuser la recherche et à faire une synthèse des savoirs.

Sa double mission est d'aider à définir les territoires de la science du design et de les rassembler, autour d'**un noyau commun de savoirs académiques et de *best practices***.

Chaque numéro de la revue porte sur une thématique différente, et sera conçu en collaboration avec **deux invités (un chercheur et un designer) travaillant ensemble. Trois fois par an, elle présentera un regard original et pertinent sur les savoirs et les savoir-faire en Design**.

Après un premier numéro consacré au thème du design et la sociologie, ce deuxième numéro se concentre sur les connections qui existent entre **le design et la psychologie cognitive** : comment les études en *cognitive design research* voient le processus du design, et comment **la psychologie des émotions est liée à la pratique du design et à son évaluation**. Les théories et les modèles présentés sont illustrés dans un contexte éducatif, à travers **des études de cas qui dessinent, chez des étudiants en design de mode, les négociations entre ces processus et leur pratique**.

Nous vous invitons, avec **Willemien Visser** (CNRS, UMR 5141, LTCI-Telecom ParisTech-INRIA), le designer **Sibylle Klose** (directrice du département Fashion Design à la Parsons Paris School of Art + Design) et le directeur artistique **Olivier Combres**, à découvrir le deuxième numéro de *Collection*.

Tony Brown,
Directeur Académique Intérimaire

Brigitte Borja de Mozota,
Rédactrice en chef

The journal *Collection* is an initiative of Parsons **Paris** School of **Art + Design.**

A professional journal compiling international research in art and design, *Collection* aims to bridge the gap between theory and practice, linking fundamental research and members of the design community, including teachers, theoreticians and professionals. *Collection* seeks to disseminate research, and to create a multidisciplinary conversation.

Collection's mission is to help define the fields of design science and creative conception through networking, to bring researchers together around **a common core of academic knowledge, humanities and social sciences, and best practices**.

Each issue of the journal is based on a different theme and science, and is conceived in collaboration with **two invited guests: one researcher and one designer. Three times a year, it presents an original and pertinent point of view on how theoretical knowledge can inform practical *savoir-faire***.

Following the theme of design and sociology in number one, this second issue focuses on the connections that exist between **design and cognitive psychology**: how cognitive design studies see the design process, and **how the psychology of emotions is connected with design practice and design evaluation**. The theories and models presented are illustrated in the educational environment through **case studies profiling selected fashion design students' negotiation of these processes in their practice**.

Along with guest editor, **Willemien Visser** (CNRS, UMR 5141, LTCI-Telecom ParisTech-INRIA), guest designer **Sibylle Klose** (Chair of Fashion Design at Parsons Paris School of Art + Design), and artistic director **Olivier Combres**, we invite you to discover *Collection* number two.

Tony Brown,
Interim Academic Director

Brigitte Borja de Mozota,
Editor in Chief / Director of Research

COLLECTION

#02

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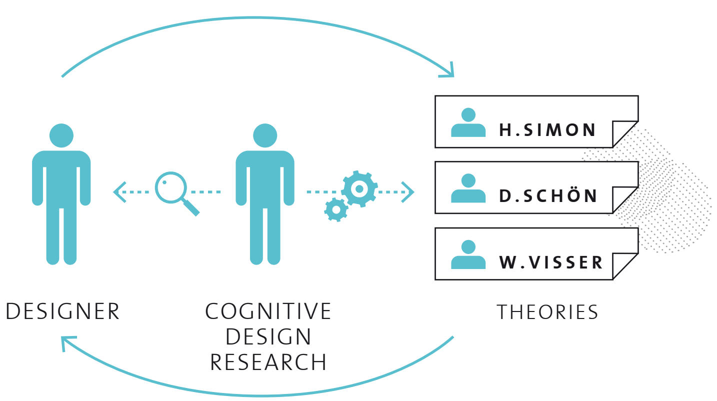
COLLECTION

VISION

Part 1: Design process

A cognitive researcher observes a designer at work

RESULT
three theories
on design emerge

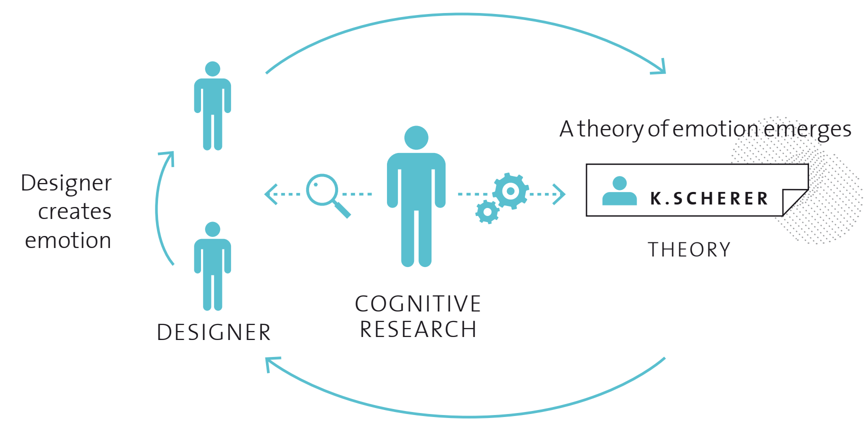


Designers learn from the theories

Part 2: Emotion

Cognitive psychology
observes human activity

A theory of emotion emerges



Designers learn from theory

Katarina Rimarcikova

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The Three Visions of Design in the Field of Cognitive Design Studies

WILLEMIEN VISSER

Introduction to issue 2 of *Collection*, on "Art + Design & Psychology"

The field in which we situate ourselves is that of *cognitive design studies*. It is a field that not only encompasses the cognitive ergonomics of design, but also goes beyond it. We have adopted the perspective of cognitive psychology in undertaking our studies – even if we have enlarged this perspective with elements of a socio-cultural nature, specifically in our analyses of design in collaborative situations.

Cognitive psychology focuses on "cognition": it studies the processes and structures concerning the manner in which people think, reason, and act in a variety of different ways, drawing from their experiences, representations, and knowledge. In addition, studies in cognitive psychology bring elements that respond to questions of training, the nature of expertise, and the possible evolution from novice to expert in the field of design.

Cognitive psychology analyzes these activities from different angles, in particular the mental processes at work, the strategies adopted, and the types of knowledge used. It also examines how learning takes place and what differentiates the experts from the novices.

Cognition is implemented in both work and leisure activities, which require people, for example, to: use language, understand others, use objects, interpret situations, plan tasks, resolve problems, pass judgments, and take decisions.

It is for numerous reasons that cognitive psychology studies design, as all of the processes and activities cited above are mobilized for this task. Experience, knowledge, and representations play a central role in the activity of design.

Until very recently, there was a clear separation between studies on cognition and studies on emotion; these two fundamental aspects of human functioning were considered quite distinct. Today, there is a growing amount of research that adopts an approach integrating these two facets. This is also the case in studies on design, as we will see in two texts within this issue.

Cognitive psychology is heavily centered in the laboratory, where it examines cognition through experimental studies. It is equally in such well-controlled situations that the activity of design has been studied. There is, however, increasing research on design that has been undertaken in "natural" situations, in working conditions such as design offices and agencies. In these studies, researchers generally make observations (often qualified as "ethnographic"), taking notes, salvaging discarded materials, and/or making video recordings of the activity of designers at work (in order to refer to them in consecutive analyses).

The following are two examples of studies that we have conducted on industrial design projects (software design and mechanical design):

The planning and organization of the activity of design. We showed how designers plan (before its actual implementation) and organize (in reality) their activity, and how the actual organization of the activity is different from the plans that the designers had developed (more or less deliberately). We have characterized this actual organization as "opportunistic", for designers deviate from their plans and/or abandon them – often temporarily – to take advantage of situations that constitute "opportunities" from a cognitive point of view. Some situations can, in effect, be interesting cognitively when they allow us to benefit from information obtained in an unexpected way (for example, suggestions from colleagues) or to use ideas developed for another part or facet of the artifact.

Reuse in the activity of design. We have examined how designers reuse solutions developed for previous projects, realized by themselves or by their colleagues. In fact, even in the most creative or innovative cases, design concepts are never developed from scratch. In these activities of reuse, analogical reasoning is central: it is in adapting solutions developed for other projects (similar or analogous solutions) that designers advance on their current projects.

As we show in the following passages, taken from our book *The Cognitive Artifacts of Designing*, design is analyzed in cognitive design studies from three angles, which will be dealt with successively in this issue:

a) Classically, it was analyzed as an activity of problem solving: the position introduced by Herbert Simon, presented in the first passage.

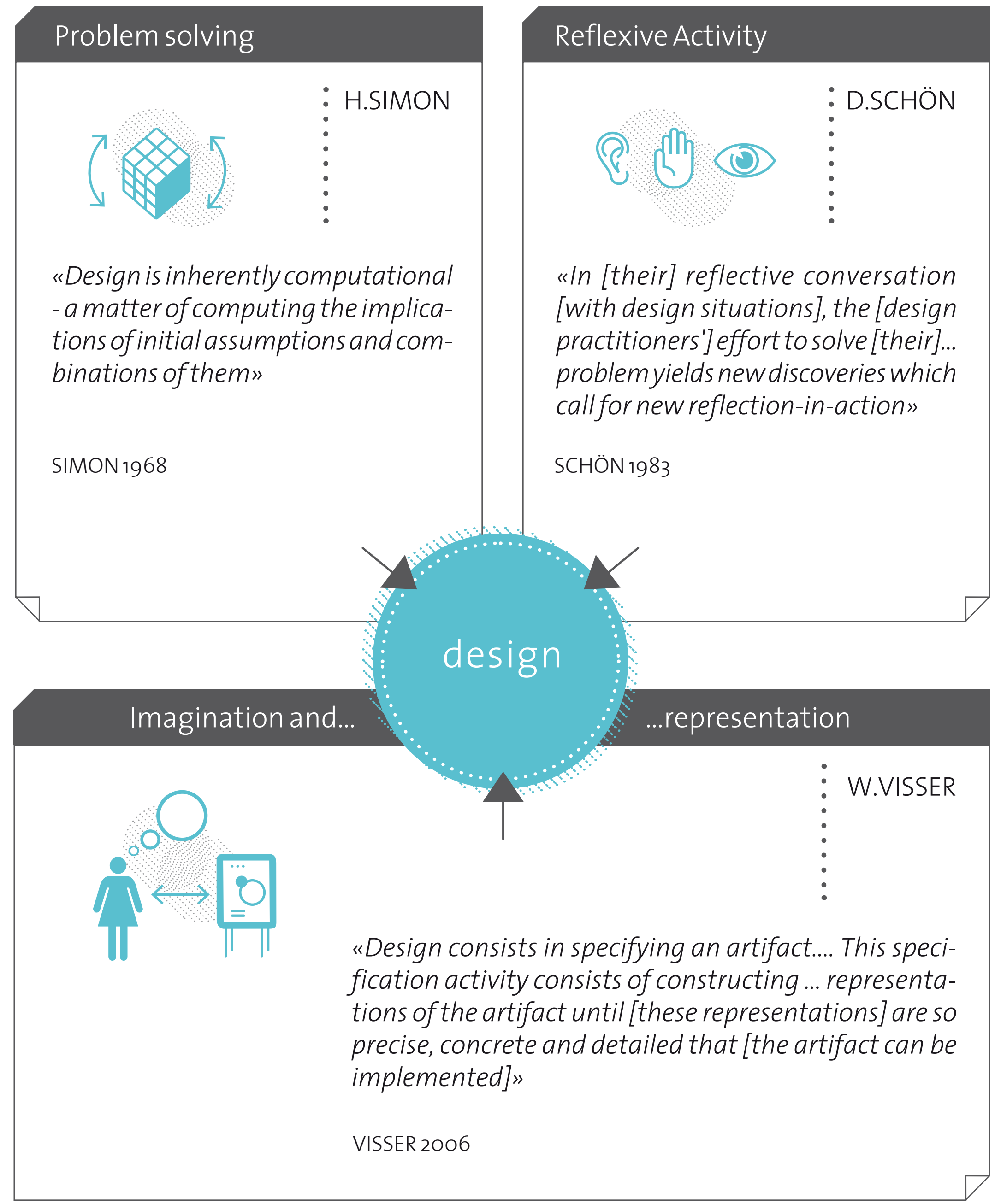
b) As a reflective practice: Donald Schön (presented in the second passage) opposed the vision that "design = problem solving". As a representative of the approach to design that has been qualified as "situated", he analyzes design as a reflective practice: the designer acts AND takes his actions as the object of reflection in his subsequent actions.

c) As a construction of representations: this is the approach that we have proposed (third passage). These representations may take different forms, and consist not only of external representations, such as drawings or *maquettes*, but also of mental representations – in other words, interpretations and other (more or less precise) ideas.

The first three articles of this journal will review these three visions of the activity of design.

TRANSLATION FROM FRENCH
Rebecca Cavanaugh

What is design?
for cognitive design research



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Simon: Design as a Problem-Solving Activity

WILLEMIEN VISSER

Abstract

In this paper, we present Simon's approach to design, as we have described it in *The Cognitive Artifacts of Designing* (2006): Simon considers the sciences of design as sciences in their own right. He sees them as distinct from natural science, which is traditionally considered as "the" "science". "Artificial" indeed refers to human-made as opposed to natural. For Simon, our modern world is much more an artificial, that is, a human-made, than a natural world. Together with various colleagues, Newell and Simon also used the approach to explore broader domains than the one analyzed in their famous *Human Problem Solving* (1972). They used it for their research into concept formation, verbal learning, and perception, but also administrative and organizational behavior, creativity and scientific discovery, and even music and emotion. It was Simon who applied to design the paradigm developed with Newell. In his analyses, he identified and elaborated various characteristics of this specific problem solving activity that have formed the basis of the approach adopted toward design by many researchers in cognitive psychology and ergonomics conducting research on design since the early 1980s.

Simon: Design as a Problem-Solving Activity

WILLEMIEN VISSER

This first chapter presents Simon's approach to design.

Simon's Framework for Design: *The Sciences of the Artificial*[1] 1

Simon's bibliography comprises nearly 1,000 titles, among which are some 700 papers published in journals in domains ranging from public management to the axiomatization of physical theories (*Bibliography of Herbert A. Simon*). He published only some 10 papers directly concerned with design (Cagan, Kotovsky & Simon, 2001; Kim, Javier-Lerch & Simon, 1995; Simon, 1969/1996, 1971/1975, 1973/1984, 1977b, 1980, 1987/1995, 1997). The number amounts to some 20 if one also includes publications dealing mostly with organizational design, but that do not handle with cognitive aspects.

The Sciences of the Artificial (Simon, 1969/1996) is, however, one of Simon's seminal works and one of the definitely fundamental references exploited in cognitive analyses of design. The "sciences of design" are the core of these "sciences of the artificial" (or "artificial sciences", e.g., engineering, computer science, medicine, business, architecture, painting, the human and social sciences). Even if only two chapters of the book are dedicated specifically to the nature of design, this is the central issue of the entire book. Together with the paper on "The Structure of Ill-Structured Problems" (1973/1984), these are Simon's central publications in his work on design. [...]

One may notice that "sciences of the artificial" may be a more appropriate appellation than "artificial sciences", which may also refer to the domains of artificial intelligence and artificial life [...].

The Sciences of the Artificial went into three, each time revised, editions. Its first, the 1969 edition, [...] introduced the chapter "The Science of Design: Creating the Artificial"... [The 1981 version] introduced a second chapter specifically on design, namely "Social Planning: Designing the Evolving Artifact". Taken together, the conclusions of the two design chapters constitute the main lines of a curriculum for design education formulated by Simon. In 1996, the third edition introduced a new chapter on complexity, "Alternative Views of Complexity". [...] In his analysis of Simon's work, Carroll (2006) [...] notices an evolution in the nature of the new chapters. The addition of the chapter "Social Planning: Designing the Evolving Artifact" translates for him Simon *considering design as a social activity in several different senses* (p. 5). In the present chapter, the page numbers for quotations from *The Sciences of the Artificial* come from the third printing of the third edition of the book (Simon, 1969/1996).

From the first edition on, Simon considers the sciences of design as sciences in their own right. He sees them as distinct from natural science, which is traditionally considered as "the" "science". Yet, in a lecture given in 1987 (not included in *The Sciences of the Artificial*), Simon proposes to "compromise" on a perhaps less "pretentious" qualification, as he calls it, speaking of *the art and science of design* (Simon, 1987/1995, p. 245). As Simon writes in the chapter titled "The Science of Design: Creating the Artificial" (in which engineering design is the reference), *historically and traditionally, it has been the task of the science disciplines to teach about natural things: How they are and how they work. It has been the task of engineering schools to teach about artificial things: How to make artifacts that have desired properties and how to design* (Simon, 1969/1996, p. 111). Natural science is concerned with the necessary, with how things are, whereas design is concerned with the contingent, with how things might be (Simon, 1969/1996, p. xii) – or *ought* to be.

Designers are *concerned with how things* ought *to be [...] in order to* attain goals *and to* function (Simon, 1969/1996, pp. 4-5). Simon's thesis is indeed that *certain phenomena are "artificial" in a very specific sense: They are as they are only because of a system's being molded, by goals or purposes, to the environment in which it lives* (Simon, 1969/1996, p. xi). That is why symbol systems (or "information processing systems") are almost *the quintessential artifacts[:] Adaptivity to an environment is their whole* raison d'être (Simon, 1969/1996, p. 22). "Artificial" indeed refers to human-made as opposed to natural. For Simon, our modern world is much more an artificial, that is, a human-made, than a natural world.

[1] This paper is entirely composed by quotes from our book *The Cognitive Artifacts of Designing* (2006), Hillsdale, NJ, USA, Lawrence Erlbaum Associates.

2 Simon's Elaboration of an SIP Design Theory[2]

Two steps can be distinguished in Simon's elaboration of a cognitive design theory. The first one was taken together with Newell, to whom Sciences of the Artificial is being dedicated "in memory of a friendship". Jointly, the two researchers extended what has since been called the principles underlying the "symbolic information processing" approach to problem solving (Newell & Simon, 1972) – or abridged the "symbolic processing" (Greeno & Moore, 1993, pp. 57-58), "symbolic" (Vera & Simon, 1993, p. 10), or "information-processing" approach (Simon, 1978, p. 272), here abridged as the SIP approach. It is also frequently referred to – often by authors adopting a different approach – as the "rational problem-solving" (Dorst, 1997), "traditional", or "computational" view.

The SIP approach has been one of the main starting points of the "cognitivistic" perspective in cognitive science. In the early years of cognitive psychology, many authors embraced this paradigm as the fundamental schema for their investigation of cognitive activities. For some 20 years, it has been the theoretical reference for the cognitive analysis, not only of problem solving (Miller, Galanter & Pribram, 1960; Reitman, 1965), but also of other types of activities: Concept learning (Bruner, Goodnow & Austin, 1956), and verbal understanding and memory (Anderson, 1976, 1983; Le Ny, 1979, 1989a, 1989b). Together with various colleagues, Newell and Simon also used the approach to explore broader domains than the one analyzed in their famous *Human Problem Solving* (1972). They used it for their research into concept formation, verbal learning, and perception, but also administrative and organizational behavior, creativity and scientific discovery, and even music and emotion (for references, see Newell & Simon, 1972, p. 791, Note 1).

It was Simon alone – namely without Newell – who, subsequently, applied this paradigm to design (Simon, 1969/1996, 1971/1975, 1973/1984, 1987/1995). In these analyses of design, Simon identified and elaborated various characteristics of this specific problem solving activity that have formed, for some 10 to 15 years, *the basis* of the approach adopted toward design by many, if not most, researchers in cognitive psychology and cognitive ergonomics who have been conducting research on design since the early 1980s.

With one exception (Okada & Simon, 1997), as far as we[3] know, Simon was only concerned with individually conducted problem solving. This does 3
not mean that he was a researcher who especially underestimated the importance of collective problem solving. In the 1960s and 1970s, few psychologists dealt with collectively conducted activities, analyzed from a cognitive viewpoint – there was, of course, research in social psychology, but these studies did not deal with cognitive aspects of problem solving.

Notice that the general reference for problem solving, the SIP model, was presented in 1972 (Newell & Simon, 1972), whereas the first edition of Sciences of the Artificial had already been published in 1969.

Simon's Analytical Approach to Design

Contrary to Simon's elaboration of a general theory of problem solving, which was based on experimental research, his work on design was analytical. With one or two exceptions (Kim *et al.*, 1995), Simon indeed has not been involved in any empirical studies on design. This observation holds for "design" in a strict sense – such as Simon gave to the term. From the end of the 1950s on, Simon realized, in collaboration with various colleagues, a considerable body of research on scientific discovery, leading to two books (Langley, Simon, Bradshaw & Zytkow, 1987; Simon, 1977a) and more than 40 papers (Cagan *et al.*, 2001; Klahr & Simon, 2001; Kulkarni & Simon, 1988; Okada & Simon, 1997; Qin & Simon, 1990; Simon, 1977a, 1992a, 1992b, 2001). Even if in our view, scientific discovery is based on the same cognitive activities and operations (and, of course, cognitive processes) as implemented in design, Simon nearly establishes no link with design (see, however, Cagan *et al.*, 2001 [...]).

Reception of Simon's Design Framework

In 1964, Reitman adopted a representation for problem solving that could be formalized using the IPL-V information-processing language elaborated by Newell, Shaw, Simon, and other colleagues in the 1960s[4]. Reitman applied this 4
problem solving schema to the solving of what he

[2] "SIP" is the abbreviation for "symbolic information processing", the approach adopted by Simon (1969/1996) for analyzing design. This approach was originally developed by Newell and Simon (1972) for problem resolution.

[3] The use of "we" and "our" throughout these passages refers to Willemien Visser, the author of *Cognitive Artifacts of Designing*.

[4] IPL (information-processing language) was the first list-processing computer language.

5 qualified as “ill-defined” problems [...][5].

The architect Eastman (1969) was one of the first researchers to adopt the SIP framework for the analysis of design. He did so in what was at the time a particularly original study in the domain of empirical design research.

He analyzed a protocol collected in a laboratory study concerning an architectural problem. Even if the problem was rather simple, his protocol study constitutes a reference in the domains of empirical studies of design, on the one hand, and of ill-defined problems, on the other.

There are also many authors who globally adopt Simon’s framework, but propose more or less profound complements or modifications (Akin, 1986a, 1986b; Baykan, 1996; Goel, 1994; Goel & Pirolli, 1992; Hamel, 1995; Lebahar, 1983). Simon’s ideas continue to be *a dominant force within the field*, as noted by Roozenburg and Dorst (1999), who illustrate their claim by an analysis of the papers presented at the two first Design Thinking Research Symposia (DTRS) organized in Delft in 1992 and 1994 (Cross, Christiaans & Dorst, 1996; Cross, Dorst & Roozenburg, 1992). They observe that *Simon was referred to more than anyone else: 31 direct references and goodness knows how many indirect ones in 32 papers* (p. 34, Note 3).

An explanatory hypothesis, which we have detailed in an analysis of 15 empirical design studies (Visser, 1994), is that the adoption by cognitive design researchers of rather strict SIP positions may be due to their data collection having been carried out in a laboratory or otherwise restricted context. An example is Goel (1995, p. 114) who observes and describes a quite orderly organization of the design process in different, consecutive stages. It should be noticed, however, that he has developed an innovative view with respect to a fundamental issue in cognitive modeling, that is, the status of representations. He did so around the notion of “sketch” [...].

From the end of the 1970s on, authors from various disciplines – psychology, sociology, ethnology, and anthropology – have been proposing other paradigms to the cognitive study of design (Bucciarelli, 1984, 1988; Rittel, 1972/1984, 1973/1984; Schön, 1983, 1988, 1992).

5 Adopting a slightly different position than that of Simon, we consider a “problem” to be “ill-defined” (“ill-structured” for Simon, 1973/1984) when the three components that one classically distinguishes in a problem--its initial state, its final state and the operators for moving from one to the other--are not defined in an explicit and exhaustive manner. For a design “problem”, this means that, habitually, the specifications of the design project – its final state – specify the artifact at quite an abstract level, by its function and/or by certain constraints, while the initial state and the operators are almost always under-specified.

REFERENCES

AKIN, Ö. (1986a), "A formalism for problem restructuring and resolution in design", *Environment and Planning B: Planning and Design*. 13, p. 223-232.

AKIN, Ö. (1986b), *Psychology of architectural design*. London, Pion.

ANDERSON, J. R. (1976), *Language, memory, and thought*. Hillsdale, NJ, Lawrence Erlbaum Associates.

ANDERSON, J. R. (1983), *The architecture of cognition*. Cambridge, MA, Harvard University Press.

BAYKAN, C. A. (1996), “Design strategies”, in CROSS, N., CHRISTIAANS, H. et DORST, K. (dir.), *Analysing design activity*. Chichester, England, Wiley.

Bibliography of Herbert A. Simon: see references on http://www.psy.cmu.edu/psy/faculty/hsimon/hsimon.html (Retrieved September 30, 2010)

BRUNER, J. S., GOODNOW, J. J. et AUSTIN, G. A. (1956), *A study of thinking*. New York, Wiley.

BUCCIARELLI, L. (1984), “Reflective practice in engineering design”, in *Design Studies*, 5(3), p. 185–190.

BUCCIARELLI, L. (1988), “An ethnographic perspective on engineering design”, in *Design Studies*, 9(3), p. 159–168.

CAGAN, J., KOTOVSKY, K. et SIMON, H. A. (2001), “Scientific discovery and inventive engineering design: Cognitive and computational similarities”, In ANTONSSON, E.K. et CAGAN, J. (dir.), *Formal engineering design synthesis*. Cambridge, England, Cambridge University Press.

CARROLL, J. M. (2006), “Dimensions of participation in Simon’s design”, in *Design Issues*, 22(2), p. 3-18.

CROSS, N., CHRISTIAANS, H. et DORST, K. (dir., 1996), *Analysing design activity*. Chichester, England, Wiley.

CROSS, N., DORST, K. et ROOZENBURG, N. F. M. (dir., 1992), *Research in design thinking*, Delft, The Netherlands, Delft University Press.

DORST, K. (1997), *Describing design, A comparison of paradigms*, thèse de doctorat non publiée, Technische Universiteit Delft [University of Technology], Delft, The Netherlands.

EASTMAN, C. (1969), “Cognitive processes and ill-defined problems: A case study of design”, in WALKER, D. et NORTON, L. M. (dir.), *IJCAI’69, International Joint Conference on Artificial Intelligence*, San Mateo, CA, Kaufmann.

GOEL, V. (1995), *Sketches of thought*, Cambridge, MA, MIT Press.

GOEL, V. (1994), “A comparison of design and non-design problem spaces”, in *Artificial Intelligence in Engineering*, 9, p. 53-72.

GOEL, V. et PIROLLI, P, (1992), “The structure of design problem spaces”, in *Cognitive Science*, 16, p. 395-429.

GREENO, J. G. et MOORE, J. L. (1993), “Situativity and symbols: Response to Vera and Simon”, in *Cognitive Science*, 17(1), p. 49-60.

HAMEL, R. (1995), “Psychology and design research”, cf. http://www.designresearch.nl/PDF/DRN1995_Hamel.pdf.

KIM, J., JAVIER-LERCH, F. et SIMON, H. A. (1995), “Internal representation and rule development in object-oriented design”, in *ACM Transactions on Computer-Human Interaction*, 2(4, December), p. 357-390.

KLAHR, D. et SIMON, H. A. (2001), “What have psychologists (and others) discovered about the process of scientific discovery?”, in *Current Directions in Psychological Science*, June, 10(3), p. 75-79.

KULKARNI, D. et SIMON, H. A. (1988), “The processes of scientific discovery: The strategy of experimentation”, in *Cognitive Science*, 12, p. 139-175.

LANGLEY, P., SIMON, H. A., BRADSHAW, G. L. et ZYTKOW, J. M. (1987), *Scientific discovery, Computational explorations of the creative processes*, Cambridge, MA, MIT Press.

LE NY, J.-F. (1979), *La sémantique psychologique*, Paris, Presses Universitaires de France.

LE NY, J.-F. (1989a), “Questions ouvertes sur la localisation”, in *Intellectica*, 2(8), p. 61-84.

LE NY, J.-F. (1989b), *Science cognitive et compréhension du langage*, Paris, Presses Universitaires de France.

LEBAHAR, J. C. (1983*), Le dessin d'architecte, Simulation graphique et réduction d'incertitude*, Roquevaire, France, Éditions Parenthèses.

MILLER, G. A., GALANTER, E. et PRIBRAM, K. H. (1960), *Plans and the structure of behaviour*, New York, Holt.

NEWELL, A. et SIMON, H. A. (1972), *Human problem solving*, Englewood Cliffs, NJ, Prentice-Hall.

OKADA, T. et SIMON, H. A. (1997), "Collaborative discovery in a scientific domain", in *Cognitive Science*, 21(2), p. 109-146.

QIN, Y. et SIMON, H. A. (1990), "Laboratory replication of scientific discovery processes", in *Cognitive Science*, 14, p. 281-312.

REITMAN, W. (1965), *Cognition and thought*, New York, Wiley.

RITTEL, H. W. J. (1972/1984), "Second-generation design methods" (interview avec Donald P. Grant et Jean-Pierre Protzen), in CROSS, N. (dir.), *Developments in design methodology*, Chichester, England, Wiley.

RITTEL, H. W. J. et WEBBER, M. M. (1973/1984), "Planning problems are wicked problems", in CROSS, N. (dir.), *Developments in design methodology*, Chichester, England, Wiley.

ROOZENBURG, N. F. M. et DORST, K. (1999), "Describing design as a reflective practice: Observations on Schön's theory of practice", in FRANKENBERGER, E., BADKE-SCHAUB, P. et BIRKHOFER, H. (dir.), *Designers, The key to successful product development* (p. 29-41), London, Springer.

SCHÖN, D. A. (1983), *The reflective practitioner: How professionals think in action*, New York, Basic Books. (Reprinted in 1995)..

SCHÖN, D. A. (1988), "Designing: Rules, types and worlds", in *Design Studies*, 9(3), p. 181-190.

SCHÖN, D. A. (1992), "Designing as reflective conversation with the materials of a design situation", in *Knowledge-Based Systems*, 5(1), p. 3-14.

SIMON, H. A. (1969/1974), *La science des systèmes, Science de l'artificiel*, Paris, Epi.

SIMON, H. A. (1969/1996), *The sciences of the artificial* (3ème éd., 1996 ; 1ère éd., 1969 ; 2ème éd., 1981), Cambridge, MA, MIT Press.

SIMON, H. A. (1969/1996/2004), *Les sciences de l'artificiel*, Paris, Gallimard.

SIMON, H. A. (1971/1975), "Style in design", in EASTMAN, C. (dir.), *Spatial synthesis in computer-aided building design* (p. 287-309), London, Applied Science Publishers.

SIMON, H. A. (1973/1984), "The structure of ill-structured problems", in *Artificial Intelligence*, 4, p. 181-201 – aussi in CROSS, N (dir., 1984), *Developments in design methodology*, Chichester, England, Wiley.

SIMON, H. A. (1977a), *Models of discovery*, Boston, MA, Reidel.

SIMON, H. A. (1977b), "The next hundred years: Engineering design", in JONES, L. E. (dir.), *The next hundred years*, Toronto, University of Toronto, Faculty of Applied Science and Engineering.

SIMON, H. A. (1978), "Information-processing theory of human problem solving", in ESTES, W. K. (dir.), *Handbook of learning and cognitive processes* (Vol. V, «Human information processing »), Hillsdale, NJ, Lawrence Erlbaum Associates.

SIMON, H. A. (1980), "Technology: Source of opportunity and constraint in design", *in College of Design, Architecture, and Art Journal*, 1, p. 26-33.

SIMON, H. A. (1987/1995), "Problem forming, problem finding, and problem solving in design", in COLLEN, A. et GASPARSKI, W. W. (dir.), *Design and systems: General applications of methodology* (Vol. 3), New Brunswick, NJ, Transaction Publishers

SIMON, H. A. (1992a), "Scientific discovery as problem solving", in *International Studies in the Philosophy of Science*, 6, p. 3-14.

SIMON, H. A. (1992b), "Scientific discovery as problem solving: Reply to critics", *in International Studies in the Philosophy of Science*, 6, p. 69-88.

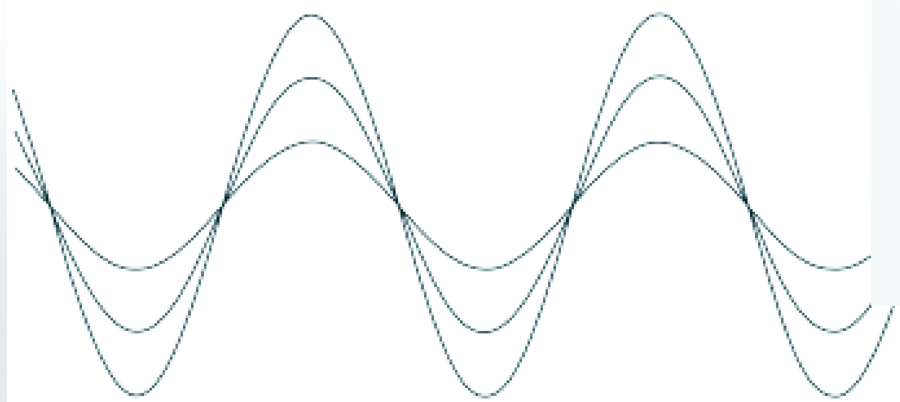
SIMON, H. A. (1997), "Integrated design and process technology", in *Journal of Integrated Design and Process Science*, 1(1), p. 9-16.

SIMON, H. A. (2001), "Seek and ye shall find. How curiosity engenders discovery", in CROWLEY, K. D., SCHUNN, C. D. et OKADA, T. (dir.), *Designing for science: Implications from everyday classroom, and professional settings*, Mahwah, NJ, Lawrence Erlbaum Associates.

VERA, A. H. et SIMON, H. A. (1993), "Situated action: A symbolic interpretation", in *Cognitive Science*, 17(1), p. 7-48.

VISSER, W. (1994), "Organisation of design activities: Opportunistic, with hierarchical episodes", in *Interacting with Computers*, 6(3), p. 239-274.

VISSER, W. (2006), *The cognitive artifacts of designing*, Mahwah, NJ, Lawrence Erlbaum.



Karin Schneider

"...My Aural Vision!"

"The 20th century was strongly affected by visual design approaches. So what might be next?
Did we allready stretch the visual boundaries to the limit? Why didn´t we pay as much attention to other sensations? Are we not meant to judge our surroundings with the help of all our senses?

At which level do we already do that unconsciously? Fashion is all about communication... why do we think so much more about our look then the personal sound message we are creating while wearing our cloth?

Who questions the sound of an outfit? If it suits us in our current situation or if we like it at all?
What separates sound from all the other sensations? For me it is it´s dynamic... sound is allways in motion, cessation means silence, sound is an ever dynamic sensation in speed space and time."

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Schön: Design as Reflective Practice

WILLEMIEN VISSER

Abstract

In this paper, we present Schön's approach to design, as we have described it in *The Cognitive Artifacts of Designing* (2006): Schön is (if one excepts the design theorist Rittel) the first author after Simon to introduce a new approach to cognitive design theory. Schön formulated his view on design in terms of "reflective activity" and related notions, especially "reflective practice", "reflection-in-action", and "knowing-in-action"; we interpret the underlying activities as forms of what situativity authors have qualified as "situated action" and "situated cognition". In "reflection-in-action", doing and thinking are complementary. Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other (Schön, 1983, p. 280). Reflection-in-action is the reflective form of knowing-in-action: It is Schön's assumption that competent practitioners usually know more than they can say: this illu-strates the classical, generally applicable difference between "knowing how" and "knowing that". For Schön, design was one of a series of activities in domains that involve reflective practice: City planning, engineering, management, and law, but also education, psychotherapy, and medicine. And, as he says it, the designer constructs the design world within

which he/she sets the dimensions of his/her problem space, and invents the moves by which he/she attempts to find solutions.

Schön: Design as a Reflective Practice

WILLEMIEN VISSER

This second chapter presents Schön's approach
1 to design[1].

Except for Rittel, Schön is, as far as we know, the first author after Simon to introduce a new approach to cognitive design theory. Another author of early SIT-in-
2 spired[2] research is Bucciarelli, who has focused, in particular, on collaborative design analyzed from a social perspective.

Schön formulated his view on design in terms of "reflective activity" and related notions, especially "reflective practice", "reflection-in-action", and "knowing-in-action". We interpret the underlying activities as forms of what situativity authors have qualified as "situated action" and "situated cognition".

"Reflective activity" may be defined as the *activity by which* [people] *take work itself as an object of reflection* (Falzon *et al.*, 1997, quoted in Mollo & Falzon, 2004, p. 532). Schön (1983) writes:

When a practitioner reflects in and on his practice, the possible objects of his reflection are as varied as the kinds of phenomena before him and the systems of knowing-in-practice which he brings to them. He may reflect on the tacit norms and appreciations which underlie a judgement, or on the strategies and theories implicit in a pattern of behaviour. He may reflect on the feeling for a situation which has led him to adopt a particular course of action, on the way in which he has framed the problem he is trying to solve, or on the role he has constructed for himself within a larger institutional context (1983, p. 62).

In "reflection-in-action", *doing and thinking are complementary. Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other* (Schön, 1983, p. 280).

In a presentation of "Donald Alan Schön (1930–1997)" in *The Encyclopedia of Informal Education*, M. K. Smith (2001) writes that, even if Schön was *trained as a philosopher, [...] it was his concern with the development of reflective practice and learning systems within organizations and communities for which he is remembered*. In design circles, one generally refers to Schön as the author who, through his proposal of the reflective-practice concept, offered an alternative to the SIP approach defended by Simon in *Sciences of the Artificial* (Simon, 1969/1996).

Schön's research and thoughts on design thus originate from an educational perspective. Schön was an educator. He was Ford Professor Emeritus on Urban Studies and Education, and Senior Lecturer in the Departments of Urban Studies and Planning, and Architecture, at the Massachusetts Institute of Technology, from the early 1970s until his death in 1997 (Pakman, 2000, p. 5). Schön's enterprise is concerned with the way in which *professionals think in action* as *reflective practitioners* (Schön, 1983), and with "educating" this reflective practitioner (Schön, 1987a, 1987b).

Relative to the contrast between the "reflection-in-action" that underlies reflective practice, and "school knowledge" (1987a), Schön does not see himself *as saying anything really new at all*. He is drawing on *a tradition of reform and criticism which begins with Rousseau and goes on to Pestilotsy and Tolstoy and Dewey and then, as we approach more contemporary times, Alfred Schultz and Lev Vygotsky and Kurt Lewin, Piaget, Wittgenstein and David Hawkins today* (1987a). It is Dewey who introduced the concept of *reflective conversation with the situation* that is the locus of reflection-in-action (see the title of Schön's famous paper "Designing as reflective conversation with the materials of a design situation", 1992).

According to Schön (1987a), reflection-in-action is the *kind of artistry that good teachers in their everyday work often display*, whereas school knowledge refers to a "molecular" idea of knowledge, to *the view that what we know is a product*, and that *the more general and the more theoretical the knowledge, the higher it is*. From the school-knowledge perspective, *it is the business of kids to get it, and of the teachers to see that they get it.*

Reflection-in-action is the reflective form of knowing-in-action. It is Schön's assumption at the start of his famous 1983 book, *The Reflective Practitioner*, that competent practitioners usually know more than they can say.

They exhibit a kind of knowing in practice, most of which is tacit. [...] Indeed, practitioners themselves often reveal a capacity for reflection on their intuitive knowing in the midst of action and sometimes use this capacity to cope with the unique, uncertain, and conflicted situations of practice (1983, pp. 8-9).

In order to show the nature of knowing-in-action, Schön (1987a) uses the example of what happens *if you are riding a bicycle, and you begin to fall to the left*. People who *know* riding a bicycle will do the right thing when *in situ*, but will often give the wrong answer when asked certain questions, in a classroom or anywhere else, outside of a bike-riding situation.

An example of such a question out of context, might be: *If you are riding a bicycle, and you begin to fall to the left, then in order not to fall you must turn your wheel to the ___?*. This contrast between *[doing] the right thing when* in situ and being unable to answer correctly when not, requires an explanation.

This capacity to do the right thing [...] exhibiting the more that we know in what we do by the way in which we do it, is what we mean by knowing-in-action. *And this capacity to respond to surprise through improvisation on the spot is what we mean by reflection-in-action. When a teacher turns her attention to giving kids reason to listening what they say, then teaching itself becomes a form of reflection-in action, and we think this formulation helps to describe what it is that constitutes teaching.*

Even if not taken from a professional situation, this example illustrates the classical, generally applicable difference between "knowing how" and "knowing that" (Ryle, 1949/1973, pp. 28-40 and passim).

For Schön, design was one of a series of activities in domains that involve reflective practice: City planning, engineering, management, and law, but also education, psychotherapy, and medicine. Architectural design was the first professional domain studied by Schön in order to develop his epistemology of professional practice based on the concepts of reflection-in-action and knowledge-in-action. In his 1983 book, Schön has *collected a sample of vignettes of practice, concentrating on episodes in which a senior practitioner tries to help a junior one learn to do something.* [...] *The heart of this study is an analysis of the distinctive structure of reflection-in-action* (pp. 8-9). Indeed, the characteristics of design that Schön presented as general were displayed in the communicative context that he used to collect his observations, that is, educational situations. Focusing on the education of reflective practitioners in the domain of design, Schön's studies examined design students learning with experienced designers (Schön, 1992; Schön & Wiggins, 1992). These studies have been conducted in *reflective practicums such as the design studio in architecture* (Schön, 1987a).

Adopting ethnographically-inspired or workplace-oriented perspectives (Nilsson, 2005) in his analysis of particular educational design projects, Schön (1983) discusses specific situations in detail, in order to reveal the central role of reflection-in-action in professionals' practice. In their reflective conversations with design situations, designers "frame" and "reframe" problems. In such conversations, *the practitioner's effort to solve the reframed problem yields new discoveries which call for new reflection-in-action. The process spirals through stages of appreciation, action, and reappreciation. The unique and uncertain situation comes to be understood through the attempt to change it* (Schön, 1983). *Furthermore, the practitioners' moves also produce unintended changes which give the situation new meanings. The situation talks back, the practitioner listens, and as he appreciates what he hears, he reframes the situation once again* (Schön, 1983, p. 131-132).

In one of his first papers handling specifically with design (1988), Schön announces that, *in this paper*, [he] *will treat designing not primarily as a form of "problem solving", "information processing", or "search"* (p. 182).

Problem solving is generally considered as handling problems as "given", whereas the process of "problem setting" is neglected. Starting with problems as "given", matters of *choice or decision are solved through the selection, from available means, of the one best suited to established ends. But with this emphasis on problem solving, we ignore problem setting, the process by which we define the decision to be made, the ends to be achieved, and the means that may be chosen. In real-world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling, and uncertain* (1983, pp. 39-40). *Problem setting is a process in*

1 This paper is entirely composed by quotes from our book *The Cognitive Artifacts of Designing* (2006), Hillsdale, NJ, USA, Lawrence Erlbaum Associates.

2 "SIT" is the abbreviation of "situativity", an approach to action, which is not only cognitive (Greeno & Moore, 1993) and which Schön adopted in his analysis of design in terms of "reflective practice".

which, interactively, we name *the things to which we will attend and* frame *the context in which we will attend to them* (Schön, 1983, p. 40, the emphasis is ours).

Naming, framing, moving, and evaluating are central in Schön's view of design. As we see later, one of the advances of current SIT-inspired research is the operationalization of these and other notions that are central in reflective practice. For Schön, his observations and his approach to these observations *should be contrasted with the familiar image of designing as "search within a problem space".* [...] *The designer* constructs *the design world within which he/she sets the dimensions of his/her problem space, and invents the moves by which he/she attempts to find solutions* (Schön, 1992, p. 11).

An example of problem setting in architectural design is the following. Problem setting occurs when architects see the project on which they work in a new way: for example, they see a T-form figure as two L-form figures back to back.

Another design characteristic, introduced through an example from architectural design, is the "seeing-moving-seeing" sequence, which is applied iteratively on "design snippets" (Schön & Wiggins, 1992). It consists of action sequences such as observing a drawing, transforming it, and, observing the result, discover *certain unintended consequences* of the transformation move (p. 139). Architects may indeed have a certain intention in transforming a drawing, but they are generally unaware of all possible consequences of their actions. Their intention is liable to evolve in their conversation with the drawing. Referring to Simon, Schön notices that it is because of our *limited awareness* and our *limited ability to manage complexity* that designing has this *conversational structure of seeing-moving-seeing* (Schön & Wiggins, 1992, p. 143). Schön and Wiggins refer several times to *Sciences of the Artificial*, in which Simon introduced his idea of human limited information-processing capacity into the theory of designing. They emphasize, for example, that people, therefore, *cannot, in advance of making a particular move, consider all the consequences and qualities* [they] *may eventually consider relevant to its evaluation* (Schön & Wiggins, 1992, p. 143).

Schön thus notices *the remarkable ability of humans to recognize more in the consequences of their moves than they have expected or described ahead of time* (Schön, 1992, p. 7). As pointed out long ago by the urban designer Christopher Alexander, who is also quoted by Schön, *our ability to recognize qualities of a spatial configuration does not depend on our being able to give a symbolic description of the rules on the basis of which we recognize them* (Schön, 1992, p. 137). Analogously, and as noticed by Christopher Alexander as well, even if designers are able to make, tacitly, "qualitative judgments", they are not necessarily able to state, that is, to make explicit, the criteria on which they base them (Schön, 1992, p. 138).

This observation once again refers to the knowing-in-action as distinguished from reflection-in-action.

REFERENCES

GOLDSCHMIDT, G. (1991), "The dialectics of sketching", in *Creativity Research Journal*, 4(2), 123-143.

GREENO, J. G. & MOORE, J. L (1993), "Situativity and symbols: Response to Vera and Simon", *in Cognitive Science*, 17(1), 49–60.

MOLLO, V. & FALZON, P. (2004), "Auto- and allo-confrontation as tools for reflective activities", in *Applied Ergonomics*, 35(6), 531–540.

PAKMAN, M. (2000), "Thematic foreword: Reflective practices: The legacy of Donald Schön", in *Cybernetics and Human Knowing*, 7(2-3), 5-8.

RYLE, G. (1949/1973), *The concept of mind*. Harmondsworth, England: Penguin (First published by Hutchinson, 1949).

SCHÖN, D. A. (1983), *The reflective practitioner: How professionals think in action*. New York: Basic Books. (Reprinted in 1995).

SCHÖN, D. A. (1987a), *Educating the reflective practicioner*. Washington, DC.: American Educational Research Association.

SCHÖN, D. A. (1987b), *Educating the reflective practicioner*. San Francisco: Jossey-Bass.

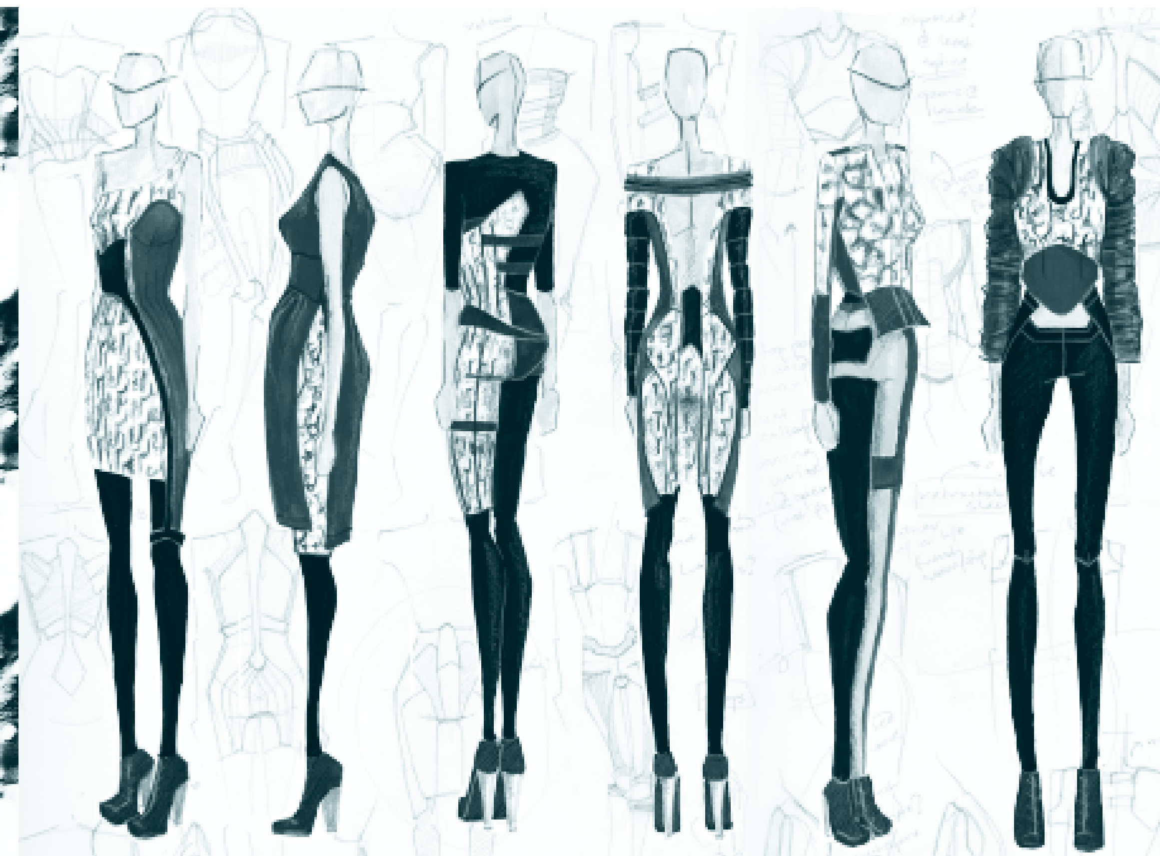
SCHÖN, D. A. (1988), "Designing: Rules, types and worlds", in *Design Studies*, 9(3), 181-190.

SCHÖN, D. A. (1992), "Designing as reflective conversation with the materials of a design situation", in *Knowledge-Based Systems*, 5(1), 3-14.

SCHÖN, D. A. & WIGGINS, G. (1992), "Kinds of seeing and their functions in designing", in *Design Studies*, 13(2), 135-156.

SIMON, H. A. (1969/1996), *The sciences of the artificial* (3rd, rev. ed. 1996; Orig. ed. 1969; 2nd, rev. ed. 1981) (3 ed.). Cambridge, MA: MIT Press.

SMITH, M. K. (2001, July), "donald schon (schön): learning, reflection and change". Retrieved September 30, 2010, from http://www.infed.org/thinkers/et-schon.htm



Juliane de la Torre

"Fashion for space aventure"

Humans have not been to the Moon since the Apollo missions of the 1970s; preoccupied with building and maintaining the International Space Station, astronauts never voyaged further into the solar system. Now, NASA is attempting to change that by building new rockets and training new astronauts. Their goal: human space flight to Mars. But with this new objective comes a host of new unknowns. As I delved further into the implications of human travel to Mars, I was most intrigued by the effects and damage that zero gravity and long term isolation will have on the body. A successful research excursion to Mars would last around 36 months; no astronaut has lived in space even for a whole year. With such a sustained lack of gravity will most likely come a severe decrease in bone density. The spine will lengthen and bow, muscles will weaken, and the skeleton - no longer necessary - will become too weak for life on Earth. Keeping this in mind, I designed the collection for a new type of body, one that has survived a 36 month round trip to Mars, but just barely, a body with a new silhouette that needs exoskeletal support. In order to simulate this silhouette, I fabricated a fiber glass cast of my own body drastically hunched over, draped a simple bodice on the cast and then applied it to a standard fashion dress form. Mixing the new bodice with elements from medical corsets and back braces, I created new garments for a future reality.

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Visser: Design as Construction of Representations

WILLEMIEN VISSER

Abstract

In this chapter, we present our own approach to design, as we have described it in The Cognitive Artifacts of Designing: from a cognitive viewpoint, designing is constructing representations.

What is this link between design and representations? Designing consists in specifying an artifact, for example a machine tool – not in its implementation, its fabrication in the workshop. The result of design is a representation: the specifications of the machine tool. These representations are also artifacts, that is, entities created by people – they are "man-made as opposed to natural" (Simon, 1969/1996). Artifacts may be physical (machine tools, buildings, cars, or garments) or symbolic (software, social welfare policies, route plans, or any procedure); they may be internal (mental representations) or external (drawings, mock-ups). The term thus pertains not only to material objects. The antonym of an "artifact" is a "natural" – not an "immaterial" entity.

After a presentation of our definition of design, this chapter presents three types of activities designers perform on representations, namely generation, transformation, and evaluation. In special subsections, we review the use of knowledge in design, and how collaborative design

proceeds through interaction. In the last two divisions of this section, we discuss activities that are specific to collaborative design.

Visser: Design as Construction of Representations

WILLEMIEN VISSER

In this chapter, we present our own approach to design, as we have described it in *The Cognitive*
1 *Artifacts of Designing* (Visser, 2006)[1].

Definition of Design

Definitions are representations: They focus on *aspects of the object they aim to cover – even if their authors imagine that their focus is the object's essence*. In our following review of definitions, we restrict ourselves to cognitive aspects of design.

Even considered from such a perspective, the characteristics of design that are selected as essential may still differ. Our focus on the activity of design further orients our view. Definitions may thus focus on characteristics whose relevance we do not deny, but that do not inform us about cognitive aspects of designing. An example is the definition by Moran and Carroll (1996): *The primary goal of design is to give shape to an artifact – the product of design. The artifact is the result of a complex of activities – the design process* (p. 1).

Many definitions of design focus on the result of the activity, that is, the artifact product, ignoring the nature of the activity. In their *wording*, they may use references to actions, such as "specifying", "defining", or "creating", but not detail any activity in developments of the definition. Another characterization by Moran and Carroll (1996, p. 13) considers design as *the process of creating tangible artifacts to meet intangible human needs* (p. 2), to which the authors add, *creating and constructing* are *the defining acts of design*. There are authors, such as Stacey and Eckert (2003, p. 164), who view designing as "modeling". Both are positions close to ours, but they present no further specification of the cognitive aspects of the activity. Other authors, often from AI-related communities, consider design as a constraint-satisfaction activity, but propose methods without any cognitive underpinnings (see Darses, 1990, for a cognitive-psychology discussion of this approach).

Designers are not to produce the artifact product, but its specifications. We consider essential to distinguish between these specifications and the artifact product itself. A group of definitions seems to neglect this difference. They qualify design, for example, as *the creation of artifacts that are used to achieve some goal* (Mayall, 1979, in his *Principles in Design*, referred to in Atwood, McCain & Williams, 2002).

For authors focusing on the specifications, design consists of producing plans or descriptions, or still other forms of representations of the artifact product (Archer, 1965/1984; Brown & Chandrasekaran, 1989; De Vries, 1994; Hoc, 1988; Jeffries, Turner, Polson, & Atwood, 1981; Kitchenham & Carn, 1990; Schön, 1988; Whitefield, 1989). Applied to software design, for example, this means that design leads to a plan that allows transformation of these specifications into executable code (Jeffries *et al.*, 1981; Kitchenham & Carn, 1990). Many empirical studies of "software *design*" focus, however, on elaboration of executable code – that is, coding – rather than design.

According to most definitions, the artifact product has to meet certain requirements, that is, accomplish certain functions, fulfill certain needs, satisfy certain constraints, allow attaining certain objectives, and possess certain characteristics. Designing is thus usually defined – even if implicitly – as a goal-oriented activity – even if this goal is not fixed, or preestablished.

After a presentation of our definition of design, this chapter presents three types of activities designers perform on representations. We review the use of knowledge in design, and how collaborative design proceeds through interaction. In the last two divisions, we discuss activities that are specific to collaborative design.

Our Definition of Design

Globally characterized, from our viewpoint, design consists in specifying an artifact (the artifact product), *given requirements* that indicate – generally neither explicitly, nor completely – one or more functions to be fulfilled, and needs and goals to be satisfied by the artifact, under certain conditions (expressed by constraints). At a cognitive level, this specification activity consists of constructing (generating, transforming, and evaluating) representations of the artifact *until they are so precise, concrete, and detailed* that the resulting representations – the "specifications" – specify explicitly and completely the implementation of the artifact product. This construction is iterative: many intermediate representations are generated, transformed, and evaluated, prior to delivery of the specifications that constitute the final design representation of the artifact product together with its implementation. The difference between the final and the intermediate artifacts (representations) is a question of degree of specification, completeness, and abstraction (concretization and precision). A similar view is expressed by Goel (1995), who writes: Design, at some very abstract level, is the process of transforming one set of representations (the design brief) into another set of representations (the contract documents) (p. 128).

Our focus on the activity and the intermediate representational structures should not lead to forgetting the central role of both the requirements as source and the implementable specifications as goal, that together steer both activity and representations. There are other activities that construct representations (especially, the interpretation of semiotic expressions), but due to their having other types of inputs and outputs than design, the underlying activities differ as well (cf. Hayes-Roth, Hayes-Roth, Rosenschein, & Cammarata, 1979, August's distinction between generation and interpretation problems [...]).

In our core definition, we qualify design as *construction*, rather than transformation of representations, because "transformation" may convey the connotation of the representations to be transformed, being *given* [...]. "Construction" is more general: [...] It involves both generation and transformation activities (and it also requires evaluation).

Design Representation Construction Activities

Many recent studies concern representational structures in design, especially external representations, but the cognitive activities and operations involved in their construction and use have not been the object of much research. Publications mention activities such as "transformation", "(re)interpretation", and "restructuring and combining". Generally, they describe the results that are obtained, but rarely make explicit the underlying cognitive activities or operations.

We distinguish three types of activities on representations, namely generation, transformation, and evaluation. These activities, their underlying operations, and related activities and operations are discussed below. In special subsections, we review the use of knowledge in design, and specific aspects of collaborative design.

Problem Representation, Solution Generation, and Solution Evaluation: Three Stages in Design as Problem Solving

From a problem solving perspective, design has often been described as proceeding through three stages, namely construction of problem representations, solution generation, and solution evaluation. A related, less high-level model sees these stages occurring in iterative cycles that, progressively, lead from the abstract, globally specified problem to its concrete, detailed implementable solution. None of these two models renders the *actual* design activity. The three stages correspond nevertheless to fundamental design activities, which are completely intertwined – and not at all consecutive, as stages are supposed to be.

The perspective we have adopted, namely to consider design as the construction of representations rather than as problem solving, leads us to consider these three activities as construction of representations, even if they may involve different types of input and output representations.

Using Knowledge in Design

Knowledge is a central resource in the construction and use of representations. The importance of knowledge holds for most professional domains, but it is of course particularly critical in an activity that essentially consists in representational activities. Design requires general, abstract knowledge and weak, generally applicable methods, but designers also need domain-specific knowledge and the corresponding strong, knowledge intensive methods. We suppose that satisficing, for example, requires more domain-specific knowledge than does optimizing. This also holds for the exercise of creativity, which is so important in design. In addition, knowledge is a key element in the exercise of analogical reasoning – which may, in turn, be related to design creativity (but see Visser, 1996).

[...] In the presentation of the SIP approach, [references to the role of knowledge] were very general, because this problem solving view insists mainly on generic knowledge and weak methods. In the SIP approach to problem solving,

[1] This paper is entirely composed by quotes from our book *The Cognitive Artifacts of Designing* (2006), Hillsdale, NJ, USA, Lawrence Erlbaum Associates.

one searches for solutions in the "problem space", going *from one knowledge state to another, until the current knowledge state includes the problem solution* (Simon, 1978, p. 276). [...]

In our presentation of the SIT view, knowledge did not play an important role neither, but for different, nearly opposite, reasons. SIT-inspired researchers have identified and described in detail much domain-specific knowledge. They insist on the role of "knowledge-in-action" – which they oppose to school knowledge, whose role is of course not denied, but ignored in their research. SIT-inspired studies have provided us with extremely rich descriptions of situations that were often so unique that presentation of the knowledge identified would have been rather anecdotal. One may notice that it is undeniably difficult to find a level of description of interest to many different people (researchers, practitioners, students, general public), with different backgrounds and interest in different domains. Furthermore, SIT-inspired researchers emphasize that there is more to design – and other professional practice – than knowledge (cf. Bucciarelli, 1988).

[...]

Yet, without knowledge, no representation! Knowledge is necessary – but of course not sufficient – for the construction of representations. Without knowledge, no interpretation, thus neither the possibility to look at a project in a way different from one's colleagues, nor that of seeing things differently than one did during a previous project! The operative and goal-oriented character of representation results from an interaction between one's knowledge and experience, and the situation one is in.

Nonalgorithmic activities – necessary in, for example, creativity, satisficing, (re)interpretation, and qualitative simulation – require knowledge. In order to proceed to complex calculations, a designer, of course, also needs knowledge, but of a sort that can be learned in school. The knowledge that is very important in design is not gained through formal education, but through experience. Designers may acquire such knowledge because of their work on many different types of projects, and their interaction with colleagues who have other specialties (see Falzon & Visser, 1989).

Knowledge determines if a design task constitutes a problem for someone. Working with ill-defined problem data is only possible if one has specific knowledge (in addition to generic knowledge, of course).

Furthermore, knowledge is a critical resource underlying most strategies. If simulation via representations works, it is thanks to one's knowledge. Reuse is, by definition, impossible without knowledge (it is not a components library that makes knowledge superfluous). Handling constraints (especially constructed constraints) would be hard without it.

The domains from which this knowledge comes are not only the application domain and that of design methods, but also the underlying technical and theoretical domains (mathematics, science, engineering) – and even nontechnical domains. In our carrying/fastening device study (Visser, 1995), we showed the importance of commonsense knowledge (in the design project examined, this was the knowledge of cycling). Additionally, designers, one may hope, also draw on ergonomics and knowledge of social, political, economic, and legal aspects of the artifact and its use. As designers generally are not expert in all these different domains, the need of design projects for wide-ranging knowledge requires collaboration between professionals from various domains-and users.

With respect to knowledge of different abstraction levels, designers of course use much generic, abstract knowledge (first principles, general-purpose knowledge, weak methods). However, the reuse of specific knowledge related to particular past design projects plays an essential role in design (Visser, 1995). In our carrying/fastening device study (Visser, 1995), we observed how the knowledge of cycling is not theoretical, school knowledge, but the result of personal experience in cycling, with or without a backpack, on a mountain bike or other bicycle. We showed how this episodic knowledge (Tulving, 1972, 1983) grounded in personal experience may be used in various ways (both in the construction of representations used for the generation of solution ideas, and in the evaluation of solution proposals). In this study, we also showed the importance of human informants besides non-human information sources. We observed how designers often use colleagues as informants – and how colleagues present themselves as such without being requested explicitly (Berlin, 1993; Visser, 1993).

These are only a few examples, mentioned in order to indicate the importance of knowledge in design.

Expertise and knowledge. [...] There are at least three types of research on expertise. The comparison between experts and novices in a domain, that is, studies on *levels* of expertise, is the classical paradigm in studies on interindividual differences in this domain (Chi, Glaser, & Farr, 1988; Cross, 2004a, 2004b; Glaser, 1986; Glaser & Chi, 1988; Reimann & Chi, 1989). Experts have also been studied in clinical studies, leading researchers to identify particular characteristics of particular experts (Cross, 2001, 2002).

We have proposed to distinguish also different *types* of expertise (Falzon & Visser, 1989; see also Visser & Morais, 1991). We analyzed how experts in the same domain may exhibit different types of knowledge, and observed that this knowledge is also organized differently between the experts. We attributed these differences to different task experience (workshop vs. laboratory in the context of the aerospace industry). Our analysis of previous studies by colleagues who compared experts showed, in addition to the role of one's task, the importance of the representation that one constructs of one's task. The comparison between the two experts examined led us to qualify the knowledge of one expert's as "operative" and that of the other as "general". *The two experts differ in the same way as a teacher differs from a practitioner, in the same way as an epistemic subject differs from an operative subject* (Falzon & Visser, 1989; see also Visser & Morais, 1991).

Generation and Transformation of Representations

[...]

Generation. A representation is never generated "out of nothing" (*ex nihilo*, from scratch). We consider it difficult, if not impossible, to decide if an idea or drawing (or other representation) is "new." In accordance with Goel [...] we consider that design always consists in *transformation* of representations. We qualify the construction of representations as "generation" [...] if its *main* source is one's memory – something that will be difficult to observe for an external observer. We insist on "main", because memory will never be the only source. By definition, the state of a design project (requirements and their follow-up included) will influence a designer. In addition to this influence, there will be other contributions "from the outside world".

Designers will interpret the input to a design project, that is, the requirements and other data that they receive or collect (e.g., reference documents, similar artifacts), in order to generate a first representation – which may consist of an ensemble of representations: for example, one or more related mental and external representations.

Generation may be implemented by different types of processes and operations: From the "simple" evocation of knowledge from memory to the elaboration of "new" representations out of mnesic knowledge entities without a clear link to the current task (e.g., through analogical reasoning and other nondeterministic leaps; Visser, 1991).

[...]

The distinction between generation by evocation and by elaboration of course does not correspond to a clear-cut opposition, but is an analytical distinction that refers to a continuous dimension. Elaboration of a representation always uses mnesic entities, which will have been evoked from memory [...]. We have illustrated this idea elsewhere by observations from our composite-structure design study (Visser, 1991).

Schema instantiation is a form of knowledge evocation that has received much attention in software-design studies. Schemata have indeed been the main framework for the analysis of knowledge representation in cognitive software design research (Détienne, 2002).

Generation of representations may use operations and other activities, such as information gathering.

Transformation. We propose to distinguish transformation activities according to the type of transformation between input representation rx and output representation ry, through intermediary representations ri. We distinguish the following forms. Transformation activities may

- *duplicate* (Goel, 1995), that is, replicate or reformulate ri.

- *add,* that is, introduce new information or "small alterations" (Van der Lugt, 2002) into ri.

- *detail,* that is, break up ri into components ri1 to rin.

- *concretize*, that is, transform ri into ri' which represents ri from a more concrete perspective.

- *modify*, that is, transform ri into another version ri', neither detailing, nor concretizing it.

- *revolutionize* (Visser, 2009), that is, replace ri by an alternative representation rj, neither detailing, nor concretizing it (corresponding to Van der Lugt, 2002's "tangential transformations", i.e. "wild leaps into a different direction").

[...] We consider that both transformations into different versions (through modifying) and into alternative representations (through revolutionizing) constitute "lateral" transformations. [...]

Many activities play a more or less direct role in these different types of transformation. Some examples (varying between operations and activities) are interpretation, association, brainstorming, reinterpretation, confrontation, articulation, integration, analysis, exploration, inference, restructuring, combining, drawing (sketching, drafting, and other forms), hypothesizing, and jus-
3 tifying. In this book[3], we comment on only some of them.

[...]

Even if it is too simplistic to qualify "analysis" as a first design "stage", analyzing indeed corresponds to a central activity in the initial phases of a design project. Constraints analysis is essential to disambiguate design requirements. Analyzing the current design state may be a way to introduce detail or concreteness in the project. "Analysis" has, however, a logical undertone, which causes that it can certainly not be the only – or even the main – activity in the initial design phases. Other, more nonalgorithmic activities will also be required, such as interpretation, association, brainstorming, and exploration.

Analogical reasoning occurs in all three representational activities. We have mentioned it in different contexts: as a factor of opportunism, in creativity-requiring activities, as a way to tackle ill-defined problems by interpreting them, and as a possible form to generate "interesting" design ideas. It is also the reasoning form that underlies reuse, which plays an important role in design.

We observed its role in different studies, several examples of which have been presented in this book. [...] We described analogical reasoning used by the mechanical-design engineer in our functional-specification study [...]. Using analogies, he took advantage of representations that he was constructing and using for his current design actions, to design analogically related design objects. A completely different use of analogy has been observed in the composite-structure aerospace design study [...]. There, the designer especially employed analogical reasoning in the conceptual-design stage. When elaborating conceptual solutions to design problems, he and his colleagues frequently were observed to be reminded of extradesign domain objects that implemented concepts (principles, mechanisms) that they judged potentially useful for development of a solution to the current design problem. The following example (from Visser, 1996) illustrates this use of analogy that we analyzed as contributing to the innovative character of the design project (other examples are presented in Visser, 1991).

Example. When the composite-structure designer and his colleagues are developing, in a discussion, "unfurling principles" for antennas, they come up with ideas such as an "umbrella" and other "folding" objects. They proposed, for example, a "folding photo screen", a "folding butterfly net", and a "folding sun hat", all related to the target by analogical relationships.

Different forms of inference are of course also used in design. Induction is used much more frequently than deduction. Goel (1995) identifies only 1.3% "(overt) deductive inferences" in his observations. In our composite-structure design study, neither did we notice any overt form of deduction.

The articulation, combination, and integration of representations play a particular role in collaborative design. So do inform, comment, and request. Such activities are discussed in the subsection *Construction of Interdesigner Compatible Representations*.

Restructuring and combining representations are often mentioned as components of the creative process (Verstijnen, Heylighen, Wagemans, & Neuckermans, 2001; Verstijnen, van Leeuwen, Goldschmidt, Hamel, & Hennessey, 1998). Verstijnen *et al*. show that restructuring and combining are two separate constituents of creativity that function differently. In distinct ways, each can lead designers to introduce new information in the current design representation – something that is useful in generation and transformation of representations.

Restructuring is qualified by the authors as *getting free from an original conception* (1998, p. 545). Verstijnen *et al*. claim that "mental imagery" operations (i.e., operations on mental images) may lead to discovery of new ideas – but only under certain conditions. Some operations cannot be performed *within mental imagery alone* and other operations *are much easier to perform externally* (p. 522).

It is difficult to restructure completely mentally an existing external representation (i.e., a drawing, in Verstijnen *et al.*'s experimental studies) – for novices, it is even impossible. It is facilitated if one is allowed or encouraged to sketch – but this facilitation only holds for experienced designers. However, combining (synthesizing) parts of a representation can be performed mentally by only using mental imagery. In that case, *no additional value is obtained from sketching* (Verstijnen *et al.*, 1998, p. 535). One may indeed suppose that the two operations – restructuring and combining – impose different loads on mental processing.

Yet, inventors (such as Kekulé, an example presented by Verstijnen *et al.*) seem to be able to restructure exclusively "in their head". Verstijnen *et al.* (1998, p. 546) formulate the interesting hypothesis that *extraordinarily creative individuals* may be able to *construct analogies within imagery, for which others, in more mundane cases, require a sketch* (1998, p. 546). Indeed, what an external representation such as a sketch allows a person is to restructure their image (i.e., an internal representation) in analogy to that external representation. This inspires in Verstijnen *et al.* (2001, p. 1) the idea that *with no paper available or no expertise to use it, analogies can be used to support the creative process instead of sketches* (2001, p. 1) – but perhaps only in "extraordinarily creative individuals" (the addition is ours).

As tools for reinterpretation, activities such as restructuring and combining may thus be used to come up with new ideas. Drawing (i.e., sketching, drafting, and other forms of drawing) may also be a tool for other activities. Besides restructuring, it may serve, for example, analysis, and simulation. It may also fulfill interactional functions, such as informing or explaining. It can even have several functions simultaneously: For example, simulation, explanation, and storing. The relatively unstructured, fluid, and imprecise drawings that sketches are, may give access to knowledge not yet retrieved and may evoke new ways of seeing [...]. Unforeseen views on the design project in progress are supposed to open up unanticipated potentialities for new aspects or even completely new directions.

Evaluation of Representations

According to design methodologies, the generation and evaluation of solutions are two different stages in a design project. Many empirical studies have shown, however, that designers intertwine the two. The participants in the technical review meetings that we studied (D'Astous, Détienne, Visser & Robillard, 2004) were supposed to follow a particular method in which design was not supposed to occur. They came up, however, with alternative solutions; that is, not only were they recording the underlying negative evaluations, but they also proceeded to design.

Evaluating an entity consists in assessing it *vis-à-vis* one or more references (Bonnardel, 1991a). In the context of design, evaluation may occur when a representation is presented by its author, or interpreted by colleagues, as an "idea" or "solution proposal". Colleagues may interpret a representation as a solution proposal without its author presenting it explicitly as such, and they may evaluate it without its author explicitly requesting them to do so (Visser, 1993).

The terminology around "constraints" and "criteria" is still under debate in the domain of cognitive design studies. Bonnardel (1989) reserves the term "constraints" for operative evaluative references and "criteria" for conceptual references, whereas we use "constraints" for generative references that steer solution generation and "criteria" for critical evaluative references guiding solution evaluation (Visser, 1996). Other distinctions have also been proposed.

According to the source of an evaluative reference, researchers distinguish different types of evaluative references (Bonnardel, 1991a; Ullman, Dietterich, & Staufer, 1988):

- Prescribed constraints, which are given to the designer or which the designer infers from the problem specifications.

- Constructed constraints, for which designers mainly use their domain knowledge.

- Deduced constraints, which designers infer

[3] Willemien Visser (2006), *The Cognitive Artifacts of Designing*, Hillsdale, NJ, USA, Lawrence Erlbaum Associates (NdR).

based on other constraints, the current state of the design project (the problem solution), and design decisions made during their design problem solving.

Depending on the type of reference used by a designer, researchers distinguish three evaluation strategies (Bonnardel, 1991b; Martin, Détienne, & Lavigne, 2000, 2001), all three of which we qualify as "comparative":

- Analytical evaluation: A solution is assessed *vis-à-vis* a number of constraints.

- Comparative* evaluation: Various solution versions or alternatives are compared with each other.

- Analogical evaluation: A solution is assessed using knowledge acquired in relation to a previous solution.

In an analysis of negotiation patterns between participants in multidisciplinary aeronautical-design meetings, Martin *et al.* (2000; 2001) show that if such evaluation does not lead to a consensus between the different partners, arguments of authority may be used. Evaluative references are forms of knowledge. As expected, designers' expertise in a domain influences their use of these references (D'Astous *et al.*, 2004).

Given that, in a collaborative design setting, designers may have different representations of a project, proposals are evaluated not only based on purely technical, "objective" evaluative criteria. They are also the object of negotiation, and the final agreement concerning a solution also results from compromises between designers (Martin *et al.*, 2000, 2001). In addition, not only solution proposals, but also evaluation criteria and procedures undergo evaluation (D'Astous *et al.*, 2004).

The preceding discussion concerned different forms of evaluation by comparison, that is, with respect to evaluative references. This type of evaluation is possible if the form of the representation that is to be evaluated allows such a comparison. For example, if one knows already the performance measures of the artifact. This is often the case in engineering, where "objective" measures of artifacts are possible (e.g., measures of their future performance).

The evaluation of other types of artifacts may be based on simulation. The result of such simulation (e.g., a certain behavior displayed by the artifact) may constitute the input of comparative evaluation.

Evaluation has functions at both the action-execution and the action-management level of the design activity. The classical solution evaluation occurs at the action-execution level and leads generally to the selection of one proposal – possibly after one or more iterations. At the action-management level, evaluation affects the progress of the design process. Depending on the results, design may be pursued in different ways. Designers, thus, evaluate not only solutions, but also their possible design process, its progression, and direction (Visser, 1996).

Collaborative Design Through Interaction

Collaborative design takes different forms and refers to the various representation-construction activities presented earlier. Besides the functions that representations play in both individual *and* collective design settings (mainly cognitive offloading, reminding, keeping track, storage, communication, organizing, reasoning, and discovery), various aspects of the externalization possibilities of representations provide additional functions specific to collective design. These functions go together with different cooperative activities, which vary according to the phases of the design project. During distributed design, when the designers' central activity is coordination in order to manage task interdependencies, representations of course play a role. Yet, it is in co-design that they have a particular function, due to its collaborative setting.

In collaborative-design situations, individual design plays of course also an important role (as we have emphasised at different occasions in this text, see also Visser, 1993; 2002). Yet, an essential part of collaborative design, especially during co-design, takes place – that is, advances – through interaction. This apparently unequivocal statement – it may even seem tautological – conveys characteristics of design thinking that we consider essential.

Indeed, the different forms that interaction may take in collaborative design – especially, linguistic, graphical, gestural, and postural – are, in our view, not the simple *expression* and *transmission* (communication) of ideas previously developed in an internal medium (such as Fodor's "language of thought"). They are more and of a different nature than the trace of a so-called "genuine" design activity, which would be individual and occur internally, and which verbal and other forms of expression would allow sharing with colleagues. On this issue, we do not concur with Goldschmidt (1995) when she writes that *thinking aloud and conversing with others can be seen as similar reflections of cognitive processes*, which we can accept as *equal windows into the cognitive processes involved in design thinking* (p. 193).

Notice that, in these collaborative contexts, a fundamental part is played by other factors than cognitive ones (representations, knowledge). These are especially emotional factors, and social, institutional, and interactional factors, such as the roles of the different design participants (formal, static roles that depend on one's predefined function in the design project, and informal roles that emerge and evolve depending on the interaction, see D'Astous, Robillard, Détienne & Visser, 2001; Fagan, 1976; Herbsleb *et al.*, 1995; McGrath, 1984; Seaman & Basili, 1998).

In the following and last two divisions of this section, we discuss activities that are specific to collaborative design.

Construction and Use of Intermediary Representations in Collaborative Design

Many notions referring to the interdesigner intermediary function of representations in collaborative design have been proposed in the literature, such as "intermediary objects", "coordinative artifacts" (Schmidt & Wagner, 2002), "entities for cooperation" (Boujut & Laureillard, 2002), and "boundary objects" (cf. Star, 1988, discussed below).

Emphasizing the material setting and the artifactual nature of these entities that are essential in designers' interaction, Schmidt and Wagner (2002) emphasize that, in cooperative work, their main role is not informative, but coordinative: They contribute to a more or less effortless and fluent coordination and integration of individual activities in coordinative practices.

For architects, a particular form of coordinative artifacts is "layered artifacts". They are a tool that architects use *for communicating things that need to be taken account of or changed*. Schmidt & Wagner (2002) describe that architects construct them by *making annotations on a document, e.g., putting a red circle around a problem, adding details (correct measures, material), marking a part of a drawing with a post-it with some instructions for changes, corrections (e.g., in pencil directly on a plan), sketching either directly on a plan copy or on transparent tracing paper. . . .*

Layered artifacts facilitate coordination between activities (and the people who are responsible for them). They, for example, provide a collective or individual space for experimentation and change. The CAD drawing itself is a layered artifact, which builds on a particular mix of codes for functions and materials and has been tailored to a particular division of labor. (Schmidt & Wagner, 2002, pp. 10-11)

The benefit of visual expression in creative collective activity has been examined by Van der Lugt (2002). One of the supposed specific contributions of visual expression to idea generation in a collective setting is that, through conversation with the drawings of colleagues, people may build on each other's ideas. Van der Lugt shows that sketching using brainsketching tools indeed contributes to creative activity in idea-generation groups, but not as expected: it especially supports reinterpretation of one's own ideas, and so stimulates creativity in individual idea generation. Reinterpretation of ideas generated by other group members is not enhanced. Collective working is thus not the panacea for all complex processes. Individually conducted activities in collective settings may sometimes lead to "better" results. The visual expression in a collective setting may nevertheless improve integration of the group process, by facilitating the access to previously expressed ideas.

Van der Lugt emphasizes that his results may be specific to the techniques and tools examined, and thus cannot be generalized to other sketching and idea-generation tools. Indeed, in another study on sketching tools, using a different technique (visual brainstorming), Van der Lugt (2000) observed a breakdown in the idea-generation process.

Another communicative situation in design projects is the interaction between people involved in design and in implementation. Eckert's study of knitwear design (presented in Stacey & Eckert, 2003) constitutes an interesting example of the difficulties that these situations may bring about.

The knitwear designers examined by Eckert use "technical sketches" in order to communicate their patterns and garment shapes to the machine technicians who are to implement the knitwear designs in garments. In addition to a freehand drawing part (the actual sketches), these documents comprise a short verbal description and a set of dimensions (Stacey & Eckert, 2003, p. 157). These technical sketches are supposed to clarify the designer's specifications, but *are often excessively imprecise or ambiguous*. The technicians tend to ignore the actual sketch part, and *rely mainly on the verbal descriptions, which only give broad indications of categories* (pp. 157–158). The technicians are not able to distinguish in these documents the important and relatively exactly specified design aspects from unimportant details and elements that are placeholders for broad categories (e.g., the type of neckline or the chest pattern). As they *have no way of judging what to believe*, [they] *usually take what is standard as more likely to be reliable* (p. 174). This leads to the products, that is, the garments, often being more traditional than intended by their designers. The technicians repeatedly produce garments *that violate the designers' intentions*. They also often state that *what the designers want can't be done* (p. 174).

Notice that this conclusion – technicians refer to standards for understanding the specifications they receive – is not restricted to these specific technicians and these particular technical sketches. It may hold for anybody who is to interpret any semiotic expression produced by other people. Both designers and other participants in the development process of an artifact, interpret the language as well as the graphical expressions by their colleagues, in terms of the standards they are familiar with – and of their own past experience of artifacts more or less similar to the current object of the design project.

Still another communicative situation – but one that is not necessarily present in every design project – is that between designers and users. With respect to interactive-software design, Carroll (2006) notices that there is a big and crucial "gap" between the worldviews held by designers of software and its potential users. Participatory design is one way to bridge this gap. Research in this domain has produced many proposals for possible design representations enabling the two parties to communicate:

Many of these approaches essentially implement a user interface design at the earliest stage of system development: designers can show concretely what they have in mind, rather than specifying it mathematically, and other stakeholders can react and critique what they can actually see and manipulate.... A slightly more abstract approach is scenario-based design in which system functionality and the experience of using that functionality are described in narrative episodes of user interaction (Carroll, 2006).

Argumentation – a "hot item" in studies on cooperative activities – has only been touched on in this book (cf. Rittel, 1972/1984's argumentative model). Authors attribute a more or less broad sense to the notion. We conceive argumentation as an attempt to modify the representations held by one's interlocutors. Many activities in co-design are thus argumentative.

Boundary representations. As advanced by Star (1988), in collaborative design, one needs "boundary objects" to serve as an interface between people from different "communities of practice". These objects may take many artifactual forms, for example, representational. We have proposed to qualify as "boundary representations" (no connection to the b-rep model for representing a cube) the representational version of boundary objects (Visser, 2009). The fact that they work does not mean that partners from different communities view or use them in the same way. Different partners may interpret them differently, but they work if they contain sufficient details understandable by these parties. No party needs to understand the full context of use adopted by their interaction partners. It is the acknowledgment and discussion of the differences that enable people to use them successfully together.

An example of a representation meant as a boundary representation is the technical sketch used by the knitwear designers examined by Eckert (see Stacey & Eckert, 2003, p. 163, see also our presentation above). They do not work as boundary objects, because they do not contain sufficient detail to be understandable by the different parties involved. Successful communication depends not only on *the sender's use of appropriate representations for information*, but also on *the recipients' ability to construct meaning from those representations* (Stacey & Eckert, 2003, p. 158).

According to Stacey and Eckert (2003), two factors play herein a particularly important role:

The extent to which the participants share context and share expertise; and the tightness of the feedback loops [...]. In face-to-face communication, failures of comprehension can be identified and conveyed very quickly, and speech, gestures and sketches are used to explain and disambiguate each other. [...] *In less tightly coupled exchanges, the need to prevent rather than correct misunderstanding is correspondingly greater* (p. 162).

With respect to these factors, Eckert observed that in nearly all companies that she had visited, designers do their conceptual design without any input from the technicians that are to implement their designs. This absence of communication may explain, at least in part, that the technical sketches used as specification documents by the knitwear designers are ambiguous – that is, in the form that the two parties use them: Without any other interaction allowing them to be acknowledged and discussed. *The less the participants discuss, and the less knowledge and contextual information they share, the more sketches, diagrams and other communications need to carry with them the means of their own interpretation* (Stacey & Eckert, 2003, p. 163).

Construction of Interdesigner Compatible Representations

In a paper on "bringing different points of view together", Fischer (2000) writes:

Because complex problems require more knowledge than any single person possesses, communication and collaboration among all the involved stakeholders are necessary; for example, domain experts understand the practice, and system designers know the technology. Communication breakdowns are often experienced because stakeholders belonging to different cultures (Snow, 1993) use different norms, symbols, and representations. Rather than viewing this symmetry of ignorance *(Rittel, 1984) (or "asymmetry of knowledge") as an obstacle during design, we view it as an opportunity for creativity. The different perspectives help in discovering alternatives and can help uncover tacit aspects of problems* (Fischer, 2000, p. 3).

Construction of interdesigner compatible representations when co-designing proceeds through activities qualified as "grounding" (Clark & Brennan, 1991) and "cognitive synchronization" (D'Astous *et al.*, 2004; Falzon, 1994), through a negotiation process resulting in "social constructions" (Bucciarelli, 1988) or through argumentation resulting in the settling, "dodging", or substitution of "issues" (Kunz & Rittel, 1979). A great amount of time is spent on these activities (Herbsleb *et al.*, 1995; Karsenty, 1991; Olson, Olson, Carter & Storrosten, 1992; Olson *et al.*, 1996; Stempfle & Badke-Schaub, 2002). Recent studies have observed that synchronization can also take a gestural form (cf. research in Tversky's STAR team[4]). 4

In our study on software-review meetings (D'Astous *et al.*, 2004), we showed that the construction of interdesigner compatible representations of the to-be-reviewed design solution was a prerequisite for the occurrence of evaluation activities, which were the prescribed task. We also observed that cognitive synchronization concerned not only the problem solutions but also the criteria and the evaluation procedures.

Given that designers have their personal representations, collaboration between designers calls for confrontation, articulation, and integration of these different representations, in order for the designers to be able to reach a solution that is adopted for the common activity. The confrontation of personal representations also leads to conflicts between designers, which they are to resolve (see a remarkable early study in the domain of architectural design by Klein & Lu, 1989).

An interesting reading of Simon's (1969/1996 thinking about representations is provided Carroll (2006). Carroll notices that in the second edition of *Sciences of the Artificial*, Simon's view seems changed. In "Social Planning", a new chapter in this edition, Simon *suggested that* organizations *could be considered design representations (pp. 141-143), using the example of the Economic Co-operation Administration (ECA), the entity that implemented the Marshall Plan in 1948* (p. 12). At the outset, people involved in ECA did not agree on this agency. Carroll quotes Simon *who observes (p. 143), "What was needed was not so much a 'correct' conceptualization as one that would facilitate action rather than paralyze it. The organization of ECA, as it evolved, provided a common problem representation within which all could work"* (p. 12). As the ECA proceeded, one of the six original conceptions prevailed. Carroll comments, *many uses of prototypes in participatory design are compatible with this suggestion; prototypes provide an evolving framework for exploring design options and gradually focusing on a final solution* (Carroll, 2006).

4 Cf. http://www-psych.stanford.edu/~bt/gesture/, retrieved August 16, 2005.

REFERENCES

ARCHER, L. B. (1965/1984), "Systematic method for designers", in N. Cross (Ed.), *Developments in design methodology* (pp. 57-82), Chichester, England: Wiley (Originally published by The Design Council, London, 1965).

ATWOOD, M. E., McCAIN, K. W. et WILLIAMS, J. C. (2002, June 25-28), "How does the design community think about design?". Paper presented at DIS'02, the conference on Designing interactive systems: Processes, practices, methods, and techniques, London.

BERLIN, L. M. (1993), "Beyond program understanding: A look at programming expertise in industry", in C. R. Cook, J. C. Scholtz & J. C. Spohrer (Eds.), *Empirical Studies of Programmers: Fifth workshop* (ESP5) (pp. 8-25), Norwood, NJ: Ablex.

BONNARDEL, N. (1989), *L'évaluation de solutions dans la résolution de problèmes de conception* [Solution evaluation in design problem solving] (Rapport de recherche No. 1072), Rocquencourt, France: Institut National de Recherche en Informatique et en Automatique.

BONNARDEL, N. (1991a), "Criteria used for evaluation of design solutions", in Y. Quéinnec & F.Daniellou (Eds.), *11th Congress of the International Ergonomics Association: Designing for everyone and everybody* (Vol. 2, pp. 1043-1045), London: Taylor & Francis.

BONNARDEL, N. (1991b), "L'évaluation de solutions dans la résolution de problèmes de conception et dans les systèmes experts critiques" [Solution evaluation in design problem solving and in critic expert systems], in D. Hérin-Aime, R. Dieng, J. P. Regouard & J. P. Angoujiard (Eds.), *Knowledge modeling & expertise transfer* (pp. 371-381), Amsterdam: IOS Press.

BOUJUT, J.-F. et LAUREILLARD, P. (2002), "A cooperation framework for product-process integration in engineering design", in *Design Studies*, 23, 497-513.

BROWN, D. et CHANDRASEKARAN, B. (1989), *Design problem solving. Knowledge structures and control strategies*. London: Pitman.

BUCCIARELLI, L. (1988), "An ethnographic perspective on engineering design", in *Design Studies*, 9(3), 159-168.

CARROLL, J. M. (2006), "Dimensions of participation in Simon's design", in Design Issues, 22(2), 3-18.

CHI, M. T. H., GLASER, R. et FARR, M. J. (Eds.), (1988), *The nature of expertise*. Hillsdale, NJ: Lawrence Erlbaum Associates.

CLARK, H. H et BRENNAN, S. E. (1991), "Grounding in communication", in L. Resnick, J.-M. Levine & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 127-149), Washington, DC: American Psychological Association Press.

CROSS, N. (2001), "Strategic knowledge exercised by outstanding designers", in J. S. Gero & K. Hori (Eds.), *Strategic knowledge and concept formation III* (pp. 17-30), Sydney, Australia: University of Sydney, Key Centre of Design Computing and Cognition.

CROSS, N. (2002), "Creative cognition in design: Processes of exceptional designers", in T. Kavanagh & T. Hewett (Eds.), *Creativity and Cognition 2002* (C&C'02, the 4th conference on Creativity & Cognition) (pp. 14-19), New York: ACM Press.

CROSS, N. (2004a), "Expertise in design, introduction", in *The Journal of Design Research*, 4(2).

CROSS, N. (Ed.), (2004b), "Expertise in design" [Special issue], in *Design Studies*, 25(5).

DARSES, F. (1990), *Gestion de contraintes au cours de la résolution d'un problème de conception de réseaux informatiques* [Constraint management during a computer-network design task] (Rapport de recherche No. 1164), Rocquencourt, France: Institut National de Recherche en Informatique et en Automatique.

D'ASTOUS, P., DÉTIENNE, F., VISSER, W. et ROBILLARD, P. N. (2004), "Changing our view on design evaluation meetings methodology: A study of software technical review meetings", in *Design Studies*, 25, 625-655. Also accessible at http://hal.inria.fr/inria-00117060/en/.

D'ASTOUS, P., ROBILLARD, P. N., DÉTIENNE, F. et VISSER, W. (2001), "Quantitative measurements of the influence of participant roles during peer review meetings", in *Empirical Software Engineering*, 6, 143-159. Also accessible at http://hal.inria.fr/inria-00117298/en/.

DE VRIES, E. (1994), *Structuring information for design problem solving* (Doctoral dissertation, Eindhoven University of Technology, Eindhoven, Netherlands), Den Haag, Netherlands: Koninklijke Bibliotheek.

DÉTIENNE, F. (2002), *Software design. Cognitive aspects*. London: Springer.

FAGAN, M. E. (1976), "Design and code inspections to reduce errors in program development", in *IBM Systems Journal*, 15(3), 182-211.

FALZON, P. & VISSER, W. (1989), "Variations in expertise: Implications for the design of assistance systems", in G. Salvendy & M. J. Smith (Eds.), *Designing and using human-computer interfaces and knowledge based systems* (Vol. II, pp. 121-128), Amsterdam: Elsevier.

FALZON, P. (1994), "Dialogues fonctionnels et activité collective" [Functional dialogs and collective activity], in *Le Travail Humain*, 57(4), 299-312.

FISCHER, G. (2000), "Symmetry of ignorance, social creativity, and meta-design", in Knowledge-Based Systems, 13(7-8), 527-537. Retrieved September 30, 2010, from l3d.cs.colorado.edu/~gerhard/papers/kbs2000.pdf

GLASER, R. (1986), "On the nature of expertise", in F. Klix & H. Hagendorff (Eds.), *Human memory and cognitive performances*. Amsterdam: North-Holland.

GLASER, R., & CHI, M. T. H. (1988), "Overview", in M. T. H. Chi, R. Glaser & M. J. Farr (Eds.), *The nature of expertise* (pp. xv-xxviii), Hillsdale, NJ: Lawrence Erlbaum Associates.

GOEL, V. (1995), *Sketches of thought*. Cambridge, MA: MIT Press.

GOLDSCHMIDT, G. (1995), "The designer as a team of one", in *Design Studies*, 16(2), 189-209.

HAYES-ROTH, B., HAYES-ROTH, F., ROSENSCHEIN, S. et CAMMARATA, S. (1979, August, 20), "Modeling planning as an incremental, opportunistic process". Paper presented at the 6th International Joint Conference on Artificial Intelligence, Tokyo.

HERBSLEB, J. D., KLEIN, H., OLSON, G. M., BRUNNER, H., OLSON, J. S. et HARDING, J. (1995), "Object-oriented analysis and design in software project teams", in *Human-Computer Interaction*, 10(2 & 3), 249-292.

HOC, J.-M. (1988), *Cognitive psychology of planning*. London: Academic Press.

JEFFRIES, R., TURNER, A. A., POLSON, P. G. et ATWOOD, M. E. (1981), "The processes involved in designing software", in J. R. Anderson (Ed.), *Cognitive skills and their acquisition* (pp. 255-283), Hillsdale, NJ: Lawrence Erlbaum Associates.

KARSENTY, L. (1991), "Design strategies in database conceptual modelling", in Y. Quéinnec & F. Daniellou (Eds.), *11th Congress of the International Ergonomics Association: Designing for everyone and everybody*. London: Taylor & Francis.

KITCHENHAM, B. et CARN, R. (1990), "Research and practice: Software design methods and tools", in J.-M. Hoc, T. R. G. Green, R. Samurçay & D. Gilmore (Eds.), *Psychology of Programming* (pp. 271-284), London: Academic Press.

KLEIN, M. et LU, S. (1989), "Conflict resolution in cooperative design", in *Artificial Intelligence in Engineering*, 4, 168-180.

KUNZ, W. et RITTEL, H. W. J. (1970), "Issues as elements of information systems" (Working Paper No. 131; reprinted 1979), Retrieved September 30, 2010 from http://iurd.berkeley.edu/catalog/Working_Paper_Titles/Issues_Elements_Information_Systems

MARTIN, G., DÉTIENNE, F. et LAVIGNE, E. (2000, 17-20 juillet), "Negotiation in collaborative assessment of design solutions: An empirical study on a concurrent engineering process". Paper presented at the International Conference on Concurrent Engineering, CE'2000, Lyon, France.

MARTIN, G., DÉTIENNE, F. et LAVIGNE, E. (2001, July 9-13), "Analysing viewpoints in design through the argumentation process". Paper presented at Interact 2001, Tokyo, Japan.

McGRATH, J. E. (1984), *Groups: Interaction and performance*. Englewood Cliffs, NJ: Prentice-Hall.

MORAN, T. P. et CARROLL, J. M. (1996), "Overview of design rationale", in T. P. Moran & J. M. Carroll (Eds.), *Design rationale: Concepts, techniques, and use* (pp. 1-19), Mahwah, NJ: Lawrence Erlbaum Associates.

OLSON, G. M., OLSON, J. S., CARTER, M. R. et STORROSTEN, M. (1992), "Small group design meetings. An analysis of collaboration", in *Human-Computer Interaction*, 7, 347-374.

OLSON, G. M., OLSON, J. S., STORROSTEN, M., CARTER, M. R., HERBSLEB, J. D. et RUETER, H. (1996), "The structure of activity during design meetings", in T. P. Moran & J. M. Carroll (Eds.), *Design rationale: Concepts, techniques and uses* (pp. 217-239), Mahwah, NJ: Lawrence Erlbaum Associates.

REIMANN, P. et CHI, M. T. H. (1989), "Human expertise", in K. J. Gilhooly (Ed.), *Human and machine problem solving* (pp. 161-191), New York: Plenum.

RITTEL, H. W. J. (1972/1984), "Second-generation design methods" (Interview with Donald P. Grant and Jean-Pierre Protzen), in N. Cross (Ed.), *Developments in design methodology* (pp. 317-327), Chichester, England: Wiley (Originally published in *The DMG 5th Anniversary Report*: DMG Occasional Paper No. 1, 1972, pp. 5-10),

SCHMIDT, K. et WAGNER, I. (2002), "Coordinative artifacts in architectural practice", in M. Blay-Fornarino, A. M. Pinna-Dery, K. Schmidt & P. Zaraté (Eds.), *Cooperative systems design: A challenge of the mobility age* (Proceedings of the Fifth International Conference on the Design of Cooperative Systems, COOP 2002) (pp. 257-274), Amsterdam: IOS Press.

SCHÖN, D. A. (1988), “Designing: Rules, types and worlds”, in *Design Studies*, 9(3), 181-190.

SEAMAN, C. B. et BASILI, V. R. (1998), “Communication and Organization: An Empirical Study of Discussion in Inspection Meetings”, in *IEEE Transaction on Software Engineering* (July), 559-572.

SIMON, H. A. (1969/1996), *The sciences of the artificial* (3rd, rev. ed. 1996; Orig. ed. 1969; 2nd, rev. ed. 1981) (3 ed.), Cambridge, MA: MIT Press.

SIMON, H. A. (1978), “Information-processing theory of human problem solving”, in W. K. Estes (Ed.), *Handbook of learning and cognitive processes* (Vol. V. Human information processing, pp. 271-295), Hillsdale, NJ: Lawrence Erlbaum Associates.

STACEY, M. et ECKERT, C. (2003), “Against ambiguity”, in *Computer Supported Cooperative Work*, 12(2), 153-183.

STAR, S. L. (1988), “The structure of ill-structured solutions: Heterogeneous problem-solving, boundary objects and distributed artificial intelligence”, in M. Huhns & L. Gasser (Eds.), *Distributed artificial intelligence* (Vol. 3, pp. 37-54), Los Altos, CA: Morgan Kaufman.

STEMPFLE, J. et BADKE-SCHAUB, P. (2002), “Thinking in design teams. An analysis of team communication”, in *Design Studies*, 23(5), 473–496.

TULVING, E. (1972), “Episodic and semantic memory”, in E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 381-403), New York: Academic Press.

TULVING, E. (1983), *Elements of episodic memory*. Oxford, England: Oxford, England University Press.

ULLMAN, D. G., DDIETTERICH, T. G. & STAUFER, L. A. (1988), “A model of the mechanical design process based on empirical data”, in *AI EDAM*, 2, 33-52.

VAN DER LUGT, R. (2000), “Developing a graphic tool for creative problem solving in design groups”, in *Design Studies*, 21(5), 505-522.

VAN DER LUGT, R. (2002), “Functions of sketching in design idea generation meetings”, in T. Kavanagh & T. Hewett (Eds.), *Creativity and Cognition* 2002 (C&C’02, the 4th conference on Creativity & Cognition), New York: ACM Press.

VERSTIJNEN, I. M., HEYLIGHEN, A., WAGEMANS, J. et NEUCKERMANS, H. (2001, 17-19 July), “Sketching, analogies, and creativity. On the shared research interests of psychologists and designers”. Paper presented at the 2nd International Conference on Visual and Spatial Reasoning in Design, VR’01, Bellagio, Lake Como, Italy.

VERSTIJNEN, I. M., VAN LEEUWEN, C., GOLDSCHMIDT, G., HAMEL, R. et HENNESSEY, J. M. (1998), “Sketching and creative discovery”, in *Design Studies*, 19(4), 519-546.

VISSER, W. (1991), “Evocation and elaboration of solutions: Different types of problem-solving actions. An empirical study on the design of an aerospace artefact”, in T. Kohonen & F. Fogelman-Soulié (Eds.), *Cognitiva 90. At the crossroads of artificial intelligence, cognitive science and neuroscience*. Proceedings of the third COGNITIVA symposium, Madrid, Spain, 20-23 November 1990 (pp. 689-696), Amsterdam: Elsevier. Also accessible at http://hal.inria.fr/inria-00000165/en/.

VISSER, W. (1993), “Collective design: A cognitive analysis of cooperation in practice”, in N. F. M. Roozenburg (Ed.), *Proceedings of ICED 93, 9th International Conference on Engineering Design* (Vol. 1, pp. 385-392), Zürich, Switzerland: HEURISTA.

VISSER, W. (1995), “Use of episodic knowledge and information in design problem solving”, in *Design Studies*, 16(2), 171-187. Also in N. Cross, H. Christiaans & K. Dorst (Eds.) (1996), *Analysing design activity* (Ch. 13, pp. 271-289), Chichester, England: Wiley.

VISSER, W. (1996), “Two functions of analogical reasoning in design: A cognitive-psychology approach”, in *Design Studies*, 17, 417-434.

VISSER, W. (2002), “Conception individuelle et collective. Approche de l’ergonomie cognitive” [Individual and collective design. The cognitive-ergonomics approach], in M. Borillo & J.-P. Goulette (Eds.), *Cognition et création. Explorations cognitives des processus de conception* (ch. 14) [Cognition and creation. Cognitive explorations of design processes] (pp. 311-327), Bruxelles, Belgium: Mardaga.

VISSER, W. (2006), *The cognitive artifacts of designing*. Mahwah, NJ: Lawrence Erlbaum Associates.

VISSER, W. (2009), “Co-élaboration de solutions en conception architecturale et rôle du graphico-gestuel : Point de vue de la psychologie ergonomique” [Co-elaborating architectural design solutions and the role of the graphico-gestural: The ergonomic-psychology viewpoint] (ch. 5.3), in F. Détienne & V. Traverso (Eds.), *Méthodologies d’analyse de situations coopératives de conception : Corpus MOSAIC* [Methodologies for analysing cooperative design situations: The MOSAIC corpus] (pp. 129-167), Nancy, France: Presses Universitaires de Nancy.

VISSER, W. et MORAIS, A. (1991), “Concurrent use of different expertise elicitation methods applied to the study of the programming activity”, in M. J. Tauber & D. Ackermann (Eds.), *Mental models and human-computer interaction* (Vol. 2, pp. 59-79), Amsterdam: Elsevier.

WHITEFIELD, A. (1989), “Constructing appropriate models of computer users: The case of engineering designers”, in J. Long & A. Whitefield (Eds.), *Cognitive ergonomics and human-computer interaction* (pp. 66-94), Cambridge, England: Cambridge University Press.

Katarina Rimarcikova

Fashion Designer

Setting up her own label in 2006, it could be classed as "...a high-end, prêt-a-porter womenswear collection merging into haute couture." The label reflects its design statement and aesthetics inspired by all senses of its creator – psychological theories, philosophy, personal journey, literature and art. An intriguing mix of pleasure and pain. A constant analysis of the unknown.

↘ www.katarinarimarcikova.com

Photo Credits: Jasmine Boler

"Overpowered"

Autumn / Winter 08/09

Inspired by authors Aldous Huxley,"Brave New Word", Franz Kafka, "Metamorphosis", the surrealistic work of Jean Cocteau, contemporary music of Rosin Murphy and personal fragments, the creator vision was to capture the essence of a woman living in a parallel universe - torn between two worlds and influenced by their complex relationship with each other. The story is following the rules of reality and the present life expressed by the more structured pieces; fitted dresses, which zip up all the way at the back, with playful draped suggestions of the unknown, craving to escape this reality mode. Fitted jacket with strong lines hugging the silhouette. Leather harness panels incorporated, contrasting the matt fabrics, strong lines and layers on shine surfaces. The voluminous coats, cut mostly in one piece, worn over the "the beautiful uniforms of reality" are taking over this heroine. These are finished with shawl pieces which have become part of the garments and create the illusion of lost shapes. The choice of colour plays an important role for this collection. Deep and rich tones of blue, green, purple and burgundy "overpower" this woman who keeps slipping into the surrealistic environment of her dreams and her own personality.

Photo Credits: Olaf Daniel-Meyer

"The Secret Lives"

Autumn / Winter Collection 10/11

Katarina RImarcikova's collection began with a fascination with a book of photographs titled "Prague through the Lens of the Secret Police", a collection of images taken by the surveillance secret police under the communistic regime in Eastern Europe. Their subjects (suspected conspirators against the State) are captured unaware of being observed and their lives documented.
Intrigued by these images of daily life – both banal and full of mystery – Katarina has explored the layers of identity that her heroine fluctuates between hiding and revealing. She proposes that we all hold secrets and an access to a "secret life".
A collection of personal postcards found at a Paris flea market has acted as a catalyst for imagining the lives of others. The fragments of personal, hand-written text are poignant records of the experience of a stranger and unravel into elaborate, imaginary stories that inspire the collection. Each garment is a complex story in its own right; layers of fabric are draped to cover/hide the body and cut to reveal intimate details.
The clothes are designed so that the protagonist can play, alter her personality and transform herself – at moments wanting to attract attention and then deflect it.
Katarina is intrigued by how our identities evolve and transform according to experiences that are lived. Her work reflects the intricacy of personal history, referencing events that mark themselves on our lives and become permanent parts of who we are. The collection consists of full volume coats and jackets that cover sexually charged body-conscious dresses that are almost bandaged around the body. Deep intense colours – night blues and blacks enhance the mystery and the sense of unspoken secrets.
Undergarments –harnesses, bras, and suspenders – expose themselves under the restrictive layers. The garments have the potential to "wrap up" the body, to hide the truth about something hidden. Most pieces are cut from one piece of fabric and are the result of complicated draping. Experimental fabric combinations, for example papery leather and wool twill, mirror the contradictions in an unpredictable, ungraspable character.

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Emotions and Design: Between Feelings and Cognitions

FRÉDÉRIQUE CUISINIER

Abstract

This article presents the principle knowledge about emotions, stressing the importance of a collaboration between psychology and design. At once familiar and mysterious, emotions have been studied scientifically for a century, and this research has helped us to understand the complexity of these rich human experiences. Emotions allow humans to adapt to situations because they point out any significant change in their relationship to the environment. Eminently subjective phenomena, emotions are based on one's personal appraisal of a situation and its consequences for oneself. Emotion leads to a tendency to act in a given direction (approach, avoidance, opposition). Thus, inciting emotion appears to be one goal among designers: by provoking an emotion, they arouse a desire to approach an object or situation. Design and the psychology of emotion should therefore work in concert. The field of Learning Design is one possible example of such a collaboration.

Emotions and Design: Between Feelings and Cognitions

FRÉDÉRIQUE CUISINIER

Everyone is familiar with the phenomena we call emotions. They are, however, difficult to describe for most of us. While all languages have words to describe these personal experiences, it is generally difficult to precisely express the kinds of feelings corresponding to a given "emotion"; except for the talented writer, emotions often remain in the domain of the inexpressible. Nevertheless, emotions are still communicable, even contagious. They are accompanied by events recognized by all as, for example, the expression of anger, of joy, or of sadness. For the sake of concealing intimate feelings, or out of respect for social conventions, this expression can be monitored. Emotions also vary greatly in terms of duration. Sometimes very brief, emotions may take only a few moments; other times, they are experienced over a longer duration, and may even settle in permanently over time. Sometimes, the emotion subsides and then bounces back in a succession of episodes. Emotions contain many more mysteries. Sometimes they seem to obstruct psychological functioning; sometimes they seem to boost it. Thus, an emotion can have the effect of hampering the person by preventing them from advancing towards their goals (e.g., despair, distress, boredom), or, conversely, it may help them to undertake their task (e.g., joy, pride, happiness, satisfaction but also anger).

The object of our attention and curiosity since ancient times, emotions have often inspired the thinking of philosophers and scientists (see Channouf, 2006 for a history) who have sought to explain the nature and causes of these experiences. Emotions are sometimes regarded as separate from rational thought and reason; however, this dualism, attributed to Descartes, tends to be abandoned by today's scientific community. For the past century, research has been exploring the multiple facets of our emotions, demonstrating that they merge with thoughts into a single movement: personal adaptation to a situation in the present moment. This research is centered around several questions: What is emotion?; Why do we experience emotions?; Do emotions change with time, and, specifically, with psychological development? Are the emotions of a baby comparable to those of an adult?

This article aims to present some of the answers coming from these scientific inquiries. Firstly, we will see that emotions are complex phenomena because they incorporate several components (psychological, physiological and behavioural). Then we will see that emotions seem to fulfil an adaptive function: they signal the nature of a situation to the individual (in particular, where a threat to one's security and welfare are concerned). Finally, we will outline the link between the psychology of emotion and design, especially in a critical area of human development: education and access to knowledge.

Emotions as Complex and Dynamic Phenomena

The lexicon of emotions is both economical and misleading. The "labels" anger, joy, sadness, disgust, fear, or surprise are economical because they refer to states characterized simultaneously by feelings (pleasant or unpleasant), behaviours (expressions, actions) and physiological events (involving the heart rate, sweating, driving excitement, the activity of adrenal and lachrymal glands, etc.). But this vocabulary is also misleading because it suggests that emotions are states that arise suddenly, *ex abrupto*, and without explanation, *ex nihilo*. But emotions do not occur spontaneously in the human being. They are originally constructed only because, at some point, something in particular happens to the individual. They develop and give rise to a complex and dynamic configuration of elements as diverse as the feeling of being happy, the desire to get closer to an object, person or situation, the desire to smile, and even the urge to laugh; a person may wish to prolong the feeling, doing anything to encourage its continuation or avoiding doing things that might challenge it. As previously described, the emotion is an episode and not a state. Emotion is movement; in other words, it is a sequence that feeds on several components interacting with each other: an appraisal of the situation, a change in the inclination to act a certain way (action readiness), physiological activity (trembling, sweating, agitation, etc.), psychological activity (thoughts, memories, etc.), and behaviour (laughing, attacking, escaping, etc.). Therefore, emotions are described as "multi-componential" phenomena. Among the components of an emotion, we can highlight cognitive evaluation, action tendency, physiological activity and feelings in particular. The characteristics of these components are outlined below.

The Cognitive Evaluation Component

Darwin took a deep interest in emotions and their expression during his voyage around the world aboard the *Beagle* (1831-1836). His work, considered to be the first scientific study on emotions, has led to several hypotheses that researchers have since explored. Struck by the fact that the same emotional expressions are observed throughout the world in many species – not just in humans – Darwin developed the following theses:

Emotions are a result of evolution. This explains why they occur at the level of human beings and other highly evolved species.

Emotions are important for the adaptation of the organism to its environment. This explains why they have survived the process of natural selection. They correspond to categories of situations vital to survival (hazard or threat as opposed to safety or well-being).

Emotions correspond to biological programs. This explains the universality of facial and behavioural expressions and their associated physiological activity.

In the 1950s, a lively debate took place concerning the occurrence of emotions and the need to analyze the situations that move us to experience them. The question can be stated as follows: is it sufficient that the appearance of an object, a person, or a situation should trigger an emotion? With regard to human beings, the answer to this question is now well-known: everyone should feel the same thing at every confrontation with this object if the occurrence of a particular object triggers a given emotion (e.g. fear or joy); clearly, however, this is not what is observed. Instead, the most robust finding is that the confrontation with an object varies depending on the individual and, for each individual, depends on the context. Since the 1960s, research has demonstrated that the determining factor leading to an emotion is the appraisal of the situation made by the individual. This appraisal is described as cognitive because it corresponds to an information processing. But it is also qualified as subjective because this treatment is highly singular and personal. This appraisal plays a key role in adapting the individual: it aims to identify the meaning of the situation to him. This evaluation takes place very rapidly and occurs at the subconscious level.

The appraisal is organized around several criteria whose importance and place vary slightly according to the authors (see Fonds & Cuisinier in this issue, based on the model called Stimulus Evaluation Check (SEC) developed by Klaus Scherer of University of Geneva. The interested reader may also refer to the book of D. Sander & K. Scherer, 2009). The most consensual criteria are: the relevance and consequences of the situation for the individual; his or her coping potential (his or her coping potential (possiblities for adjustment to this situation); and the situation's normative meaning, (i.e. its resonance or discordance with personal and social values). These major evaluation criteria can be broken down further into more specific criteria.

A situation's relevance includes the identification of novelty, familiarity or predictability (does this situation or object have a high probability of occurrence or is it unusual or unexpected?). Relevance is also based on an appraisal of agreeableness (is the situation or object pleasant or unpleasant to the individual?). Finally, relevance also depends on appropriateness and the situation/object's priority in relation to the goals and motivations of the individual (is it a threat or, conversely, does it harmonize in some way with the individual's personal goals? Where does the situation or object fit within the hierarchy of the individual's priorities? For example, survival takes precedence over the threat of discomfort).

Coping potential refers to the resources the individual thinks he can mobilize to fit the situation. Facing a threat, he determines his ability to cope (can he fight, which corresponds to anger, or does he feel subject to the situation, which corresponds rather to fear?). Facing a new and unusual situation or an unfamiliar object, the individual will evaluate his resources, particularly in terms of values, knowledge, and earlier representations. For example, he may feel elated at the discovery of a new line or form, allowing him to change his current representations without damage. On the contrary, he may be embarrassed or offended if his representations and values are too destabilized by the situation.

The normative significant represents another major criterion for the subjective appraisal of an event. It is based on personal and social standards, and is, therefore, an aspect of the evaluation that may vary considerably depending on one's culture, norms and values. It also varies greatly according to the history of the individual and their personal standards related to life experiences. Emotions such as disgust or pride are especially sensitive to this criterion. Since the personal standards and / or social conditions are offended, the associated emotional experience will be linked to the range of rejection and to the desire to avoid confrontation. This last consideration leads us to mention another important component of emotion connected to situational appraisal: the action tendency.

The *Action Tendency* component

According to Nico Frijda of the University of Amsterdam, one of the immediate consequences of appraisal is the development of an action tendency. This expression means that the individual is preparing to act in a certain way depending on the current state of his relationship with the situation. Still referring to the broad appraisal categories of importance to his survival and wellbeing, the individual may be prepared to *approach*, to *maintain the relationship*, to *interrupt* his present conduct, or to *escape*. This action tendency is linked to the meaning that the individual attaches to the situation. If the situation is important and pleasant, the action tendency is more likely to be *approach* or *maintain*. On the contrary, if the situation is important and unpleasant, the action tendency will more likely involve *avoidance* or *attack*, depending on whether the coping potential has been evaluated as low or high. In terms of adaptation, action tendencies correspond to the repertoire of possible behaviour in connection with the feelings of the individual (Frijda, 2007).

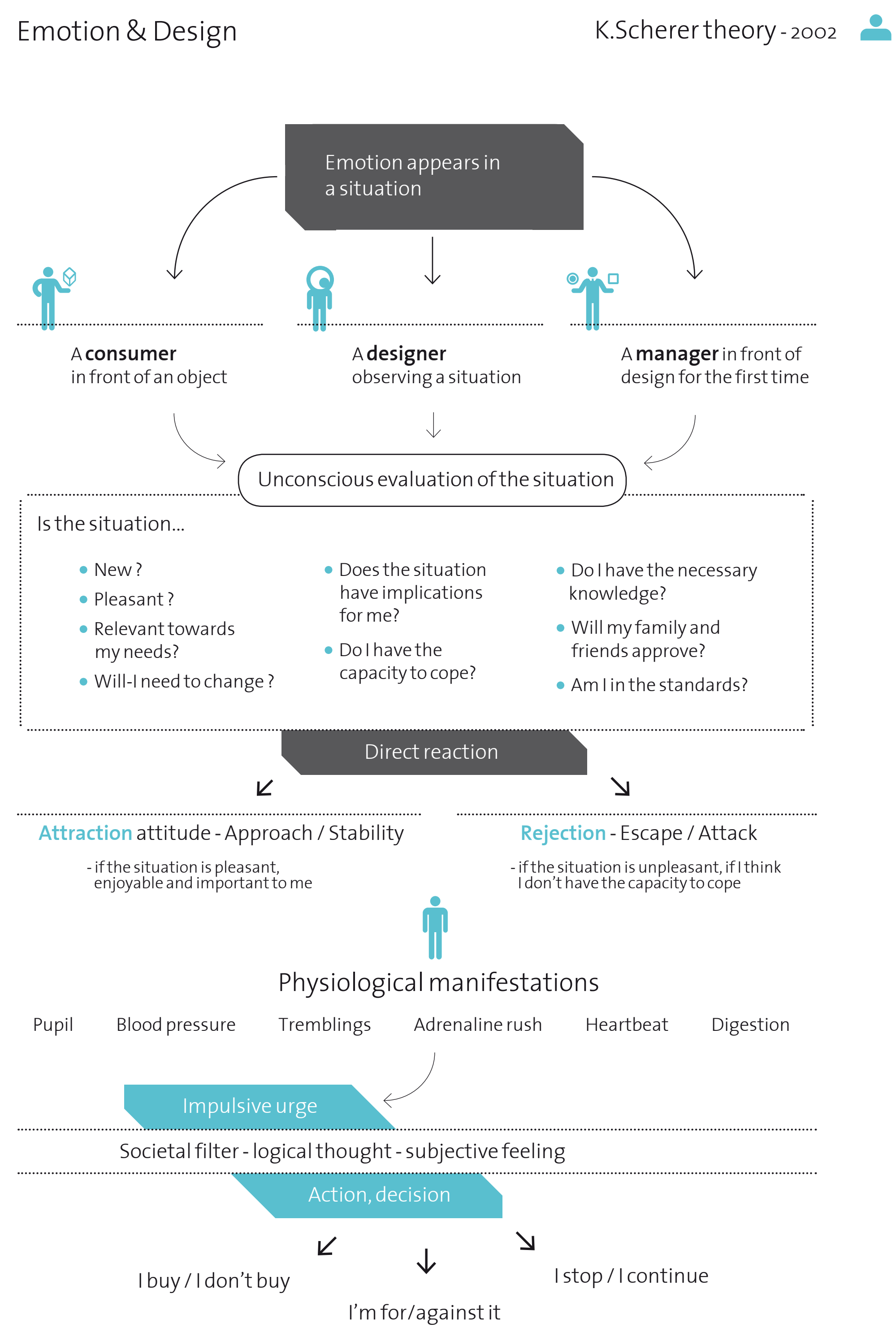
Action tendencies may be identified by studying subjects' reports of their emotional experiences. Nico Frijda has indeed seen a constant in these reports: people invited to relate an emotion systematically evoke "desires" such as "I hoped not to be here", "I felt I wanted to disappear", "I wanted to do something but I do not know what", "I wanted to embrace everyone", "I wanted to scream my joy but I could not say anything", etc. These action tendencies correspond to a preparation of the organism for an oriented behaviour. They do not, however, necessarily reflect an actual behaviour because they are subject to human control and regulation.

Nico Frijda has shown the links between subjective evaluation, action tendency, and emotion, as well as specifying the functions of these action tendencies. The writings of B. Rime (2005) present further analysis of these relationships. For example, desire would be underpinned by the action tendency *to approach*, whose function would be a willingness to consume. Pleasure and confidence would be underpinned by an action tendency *to be with*, the functionof which is to access consumption. The interested reader is invited to refer to this work and to that of Sander & Scherer (2009) for a complete overview of this concept.

In conclusion, action tendencies include the results of a personal evaluation of the significance of events, and reflect a possible adaptive response. These action tendencies are accompanied by a varying degree of physiological changes in which the body is put into motion (increase in vigilance and field of perception), or even more the readying of the body for a significant motor response (such as escape or attack).

The *Physiological Activity* Component

The physiological activities related to emotion are, for the most part, known by everyone: changes in heartbeat, sweating, motor excitation (e.g. tremors in the legs or arms, and particularly in the hands), activation of the smooth muscles (*viscera*), modifications in adrenal gland activity (production of adrenaline), etc. However, one current enigma relates to the specificity of physiological activities linked to each emotion. Research in this area is difficult, as answering this question would require provoking an emotional response in the subject, which raises two types of problem. The first is, of course, ethical. For example, provoking joy to study the resulting physiological activities may seem acceptable, but it is not the same for fear or shame. Besides this ethical problem, the very intention of instigating emotion in a laboratory under controlled conditions – far from the natural context of emotion – leads to a second problem: If an emotion results from the subjective appraisal of a situation's significance, it is difficult to anticipate this appraisal. Despite these reserves, some data are available. They indicate that physiological activities are poorly differentiated for low intensity emotions. These activities seem to correspond to the adaptive needs of the individual and are therefore even more pronounced when the emotion is intense; their priority is to respond to the survival or integrity of the organism. They are also less differentiated for positive emotions, which are pleasant and agreeable. This leads us the subject of "feeling" emotions.



The *Feeling of Emotion* Component

Another important component of emotion is called the "feeling" of emotion. This corresponds to the conscience of the emotional experience. We have seen that emotion comes from the subjective appraisal of the situation (or object) and have stressed the non-conscious character of this evaluation. The emotion is also accompanied by physiological activities depending, for example, on the sympathetic nervous system. A great number of them are imperceptible to the individual (variations in blood pressure, dilation of the pupils, or changes in digestion).

Others physiological activities are more noticeable, such as changes in heart rate, tremors, and sweating, etc.; similarly, the previously mentioned action tendency, or the organism's preparation for action, more or less perceptibly contributes to the set of elements that make the individual conscious that something is happening. At a certain point, the individual not only feels something but, more importantly, he *knows* he is feeling something. This feeling of emotion thrives on his interaction with the situation, and on personal or socially shared knowledge related to the emotion. Thus, emotions such as shame or pride involve a prior knowledge of the respective feelings associated with transgression or accomplishment. They therefore appear after several years of development, and are only actually understood around eight or nine years old. A baby of few hours feels, without a doubt, states of well-being or discomfort, but it is not yet able to differentiate satisfaction from joy. Henri Wallon, whose research in child psychology represented major progress, put great emphasis on the role of the baby/child's entourage in the development of emotional awareness: the individual "learns" to make sense of his own feelings – as well as the feelings of others – while interacting with others. This understanding is facilitated by matching emotional phenomena, through a sort of reciprocal and simultaneous imitation.

In summary, emotion is a complex phenomenon because it integrates multiple components, and the contribution of each component is part of a dynamic scheme. Emotion, far from being a condition that suddenly occurs as a result of any stimulus, is a process that finds its origin in the subjective appraisal of the situation and develops gradually as the appraisal of the change of individual relation to situation whose emotion is the signal. The emotional experience is therefore partly conscious and may even lead to a verbal labelling (anger, joy) or even to the regulation of an emotion.

Emotions: Friends or Enemies?

Judgments on emotions vary considerably. Some believe it is necessary to "let our emotions speak", to "know how to listen to them" or to "let them grow". It is particularly true for pleasant emotions. Others believe that emotions interfere with rational thought and must be contained. Scientific psychology has long regarded emotions as phenomena that are inaccessible to rigorous study; however, numerous studies have sought, since the late 19th century, to characterise them. Today, emotions take centre stage in the media as well as in research laboratories. The adaptive function is now recognized by consensus despite some differences regarding its systematic nature. Emotions are organized into categories (such as fear, anger or surprise) for different situations (danger, safety, or interruption). The emotion can be viewed from two aspects, depending on whether we consider it to be an indicator of responsiveness to a situation (subjective appraisal) or as a process of adjustment of the individual's relationship to the situation (action tendency). Emotion is a complex and rapid response organized around a change of priorities for the preservation of the organism. The essential function of an emotion is for the individual to gain self-awareness – or to inform others – about how he has appraised a given situation. According to Scherer (1994, p.127), the emotion plays the role of *an interface between environmental input and behavioural output*. He noted that Hebb (1949) pointed out the following paradox: the most advanced animal is the one with the most complex emotional directory. According to Darwin, the adaptive function of an emotion is also about social communication, especially given the concomitance between expression and state – the expression being the clue, or the signal, of the internal emotional state. Emotions therefore perform intra-personal and inter-personal functions. In the first case, they increase the availability of certain processes (escape, interruption, attention or focus for example), and in the second, they participate in communication and control. Products of evolution and culture, emotions thus play a critical role both for the individual and for social groups and cultures.

The social look on human emotions particularly concerns their impact on conduct and how we regulate our behaviour. Is our performance affected by our emotions? How do we deal with our emotions, especially when they are painful and invasive? The current issue regarding well-being (to be created, restored or maintained) indirectly points out the function of signal of the emotions which has been previously mentioned. The societal pressures are such that painful emotions, often subsumed under the term "stress", are more frequent, more intense, and sometimes unbearable. The emotion's function as a signal does, in fact, have a consequence: the emotional experience overrides any other information and becomes a drain on the organism. Consequently, research in psychology is addressing the impact of emotions on performance in problem-solving activities. Is performance better when the individual feels pleasant emotions? What happens when he feels unpleasant ones? Taken together, these studies show that being in a pleasant affective state facilitates the resolution of problems, particularly when the issues involve exploring new solutions (creativity). Conversely, being in an unpleasant emotional state more often has a negative impact on performance. Studies also show that these trends become more nuanced depending on circumstances. Thus, the impact of one's emotional state seems more important if the activity is complex or unusual; a familiar activity in which the individual is experienced will be less disturbed by his emotional state. Another distinction is related to the search for a better quality of life: the human being aspires to feel contentment. He avoids situations in which he will suffer, preferring situations which allow him to maintain a state of well-being. Therefore, he may be reluctant to fully engage in a risky endeavour, where success is uncertain. He may also use an activity as a lever to escape an unpleasant emotional state, seeking to manage the problem in order to derive joy or satisfaction from the experience.

Design and the Psychology of Emotion: a Desirable Encounter

Is an encounter between design and the psychology of emotion desirable or even possible? One of the functions of design seems to be to concretize concepts, ideas, functions, cultural referents and aesthetics in an object, image or a system. The purpose is to stimulate the encounter between the object (in the broadest sense) and the individual. In this regard, the aim of the designer is to tempt users towards this encounter – in other words, to construct the conditions for a *tendency to approach* (i.e. an emotion). We have seen that emotions develop from an evaluation and from an action tendency that characterize the current relationship to the object. The designer's conceptual activity therefore implicitly or explicitly incorporates the concept of emotion as understood by contemporary science. This encounter between design and the psychology of emotion is already underway in the field of knowledge building called Learning Design.

"Learning Design": a Preferred Place for Encounter

Knowledge building represents a major development at both the individual and the societal level. Previously seen primarily in terms of initial training, knowledge building now stresses learning throughout the individual's lifetime. We now see the rapid development of Information and Communication (education) Technologies (ICT). However, these tools, and the contexts of their use, raise a new issue, as the complexity of these tools and their diversity often prove to be barriers to learning. In addition, the place and function of the teacher must be re-thought. The teacher plays a fundamental role in knowledge building, in particular because he intervenes at several levels, organizing information for transmission and building a context of appropriation for the learner; this happens through the use of tools and materials (books and other textual documents, graphics, sound, etc...) and is performed in a dedicated space (the classroom, auditorium, or via hypermedia). Psychology proposes analytical frameworks for these very complex processes involved in knowledge building. The researcher in cognitive psychology has knowledge about learning processes, cognitive development, information processing, the effects of cognitive overload (when the information to be treated is excessive or too complex) and emotional and motivational factors in learning (which are beginning to be better identified and understood).

Gwendolyn Kolfschoten of Delft University of Technology points out a new requirement in contemporary society: in a dynamic world, always in movement, it is imperative to solve problems in a flexible way (Kolfschoten et al., 2010). Learning Design considers this need to design learning environments that incorporate, in their materiality, the meaning of the learning situation. According to Tom Boyle of the Learning Technology Research Institute (LTRI) at the University of London (London Metropolitan), conceptual clarification and development of integrative models specifying the different layers of design (design of the program, the sequence, the activities, the objects and the content of learning) is essential (Boyle, 2010).

A cross-discussion between the psychologist in learning and the designer would be a highly valuable dialogue. Indeed, the skills of the designer in the formalization of objects, tools and learning spaces are essential when seeking the most favourable conditions for fostering the development of the action tendency to *approach*. How can designers create, maintain and focus people's attention on the learning content? How can they organize the space and shape the tools of knowledge building? Collaboration between learning and emotion specialists and design professionals is certain to provide a fruitful response. The challenge will be to achieve the integration of scientific knowledge in the design of educational activities.

"Learning Design" offers a privileged space for an encounter between professionals of design and the fundamental research in psychology. This responds to societal needs, as well as an opportunity for mutual enrichment between disciplines.

TRANSLATION FROM FRENCH
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REFERENCES

GENERAL REFERENCES

CHANNOUF, A. (2006), *Les émotions : une mémoire individuelle et collective*, Bruxelles, Mardaga.
DE BONIS, M. (2006), *Domestiquer les émotions*, Paris, Les Empêcheurs de Penser en Rond.
DESPRET, V. (1999), *Ces émotions qui nous fabriquent*, Paris, Les Empêcheurs de Penser en Rond.
HEBB, D. O. (1949), *The Organization of Behavior*, New York, Wiley.
LE BRETON, D. (1998), *Les passions ordinaires*, Paris, Armand Colin.
LEWIS, M. HAVILAND-JONES, J.M. (2004), *Handbook of Emotions*, New York, London, Guilford Press.
RIMÉ, B. (2005), *Le partage social des émotions*, Paris, PUF.
SANDER, D. & SCHERER, K. (2009), *Traité de psychologie des émotions*, Paris, Dunod.Channouf, A. (2006). *Les émotions : une mémoire individuelle et collective*, Bruxelles : Mardaga.
SCHERER, K. (2002), "Les émotions et leur futur", in Y. Michaud. (Dir.), *Qu'est-ce que la vie psychique ?* (pp. 102-120), UTLS, Paris, O. Jacob.

FURTHER READING

BOYLE, T. (2010), "Layered Learning Design: Toward an Integration of Learning Design and Learning Object Perspectives", in *Computer & Education*, 54, pp. 661-668.
FRIJDA, N.H. (2007), *The Laws of Emotion*, Mahwah, New Jersey, Lawrence Erlbaum Associates Publishers.
FRIJDA, N. H. (1987/1991/1993), *The Emotions*, Cambridge, England, Cambridge University Press,
KOLFSCHOTEN, G., LUKOSCH, S., VERBRAECK, A., VALENTIN, E. & DE VREEDE, G.-J. (2010), "Cognitive Learning Efficiency Through the Use of Design Patterns in Teaching", in *Computer & Education*, 54, pp. 652-660.
SCHERER, K. (1994), "Emotion Serves to Decouple Stimulus and Response", in P. Ekman & R. J. Davidson (Eds), *The Nature of Emotion* (pp. 127-131), New York, Oxford, Oxford University Press.
VAN DER VEER, R. (1996), "Henri Wallon's Theory of Early Chid Development: The Role of Emotions", in *Developmental Review*, 13, pp. 364-390.

Hadley Johnson

"Little Altars Everywhere"

“ Voudou’s primary focus is one of love and allows its followers access to the healing powers of devotion. The practice of Voudou connects believers to friends/family who have perished as well as to the living, Therefore, the collection presents garments as altars on which we can show adoration apon. As we are all traveling altars to be cherished for eternity.”

Micheline Zhou

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Applying Psychology Research to Design: Understanding the Effects of Innovation on Emotional Process, User Acceptance, and User Acceptability

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Abstract

For decades, researchers have been documenting the questions of both acceptance and acceptability in order to identify the factors and elements which, in a situation of change or innovation, influence decision-making. After many studies on the subject, a certain number of common indicators from different categories have been revealed[1]. These indicators enable us, a priori, 1
to predict a person's behavior. Nevertheless, some issues remain unclear and an essential element of the individual's adaptation to this decision-making is never raised. Indeed, there is no research dealing with emotions resulting from this complex individual evaluation process that determines, to some extent, the relationship between the individual and his/her environment in situations of change. This article identifies common points and links between research on acceptance and acceptability. The cognitive evaluation of the emotional process (Scherer, K/R, 1984) informs each common factor, which can be re-examined using theories of emotion, notably the stimulus evaluation criteria (SEC). These criteria permit the individual to broadly and holistically assess his or her environment. It is only after this evaluation that the individual decides whether or not to proceed with an action. Therefore, in order to fully understand

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decision-making mechanisms, one must take the emotions into account.

Applying Psychology Research to Design: Understanding the Effects of Innovation on Emotional Process, User Acceptance, and User Acceptability

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Introduction

As we saw in the previous article of this issue, emotions are multi-componential phenomena. Among those emotional components we can distinguish: cognitive appraisal, action tendency, physiological manifestations and the subjective feeling of the emotion (F. Cuisinier). In the present article we will focus our attention on emotions within the context of change, first exploring the individual's cognitive appraisal and his or her interaction with a new artifact through the concepts of acceptability and acceptance. Emotional impact and user acceptance and acceptability are two relevant concepts for designers, who practice an innovation-centered activity that is very much concerned with how the user interacts with an object. We will examine this application of psychological theory to design through the example of the integration of Intelligent Transport Systems (ITS) in vehicles. This example will make explicit the interaction between the user and the artifact, and the impact of the emotions on decision-making within the context of innovation.

This article is organized in three sections:

- An overview of the appraisal phase of the emotional process and the stimulus evaluation criteria (SEC)

A practical case: the acceptability of intelligent transport systems. How do we locate emotions in concepts of acceptability and acceptance? What impact do emotions have on decision-making?

The presentation of a diagram outlining this research question, including the role of emotion in the conception of use and user-interaction, as well as the double dimension of acceptance and acceptability as they relate to the evaluative aspect of decision-making in the face of innovation.

- The Appraisal Phase of the Emotional or Cognitive Process: The Model of Stimulus Evaluation Criteria (SEC)

- Emotion results from a continual process of evaluation or appraisal. (See diagram p52). In this paper, we concentrate on the cognitive component, and, more precisely, on the criteria for cognitive evaluation. The cognitive evaluation is, in fact, the phase that most significantly affects the other components, as it occurs at the beginning of the entire appraisal process. In order to predict the evaluation of an event-stimulus' meaning for the individual, Klaus. R. Scherer has proposed the system of stimulus evaluation criteria (SEC). The SEC represent the dimensions or criteria considered necessary to define the majority of emotional states (Grandjean, D. Sander and K. Scherer, chapter 2 in *Traité de psychologie des émotions*). It is interesting to refer to this theory because it supplies the elements that enable us to predict an individual's reaction (approach or escape) and to understand how their relationship with the object is constructed. It is therefore possible to define the elements of the situation that the individual considers as he or she decides which behavior to adopt in response.

First, we will present and illustrate the SEC introduced by Scherer in order to show how the theory of emotions can be applied to the world of design innovation; we will then develop the links between this model and the question of acceptance and acceptability of an artifact.

The SEC are organized around four evaluative objectives:

1. *Relevancy evaluation*: When a new stimulus appears in his or her environment, the individual must decide whether this stimulus has a particular relevance to the activity in progress. This first appraisal will determine whether the individual allocates special treatment to this stimulus (for example more attention), thus preparing him or her to take a specific associated action. This evaluative objective consists of three criteria: the novelty criterion, the intrinsic attractiveness criterion, and the relevancy to goals and needs criterion. We can sum up this evaluative objective with the following question, using the example of the evaluation of an Intelligent Transport System (ITS): would an ITS be useful for me, and, if so, which one is preferable?

2. *Implication evaluation*: The individual then determines whether the stimulus facilitates or hinders the achievement of his or her goals, and to what extent. Four criteria are considered: the causal attribution criterion, the likelihood of consequences criterion, the divergence from expectation criterion and the urgency criterion. Again, following the ITS example, the individual may ask the question: to what extent will I have to change the way I drive my vehicle? To what extent is that change inconvenient?

3. *Mastery potential evaluation*: After having analyzed the situation, the individual must find the most favorable solution in reference to the stimulus' appearance, taking into account the control criterion, the intensity criterion and the adjustment criterion. In this case, one might ask the following: how capable am I of changing my driving style? And will I be able to use this ITS without encountering too many problems?

4. *Normative meaning evaluation*: The individual is part of a social group that influences his or her decision-making and representation. The individual must consider the group's opinion when he or she takes action as well as his or her personal norms. For example, what do people around me think about this ITS? Do the people around me approve of it?

A Practical Case: The Acceptability of Intelligent Transport Systems (ITS) in Cars

The extensive deployment of new technology is currently a crucial issue. Technology is developed to satisfy needs; it represents efficiency and is supposed to improve the user's life. Nevertheless, change comes with new problems for the user as well as for the purveyors of this technology. Producers must face a major question: will the public accept, support, and use this new technology? Therefore, it is important for all concerned to understand the mechanisms that lead to the individual's decision-making, especially concerning acceptance and acceptability. One such example is the integration of Intelligent Transport Systems, such as GPS technology, in cars.

The integration of new technologies such as GPS systems often force users to abandon their previous modes of operation in order to accommodate new ones. This radical change can generate adaptation difficulties and other conflicts, including the complete rejection of these tools. Indeed, although this technological innovation responds to certain user needs, not all users will necessarily have the *same* needs – some may identify their needs differently, or not even recognize the need at all. There are, of course, common functions that create general difficulties, but some users are able to cope with them without any specific help.

The effective integration of an ITS in a driver's activity depends entirely on the potential user's subjective appraisal. These are the driver's own expectations and specificities, which lead him or her to appraise the relevance of the of the ITS's integration to his or her driving experience. Therefore, the user must appraise the whole situation from an emotional point of view. In fact, according to emotional theory, every single situation or event is, *prima facie*, analyzed emotionally. Moreover, according to a number of studies, the way one perceives (or, in other words, "appraises") a situation will have an impact on its acceptability. If one feels joy or pleasure while thinking about using an ITS or while actually using it, they will be inclined to approach the object and to use it. If one is uncomfortable around or frustrated by the ITS technology, he or she will tend to avoid it.

When we pose the acceptability/*acceptance* question or the question of public support, we are trying to decipher how individuals react and face changes taking place in their environment. The goal of this inquiry is to understand what determines decision-making. Several studies have attempted to define the concepts of acceptance and acceptability, while others have tried to identify and describe the socio-psychological factors that influence those concepts. This article, however, focuses on the possible links between emotions and the mechanisms of decision-making. We will therefore first define acceptance, acceptability, and the context in which they occur, which will help us to differentiate the terms. Then, we will present commonly used factors to determine, measure, and influence acceptance and acceptability. Finally, having made the distinction between acceptability and acceptance and based on the factors linked to

[1] Adel, E and Varhelyi, 2008, Erikson, L., Garvill, J and Norlund, 2006, Katteler, H, 2005, Schade, J and Schlag, B, 2003, Young, K.I., Reagan, M.A., Misopoulos, E., and Haworth, N, 2003, Van der Laan, V., Morris, M., Davis, G.G, 1997.

those two concepts, we will establish connections between acceptability-acceptance and emotion. Once again we will reference studies concerning ITS technology.

Acceptance and Acceptability

For a long time, the terms "acceptance" and "acceptability" were used interchangeably in reference to the same phenomenon: user reaction when a new device, system, or set of rules is introduced. As we have stated previously, acceptance/acceptability questions appear when one wants to understand decision-making mechanisms. According to several researchers, the key factors in this decision-making are interaction, transaction, and communication with the public (potential or
2 actual users)[2]. From this point of view, the proper consideration of potential users' needs in the design phase and a clear explanation of how the ITS functions increases the chances of the ITS being used effectively in the future.

The terms acceptance and acceptability are often used in a context where public support is required. However, acceptance and acceptability are just stages. In fact, one can accept certain behavior without supporting the underlying idea, and only support can guarantee the success of a new policy. So, why do we need two words if it looks like we use them in the same circumstances and contexts? A careful examination of this question reveals that acceptance and acceptability represent two distinct moments in the decision-making process. Later, we will see more details on what distinguishes one from the other, and what the two terms have in common.

Acceptance

In 2005, Ausserer and Risser defined the acceptance of ITS technology as "a phenomenon that reflects to what extent potential users are
3 willing to use a certain system."[3] We can think of acceptance like a thermometer that indicates a person's *desire to use an object*. For Schade and Schlag (2003), acceptance implies the user's attitudes and behavioral responses following the introduction of a new system or product; it is linked to the user's effective experience of those devices. For example, is this person in favor of obstacle and collision warning, and do they use it daily? Other researchers have distinguished two types of acceptance: acceptance based on a direct evaluation of ergonomic criteria for the ITS technology and social acceptance, which is more of a predictive evaluation of consequences of the system.[4] In those studies, acceptance is measured through behavioral changes when driving with an ITS as compared to driving without it ("habitual" behavior).

Acceptability

In general, acceptability is regarded as a foreseen (prospective) judgment that leads to attitudes and specific behavior in relation to the object. Even if the individual has not experienced those devices in practice, he or she expresses a judgment based on what the system represents and their beliefs about it. While acceptability and acceptance may be confused because of the thin line between them, some authors have explained their specificities[5]. In the case of acceptability, the individual anticipates him or herself using the object and his or her relationship with the object, whereas in the case of acceptance, he or she effectively tests the object and judges it with full knowledge of the facts. In both cases, it is a matter of judgment, attitudes and behaviors (anticipated, fictional or real), and as a result we find a large number of factors in common when measuring them.

Eight useful indicators for studies about acceptance and acceptability are listed below:

- Socio-demographic user profiles such as age, driving experience, driving style, attitudes about driving safety, driving speed, and tendency toward risky road behavior.
- Social influences, notably social acceptability, or external elements that the user could take into account in deciding whether an ITS is acceptable or not.
- Problem Awareness (depending on the ITS), such as the individual's awareness of the dangers of speeding in relation to their use of the cruise control function.
- Effectiveness, or the user's conviction that the system does what it is intended to do.
- Usability corresponding to the driver's performance while using the ITS, and the ease with which it is used.
- Usefulness perceived.
- Satisfaction of the user's needs.

[2] Nelissen, W.J.A and G.C Bartels, 1998, De Mol, J.D and Vlassenroot, S, 2007, Morsink, P et al., 2006, Rogers, E.M, 2003, Schlag, B and Schade, J, 2003, Steg, L et al., 1995.
[3] Vlassenroot, S., K. Brookhuis, V. Marchau and F. Witlox (2008).
[4] Van Der Laan et al., 1997.
[5] Schlag, B. and Schade, J., 2003.

- Affordability, or the financial accessibility of the ITS.

4 Acceptability seems to be a long and unstable process, while acceptance is the final, stabilized, decisive state that is essential for decision-making. Emotion seems, therefore, to represent an important element of the acceptability process; indeed, emotion is organized around the individual's evaluation with regard to the situation (or the object). This evaluation aims to determine the significance of an event-stimulus for the individual. This constant appraisal may or may not lead to an emotion characterized by tendencies toward an associated action, a subjective feeling, a behavior, and physiological manifestations. In fact, the individual's point of view on his or her relationship with the object (the ITS) represents the major decisive element that will determine whether he or she em-
5 braces or rejects it.

Thesis Question

We propose that those common indicators used to analyze acceptability are re-read and translated using theories of emotion, in particular following the component process model and the theory of sequential criteria in the differentiation of emotions (Scherer, 1984). This re-reading reveals similarities and connections between these common indicators of acceptance and acceptability and the stimulus evaluation criteria described by Scherer's theory.

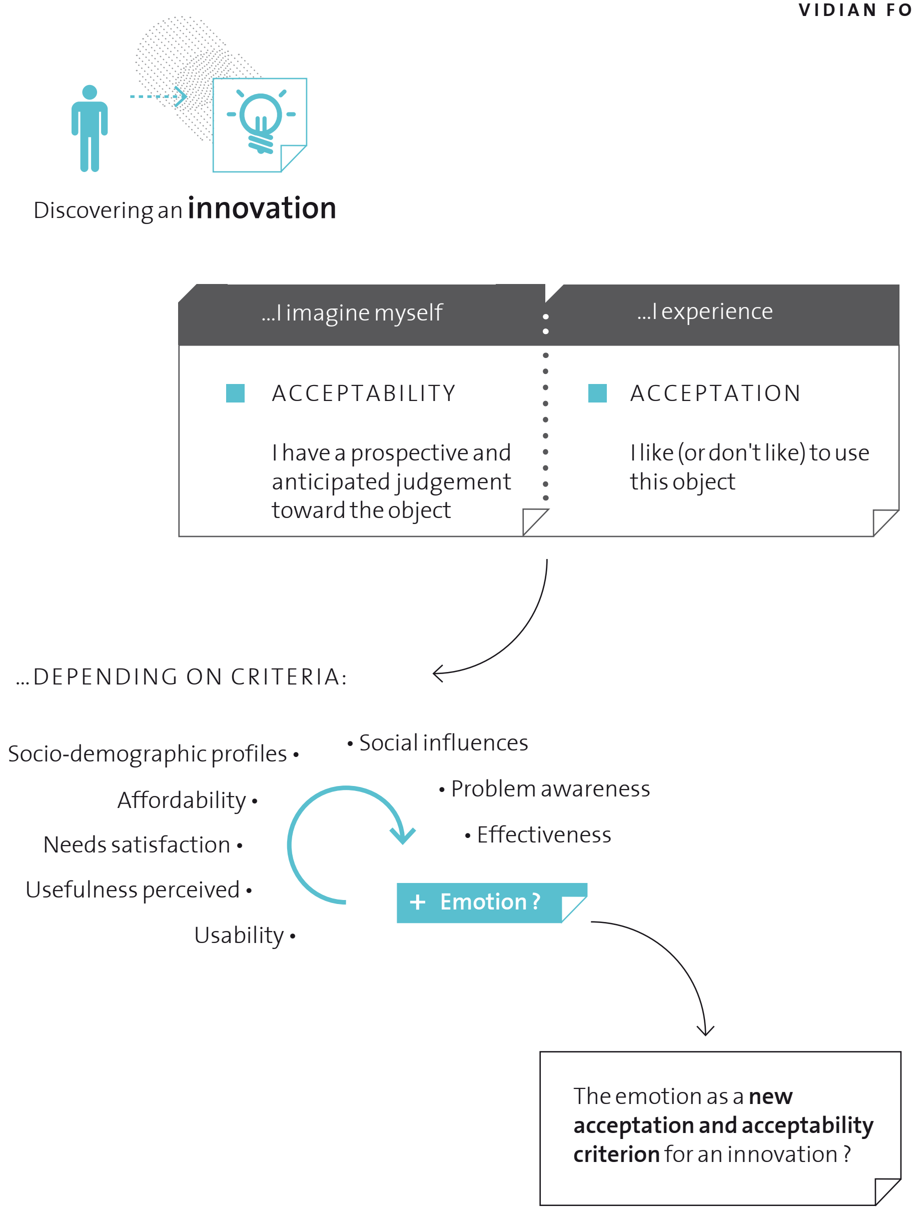
The stimulus evaluation criteria encapsulate a large number of indispensible events in the individual's life; they are at the origin of his or her adaptation strategies and actions. These events are all-powerful and ubiquitous; it is reasonable to assume that they can be identified amongst the factors used to measure acceptability. Thus, we notice that each acceptability factor echoes at least one evaluation level and consequently corresponds to at least one stimulus evaluation criterion. For example, the socio-demographic profile comprises, among other things, attitudes and behaviors associated with speeding. For an individual who likes to drive fast, a device that limits their speed would not be relevant to the satisfaction of this desire (the criterion of goals and needs relevancy) and it would therefore be considered a significant hindrance to the attainment of the user's goal (the criterion of facilitation or obstruction of goals and needs). In another example, a novice in new technologies might worry about the usability of an ITS, which would increase the importance of the potential for mastery evaluation in his or her analysis of the situation. Similarly, the criterion dealing with normative meaning is relevant when the individual is a part of a group that does not value ITS technology (social influence) or where its affordability is concerned. In effect, acceptability will depend on the cost and the available funds (socio-economic category) but also on the symbolic value attributed by the individual to the object in question (internal standards). To close this series of examples, let us look at the category of "problem awareness," which will illustrate the complexity of research on acceptability and emotions. For an individual who perceives the road as a hostile and dangerous environment, any ITS that will enable him or her to avoid or survive an accident will be considered relevant. This implies that he or she has identified the elements likely to lead to a road accident, which combines a knowledge of objective factors and value judgments on those objective elements: how do road accidents occur, what is the probability of having an accident, and what are the consequences? How can ITS technology help the individual to avoid an accident? Nevertheless, he or she will have to appraise whether it will be possible to drive with a specific ITS, and the impact that it will have on his or her driving ability (mastery potential).

Once these different evaluations have been completed (in addition to those concerning other factors of acceptability), the individual will have constructed his or her current personal relationship with the object – in other words the level of acceptability of the ITS concerned and his or her inclination to use it. One will notice that all of the elements are in constant, complex interaction with each other. The factors are all inter-related and mutually influential. It is not easy to isolate one particular element and study it separately, and/or in relation to only one evaluation stimulus criterion.

Design > emotion > innovation

PhD dissertation issue : "The emergence of emotion as an evaluation criterion of the impact of an innovation on an individual"

VIDIAN FONDS



Conclusion

Acceptability is one part of the process that leads to decision-making. Throughout this process, the individual must evaluate and re-evaluate the situation according to his or her own specificities and expectations, as well as those of the people around him or her. The environment in which the individual moves is dynamic and prone to numerous – and possibly frequent – changes; consequently he or she must analyze this environment in order to adapt to it. These mechanisms of decision-making enable us to predict one's future behavior; they are therefore the subject of numerous studies in the field of new technologies and Intelligent Transport Systems (ITS). Generally, those studies focus on variables such as attitudes, beliefs surrounding a phenomenon, noted behaviors, social influences, ergonomic criteria, and certain individual factors. However, they tend to ignore one of the individual aspects – emotion – that governs how users function and their attitudes towards the world around them. Furthermore, this aspect is omnipresent in the individual's life.

Indeed, emotion is a phenomenon that is known and experienced by everyone, but very few understand how it functions, or even its usefulness, in helping the individual to adapt to his or her environment. Emotion is, in our view, an essential element of acceptability. It establishes a relationship with the object that will determine action tendencies favoring contact, approach, or avoidance of the object, and consequently its long-term use. These action tendencies hold a central position in the attitude of the user. ITS technologies are strongly defined by their functionality for the driver. Yet the pleasurable dimension of the object is not adequately treated in acceptability models. Even the ergonomic aspects are generally oriented towards the object's functionality and the usability. Nevertheless, the designer and the design of the object undoubtedly play a major role in creating a dimension of pleasure and beauty through esthetic attraction, in order to orient the potential user towards the object, or, in other words, to solicit the user's the desire and the behavior resulting from it. This said, we can also reproach designers for giving priority to acceptance over acceptability, which suggests that they are only interested in the user's interactions with and reactions to the object.

TRANSLATION FROM FRENCH
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REFERENCES

AUSSURER, K., RISSER, R. (2005), "Intelligent Transport Systems and Services: Chances and Risk", paper presented at ICTCT- workshop.

MOLIN, E., BROOKHUIS, K.A. (2007), "Modeling Acceptability of the Intelligent Speed Adapter", in *Transportation Research Part F: Traffic Psychology and Behaviour*, 10(2), p. 99-108.

ROGERS, E. M. (2003) *Diffusion of Innovations*. 5 ed., New-York, The Free Press.

SANDER, D., SCHERER, K. R. (2009), *Traité de Psychologie des Emotions*, Paris, Dunod.

SCHADE, J., SCHLAG, B. (2003), "Acceptability of Urban Transport Pricing Strategies", in *Transportation Research Part F: Traffic Psychology and Behaviour*, 6(1), pp. 45-61.

STEG, L., DREIJERINK, L., ABRAHAMSE, W. (2005), "Factors influencing the acceptability of energy policies: A test of VBN theory", in *Journal of Environmental Psychology*, 25(4), pp. 415-425.

VAN DER LAAN, J. D., HEINO, A., DE WAARD, D. (1997), "A Simple Procedure for the Assessment of Acceptance of Advanced Transport Telematics", in *Transportation Research Part C: Emerging Technologies*, 5(1), pp. 1-10.

VLASSENROOT, S., BROOKHUIS, K., MARCHAU, V., WITLOX, F. (2008), "Measuring Acceptance and Acceptability of ITS: Theoretical Background in the Development of a Unified Concept", TRAIL Research School, Delft.

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Investigating Design: A Review of Forty Years of Design Research

NIGAN BAYAZIT

Abstract

This paper will start to answer the above question with the definition of L. Bruce Archer: "Design research is systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems."

In this paper, looking at design research from the design methodology and design science perspectives restricts our view in a sense that is necessary for such a topic. The objectives of design research are the study, research, and investigation of the artificial made by human beings, and the way these activities have been directed either in academic studies or manufacturing organizations.

Investigating Design: A Review of Forty Years of Design Research

NIGAN BAYAZIT

What Is Design Research?

This paper will start to answer the above question with the definition of L. Bruce Archer: "Design research is systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and
1 systems"[1].

In this paper, looking at design research from the design methodology and design science perspectives restricts our view in a sense that is necessary for such a topic. Design research tries to answer the obligations of design to the humanities:

a. Design research is concerned with the physical embodiment of man-made things, how these things perform their jobs, and how they work.

b. Design research is concerned with construction as a human activity, how designers work, how they think, and how they carry out design activity.

c. Design research is concerned with what is achieved at the end of a purposeful design activity, how an artificial thing appears, and what it means.

d. Design research is concerned with the embodiment of configurations.

e. Design research is a systematic search and acquisition of knowledge related to design and design activity.

The objectives of design research are the study, research, and investigation of the artificial made by human beings, and the way these activities have been directed either in academic studies or manufacturing organizations. As Simon indicates, we can call overall activities
2 of design research, "*the sciences of the artificial*"[2]. Some of the art, craft, and design people call what they do for art and design "research". That kind of research is not the subject of this paper. An artist's practicing activities when creating a work of art or a craftwork cannot be considered research. Yet it is possible for an external observer to do research into how an artist is working on his or her work of art to make a contribution to the common knowledge. These can be observable phenomena. As Christopher Frayling[3] says, "Research through art 3
and design is less straightforward, but still identifiable and visible", consisting of materials research, developmental work, and action research. Architects and engineers have applied these definitions of design research since the 1960s.

All design research reports are related to the history or past activity of the subject area under study. Studies of the present are part of the past because every research report has to prove its roots in the past[4]. I will try to identify some instances of the 4
state of the art from some research papers as well as books on design research. This paper will provide a summary of design research history concerning design methods and scientific approaches to design.

Many writers[5] have pointed to De Stijl in the 5
early 1920s as an example of the desire to "scientize" design. The roots of design research in many disciplines since the 1920s are within the Bauhaus, which was established as the methodological foundation for design education. After the Bauhaus closed, most of the staff moved to the U.S., Britain, or Russia, where they were well accepted and took the Bauhaus tradition to other institutions. Moholy-Nagy moved to the U.S., where he finally became the director of the "New Bauhaus", which became the Institute of Design at the Illinois Institute of Technology in 1949. Gropius went to Harvard, and brought a new line of thought to that side of the U.S. Le Corbusier described the house as an objectively designed "machine for living". He envisioned a desire to produce works of art and design based on objectivity and rationality. During this same period, Buckminster Fuller sought to develop a "design science" that would obtain maximum human advantage from a minimal use of energy and materials. In 1929, he called his concept of design "Dymaxion" or "4-D".

Role of Design Methods in Design Research

Main sources for the history of design methods and design research can be found in various publications. Some historical reviews of design methods have been written by Geoffrey Broad-

1 L. B. Archer, "A View of the Nature of the Design Research" in Design: Science: Method, R. Jacques, J. A. Powell, eds. (Guilford, Surrey: IPC Business Press Ltd., 1981), 30-47. L. Bruce Archer gave this definition at the Portsmouth DRS conference.

2 H. A. Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, Third Edition, 1999).

3 C. Frayling, "Research in Art and Design", Royal College of Art Research Papers 1:1 (1993/4).

4 As Jacques Barzun and Henry F. Graf indicated in their book, Modern Arastirmaci (translated into Turkish from the Modern Researcher), (Ankara: TUBITAK, 1993).

5 Nigel Cross, "Designerly Ways of Knowing: Design Discipline Versus Design Science" in Design Plus Research, Proceedings of the Politenico di Milano Conference, Silvia Picazzaro, Amilton Arruda, and Dijon De Morales, eds. (May 18–20, 2000), 43–48.

6,7,8,9 bent[6], Nigel Cross[7,8,9], Vladimir Hubka and Ernst
10,11,12 Eder[10], Nigan Bayazit[11], Margolin and Buchanan[12],
13,14,15,16 in various conferences[13,14,15,16].

17 Horst Rittel[17] made the following statement in an interview:

"The reason for the emergence of design methods in the late '50s and early '60s was the idea that the ways in which the large-scale NASA and military-type technological problems had been approached might profitably be transferred into civilian or other design areas".

After World War II, the new techniques that had been used in the design and development of arms and wartime equipment, and the methods and techniques used in developing many new inventions, attracted many designers. Creativity methods were developed mainly in the U.S. in response to the launching of the first satellite, the Soviet Union's "Sputnik," which caused the American government to free up quite a lot of money to
18,19,20 do research on creativity[18,19,20].

During the 1960s, it became evident that designers no longer could rely solely on their ability to focus upon the product as the center of a design task. Due to technological developments and the implications of mass production, interest had to be shifted from hardware and form to the consideration of human needs. This required
21 a new look at the subject of design methods[21].

First Generation Design Methods

The influence of systems analysis and systems theory on design established the grounds for the foundation of "systematic design methods", which Horst Rittel[22] later called "first generation design 22
methods". The *Conference on Design Methods*, which was organized by J. C. Jones and D. G. Thornley[23], was the first scientific approach to design 23
methods in England. The methods proposed at that conference were simplistic in character. Everyone was systematizing his or her own approach to design, and externalizing it as design method. Morris Asimow, a chemical engineer, wrote the book *Introduction to Design*, published in 1962, about engineering design. L. Bruce Archer, the previous HfG teacher, became the head of the Design Research Unit in the Royal College of Art in 1964, and published his book *Systematic Methods for Designers* in 1965. His method was based on critical path analysis, a model of operations research, and gave design research examples. These publications can be considered pioneering examples of design methods and scientific approaches to design.

The first Ph.D. thesis in design methods by Christopher Alexander[24,25], entitled "Notes on the 24,25
Synthesis of Form", brought new ground in architecture. S. Chermayeff and C. Alexander[26] dedicated 26
their book, *Community and Privacy*, to Walter Gropius. It applied "pattern language", using the same approach as Alexander in his Ph.D. thesis. Alexan-

6 G. Broadbent, "The Development of Design Methods," Design Methods and Theories 13:1 (1979): 41–45.

7 Nigel Cross has several publications in various conferences in "The Recent History of Post-Industrial Design Methods" in R. Hamilton, ed., Design and Industry (London: The Design Council, 1980).

8 N. Cross, Developments in Design Methodology (Chichester, UK: John Wiley & Sons, 1984).

9 N. Cross, "A History of Design Methodology" in Design Methodology and Relationship with Science, NATO ASI Series, M. J. De Vries, N. Cross, and D. P. Grant, eds. (Dordrecht: Kluwer Academic Publishers, 1993).

10 V. Hubka, E. Eder, Design Science (London: Springer Verlag, 1996).

11 N. Bayazit, Endüstri ürünleri Tasariminda ve Mimarlikta Tasarlama Metotlarina Giriß (*Introduction to Design* Methods in Industrial Product Design and Architecture), [In Turkish] (Istanbul: Literatur Yayinevi 1994).

12 V. Margolin and R. Buchanan, The Idea of Design: A Design Issues Reader (Cambridge, MA: The MIT Press, 1995).

13 Doctoral Education in Design: Proceedings of the Ohio Conference (8–11 October, 1998).

14 In 1986, the Design Methods Group celebrated its twentieth anniversary with some special reviews in its journal. D. Grant edited the anniversary issue of Design Methods and Theories Journal of DMG 20:2 (1986).

15 Foundation of the Future: Doctoral Education in Design Conference" at La Clusaz, France (9–12 July 2000).

16 This conference brought together the HfG people and state-of-the-art reviewers of design research, Design Plus Research, Proceedings of the Politecnico di Milano Conference (May 18–20 2000).

17 In an interview with Horst Rittel in the 1972 issue "Son of Rittelthink" in The DMG 5th Anniversary Report, he gave the basic reasons for design methods.

18 D. H. Edel, Introduction to Creative Design (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1967).

19 J. R. M. Alger and C. V. Hays, Creative Synthesis in Design (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964).

20 M. S. Allen, Morphological Creativity: The Miracle of Your Hidden Brain Power (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1962).

21 B. Jerrard, R. Newport, and M. Trueman, Managing New Product Innovation (London, Philadelphia: Taylor & Francis, 1999).

22 H. Rittel, The DMG 5th Anniversary Report (1972).

23 J. C. Jones and D. G. Thornley, Conference on Design Methods (Oxford University Press, 1963). This conference was the turning point of design studies.

24 C. Alexander, "The Determination of Components for an Indian Village" in Conference on Design Methods, J. C. Jones and D. G. Thornley, eds. (Oxford University Press, 1963). The method in his Ph.D. thesis was explained for first time at this conference.

25 C. Alexander, Notes on the Synthesis of Form (Cambridge, MA: Harvard University Press, 1964).

26 S. Chermayeff and C. Alexander, Community and Privacy: Toward a New Architecture of Humanism (New York: Doubleday and Co. Inc., 1963). This book contains the radio speeches of Chermayeff and also Alexander's method for patterns on the housing neighborhood.

der tried to split the design problems into solvable small patterns by applying information theory. He sorted out those that interacted with each other, and solved the problems of each group by drawing a diagram in which the interactions – either fit or misfit – of user requirements were resolved between the components within and among patterns.

27 In 1965, Sidney Gregory's[27] paper, included in *The Design Method* proceedings of the conference he organized in Birmingham, defined for the first time the concept of "design science". That conference contained papers on design research, as well as the design methods used in different engineering disciplines. The late Nobel laureate Herbert A. Simon from Carnegie Mellon University, invited to deliver the Karl Taylor Crompton lectures at the Massachusetts Institute of Technology in the spring of 1968, used this opportunity to present the thesis that had been central to his research. It was published under the title *The Sciences of the Arti-*
28 *ficial* that same year[28]. He proposed applying the extensive scientific approach to the sciences of the artificial in economics as well as to engineering and other disciplines, in which the design of the artificial is the subject of its own discipline. The artificial here includes all kinds of the man-made things and organizations. He and his colleagues presented artificial intelligence (AI) in design at Carnegie Mellon University.

During that period, research approaches to design became common in Europe and the U.S. The conference/course, "The Teaching of Design – Design Methods in Architecture", was held in HfG in Ulm in April 1966, and following that at the 1967
29 *Design Methods in Architecture Symposium*[29] held in Portsmouth. Organized by Geoffrey Broadbent and Anthony Ward, the symposium looked at the design research approaches to design.

Broadbent commented on the symposium as follows:

"The 1967 Symposium was held at a particular moment in history when general change in consciousness was taking place of the kind which Kuhn (1962) would have called paradigm shift. This was having profound effects on society and on social organizations in general including - which is im-
30 portant for us - the role of the designer in society[30].

Design methods people were looking at rational methods of incorporating scientific techniques and knowledge into the design process to make rational decisions to adapt to the prevailing values, something that was not always easy to achieve. They were attempting to work out the rational criteria of decision making, and trying to optimize the decisions.

Some designers thought that their approaches were a waste of time. This view was not exactly true. The design problems in architecture and in engineering after World War II were severe. The postwar diminished male labor force was a very important influence, and required new production methods, and new designs to meet the new needs of the society in Europe and in the U.S. The Cold War with the Eastern Block countries gave impetus to new human requirements, with scientific approaches to design in this new era generated from political decisions.

31 As Broadbent[31] said after the Portsmouth Symposium in 1967,

The Symposium had been set up by Tony Ward to include a specific confrontation between those whom he saw as behaviorists, representing a mechanized, quantified view of design and those (including himself) he saw as existentialist/phenomenologist (formerly Marxist) concerned, above all, "with the humanness" of human beings.

His "behaviorists" included Bruce Archer; Tom Markus above all; Ray Struder, whose very title "The Dynamics of Behavior-Contingent Physical Systems" summarized what they were all about. Design was to be "scientific" – Struder was looking for a "unit of analyses in design measurable, in his words, against dimensions that are both relevant and empirically accessible". The designer has to start by analyzing human behavior, from which he could derive "quantities, qualities, and relationships".

Meanwhile, a design methods group was established at the University of California, Berkeley in 1967, and began to publish a newsletter called
32 *Design Methods Group (DMG) Newsletter*[32]. This newsletter provided information about research in progress, as well as publications in the fields of design research covering planning, architecture, and industrial design mainly from the U.S. and UK, but seldom from Europe.

In June 1968, the DMG International Conference was organized at MIT. The purpose of the conference was identified in the "DMG Design Methods Group Conference Purpose and
33 Program"[33] leaflet:

"The First Annual International Conference is a research conference in the theory and application of design, planning, and engineering methodology. The purpose of the conference is twofold: first to provide a format for researchers to present their current work for evaluation from their peers and, second, to encourage dialogue between the researchers and the practitioners who are interested in the application of this work. Because the conference is directed both at the researcher and the practitioner, the responsibility for the level of
34 communication lies with the speaker"[34].

In 1973, The Design Activity International Conference in London, in 1977, the California-Berkeley Design Methods in Action Conference, and in 1976, the Portsmouth Changing Design Conference all were indicators of the interest by designers and neighboring disciplines in design research.

In West Germany in 1970, the Institute for the Basis of Modern Architecture (Institute für Grundlagen der Modernen Architektur) began to produce a series of publications called *Studies Related to Planning Methods (Arbeitsberichte zur Planungsmethodik).* These studies were following the design methods movement in the U.S. and
35;36;37;38 UK[35 36 37 38].

In the '70s, two leaders who were pioneers of design methodology announced a manifesto against the design methodology of the era. Chris-
39 topher Alexander[39] said:

"The odd thing is that people have lost sight completely of this objective. They have very definitely lost the motivation for making better buildings. I feel that a terrific part of it has become an intellectual game, and it's largely for that reason that I've disassociated from the field. I resigned from the Board of Editors of the *DMG Newsletter* because I felt that the purpose which the magazine represents is not really valuable, and I don't want to be identified with them".

Even though he rejected the idea of design methods, he continued to apply his own pattern language to design problems and user design participation utilizing ready-made patterns, in various places of the world.

Although he wrote the first comprehensive book, which comprised almost all of the methods relevant to design up to the 1970s, Christopher Jones first refused to be a professor of design discipline at the Open University, and then rejected design methods in the first issue of *Design Methods and Theories Journal* in 1977. He explained that his rejection aimed at the computer use, behaviorism, and continued attempts to fix all of life into logi-
cal frameworks[40]. He moved into another field of 40
design, literature.

People like Churchman had warned at least eight or ten years earlier of the consequences of the illegitimate simplifications of the first generation design techniques. But the reaction had led to a kind of unintentional self-elimination.
The first-generation design methodology had turned into
a sort of academic subculture[41]. 41

Second-Generation Design Methods

Herbert Simon, in his book *The Sciences of the Artificial*, defined design problems as "wicked" problems, for which finding appropriate solutions was very difficult and each solution to a problem created new problems to be solved. Reactions against design methods by Christopher Alexander surprised newcomers to the field. Horst Rittel, calling the paradigm shifts in design "generations", saved the design methods, according to Nigel
Cross[42] in his article. Horst Rittel's proposal of the 42
idea of generations for design let newcomers find new ways for themselves. First-generation design methods were simplistic, not matured enough, and not capable of meeting the requirements of complex, real-world problems. The design meth-

27 S. A. Gregory, ed., The Design Method (London: Butterworth Press, 1966.
28 H. A. Simon, *The Sciences of the Artificial*, 1 (Cambridge, MA: MIT Press, 1968).
29 G. Broadbent and A. Ward, eds., Design Methods in Architecture (London: Lund Humphries, 1969).
30 G. Broadbent, "The Morality of Design" in Design: Science: Method (1981), 309–328.
31 G. Broadbent in Design: Science: Method (1981): 309.
32 (DMG) Newsletter, published by Sage Publications. Gary Moore was the editor of the first issue of the second volume; and J. C. Jones, Murray Milne, Barry Poyner, Horst Rittel, Charles W. Rush, and Henry Sanoff were the Editorial Committee. C. Alexander, M. Starr, G. Nadler, W. Issard, M. B. Teitz, and B. Harris were among the members of the Review Committee for the new publication.

33 DMG Design Methods Group, "First Annual International Conference Purpose and Program," MIT (Cambridge, MA: June 2–4, 1968).
34 Ibid.
35 Siegfried Maser, Horst Rittel, Jürgen Joedicke, Hans-Otto Shulte, John Luckman, West Churchman, Horst Höfler, and many others were among the writers of these publications.
36 IGMA, Arbeitsberihte zur Planungsmethodik 1: Bewertungsprobleme in der Bauplanung (Stuttgart/Bern: Karl Kramer Verlag, 1970).
37 IGMA, Arbeitsberihte zur Planungsmethodik 4: Entwurfsmethoden in der Bauplanung (Stuttgart/Bern: Karl Kramer Verlag, 1970).
38 IGMA, Arbeitsberihte zur Planungsmethodik 6: Nutzbeteiligung an Planungprozessen (Stuttgart/Bern: Karl Kramer Verlag, 1972).
39 C. Alexander, "State of Art in Design Methodology: Interview with C. Alexander" DMG Newsletter (March 1971): 3–7.
40 J. C. Jones, "How My Thoughts about Design Methods have Changed During the Years," Design Methods and Theories: Journal of DMG and DRS 11:1 (January– March, 1977).
41 H. Rittel, The DMG 5th Anniversary Report (1972).
42 N. Cross, Design Methodology and Relationship with Science (1993).

odologists were trying to apply OR models and systems theory to design problems in a very abstract way for every problem. The first-generation design methods were formulated and applied by scientists and designers. The objectives of the design problem also were identified by them during the design process, which caused rigidity in design decisions and unexpected failures. These simplistic methods were necessary at the beginning.

Horst Rittel proposed new argumentative methods as "second-generation design methods". His methods, argumentative method, and IBIS (Issue Based Information System) were problem identification methods, which were influenced by the British philosopher Karl Popper. These second-generation design methods began to compensate for the inadequacy of the first-generation design methods. User involvement in design decisions and the identification of their objectives were the main characteristics of the second-generation design methods. User participation was a new democratic approach parallel to the prevailing political movements of the era. The Design Participation Conference in Manchester was organized by Nigel
43 44 Cross in 1971. As indicated by Bayazit[43 44].

User participation to P&D is a very wide and comprehensive subject, with its political, ideological, psychological, managerial, administrative, legal and economical aspects in relation to various countries. The concept of user participation is as wide and variable as that of democracy.

The success of the participatory design process depended on the designer's awareness of user values, and obliged professionals to collaborate with social scientists as well as anthropologists to carry out design research. There were some obstacles in the application of participatory design in larger-scale projects, such as those in urban planning.

Development of Scientific Research in Design

In the manufacturing industry, design has been formally acknowledged as a separate activity for at least the last 150 years. From the beginning of the twentieth century, the concept of design systems and operations was familiar to the people who developed and used the methods of work-study. In the U.S. in 1909 and 1917, Gilbert's motion study was based on the intelligent observation of people at work. Through the end of World War I, the equipment and machines in factories used by the war industries were relatively unsophisticated. During that war, new kinds of weapons such as aircraft and tanks came into widespread use, and were designed for mechanical efficiency. The first research studies focused on the design of aircraft to improve the performance of the product. Throughout the 1920s, industrial fatigue research became the most important subject. Volkswagen was another initiator of performance studies aimed at increasing the efficiency of the car for the German public. In 1937, Volkswagen sought to produce cheap as well as physically powerful and long-lasting cars. Thousands of repeated performance tests influenced their engineering as well as industrial design, and inspired the development of new and unusual designs. It became a good model for the design of cars and a host of other products.

Facing social and economic problems after World War II, and for the purpose of solving complex design problems and meeting user requirements, the fact of design was considered as a problem-solving and decision-making activity. The scientific developments during World War II made great contributions to the solutions of design problems, especially in the engineering disciplines. Multidisciplinary teams were set up consisting of engineers, industrial designers, psychologists, physiologists, and above all, statisticians. Especially on the engineering side after the war, it was necessary to move faster and faster to reconstruct Europe from its rubble. Cybernetics developed during the war by Norbert Wiener as the science of management became the model for rational behavior employed in economics, and obtaining information and making decisions using computer systems[45]. Consequently, cy- 45
bernetics influenced many design methodologists and design theoreticians. Design theoreticians such as L. Bruce Archer[46] and Gordon Pask[47] saw 46 47
the similarities between designers' design behavior and the organisms' self-control systems, and developed their own theories accordingly.

The study of human performance and man-machine relationship developed great momentum. Ergonomics and work-study were well known by many people, and applied to designs during the war. Scientific management gave workers a healthier environment, and introduced new designs of office furniture, thereby improving worker comfort. Changing postures with furniture reduced fatigue, and made workers happier and more efficient.

48 As Broadbent[48] said: "After the war, it became necessary, therefore, to identify their combined interest in such a way that they could continue to contribute to it with a real sense of purpose. So, in 1949, Murrell and others arranged an interdisciplinary meeting of anatomists, physiologists, industrial medical officers, industrial hygienists, design engineers, architects, illuminating engineers, and so on, out of which the Ergonomic Research Society was formed".

These experiences stimulated interest in design research in the 1950s.

Cornell University, MIT, the University of Sydney, Carnegie Mellon University, and the University of California were the centers for this development line, especially in the design science and computer
49 aids to design by the leading theorists[49]. One of the first social research studies was conducted at the Cornell University Agricultural Experiment Station on one-thousand army personnel to investigate
hygienic behaviors and attitudes[50]. That was fol- 50
lowed by one of the ergonomics as well as cultural studies on bathroom and sanitary fixtures, which
was conducted by Alexander Kira[51], and influenced 51
the sanitary fixture market with its new approach to human body and cleanliness concepts all over
the world, starting in the U.S. and the UK[52]. Cultural 52
anthropology and its influence on design began
during the 1950s[53 54 55 56]. In the UK, the application 53,54,55,56
of social psychology to design started in the 1960s[57] 57
[58 59 60]. In Sweden, various ergonomics studies were 58,59,60
made on housing, especially on bedrooms and oth-
er home spaces[61 62 63 64]. In the UK, Loughborough 61,62,63,64
was another center for scientific research related to ergonomics. At the Royal College of Art, Misha Black and L. Bruce Archer were doing extensive design research for industry. In his book, L. Bruce
Archer[65] mentions research work on hospital beds 65
that derived from work-study observations in the
"Design of Hospital Bedsteads"[66 67]. 66,67

The Environmental Design Research Association (EDRA) was founded in 1970, and the first

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[43] Cf. G. Friedman, *La Crise du progrès*, Paris, 1936, p. 138

[44] N. Bayazit, (Guest Editor of the issue), Papers: Architectural design. "Interrelations among Theory, Research, and Practice," Design Methods and Theories 13:3/4, (1979).

[45] H. A. Simon, "Rational Choice and the Structure of the Environment," Psychological Review 63 (1956): 129–138.

[46] L. B. Archer, Systematic Methods for Designers (London: The Design Council, 1965).

[47] G. Pask, "The Conception of a Shape and the Evolution of a Design" in J. C. Jones and D. G. Thornley, eds., Conference on Design Methods (Oxford: Pergamon Press, 1963).

[48] G.Broadbent, Design in Architecture (London: John Wiley and Sons, 1973), 115.

[49] Leading design researchers of the era were Peter Cowan at the University of Sydney, Herbert A. Simon and Alan Newell at Carnegie Mellon University, and Horst Rittel at the University of California at Berkeley.

[50] M. Langfort, Personal Hygiene Attitudes and Practices in 1000 Middle-Class Households (Ithaca, New York: Cornell University Agricultural Experiment Station, New York State College of Home Economics, 1965).

[51] A. Kira The Bathroom (New and expanded edition), (Ithaca, New York: The Viking Press, 1966).

[52] Cornell researchers also did various studies on housing. See G. H. Beyer, Housing and Personal Values, Memoir 364 (Ithaca, New York: Cornell, University Press, 1959); office furniture, as well as different energy-consuming activities of workers in E. C. Bratton, Oxygen Consumed in Household Tasks (Ithaca, New York: Cornell University Press, 1950); E. C. Bratton, Some Factors of Cost to the Body in Standing and Sitting to Work Under Different Postural Conditions (Ithaca, New York: Cornell University Press,1959); E. Knowles, Postures and Other Physiological Responses of the Working Surfaces in Household Ironing (Ithaca, New York: Cornell University Press, 1943).

[53] A. Forty, *Objects of Desire: Design and Society, 1750–1980* (London: Thames and Hudson, 1986), 131–132.

[54] Ibid., 131–132.

[55] S. Giedion, *Mechanization Takes Command* (New York: Oxford University Press, 1948).

[56] TM. Mead, *Cultural Patterns and Technical Change* (UNESCO, 1955).

[57] J. Noble, "How and Why of Behaviour: Social Psychology for the Architect," *The Architects' Journal* (March 6, 1963).

[58] F. J. Langdon, "The Design of Mechanized Offices," *The Architects' Journal* (May 1 and 22, 1963).

[59] P. Manning, ed., *Office Design: "A Study of Environment, Department of Building Science,"* University of Liverpool (Liverpool: Pilkington Research Unit, 1965), 27.

[60] Ibid., 45–51.

[61] More than 928 different anthropometric measurements, as well as dimensional literature on dwelling equipment, under the title of "Anatomy for Planners" were collected by the National Swedish Institute for Building Research Ergonomic Studies were necessary in these countries because people in the past were sleeping in a sitting posture, and had bed lengths shorter than the height of an average person which was not healthy.

[62] E. Berglund, *Bord* (Stockholm: Svenska Slöjdföreningen, 1957).

[63] E. Berglund, *Skap* (Stockholm: Svenska Slöjdföreningen, 1960).

[64] Styrelsen Kugl, *God, Bostad* I dagt och I morgon, (Stockholm: Bostada 1964).

[65] L. B. Archer, *Systematic Method for Designers* (London: The Design Council, 1965).

[66] S. E. Harrison, Work Study Officer of the North East Metropolitan Regional Hospital Board, conducted the trials. During the research study, no less than one million items of information were recorded. At the same time, sociologists under the direction of Joan Woodward of the Imperial College of Science and Technology were engaged in finding out the opinions of patients and staff about conventional and prototype bedsteads at King Edward's Hospital (Design of Bedsteads, King Edward's Hospital, London, 1967).

[67] Kenneth Agnew, along with a supporting team, designed the bedstead in the Royal College of Art, as cited by L. B. Archer in "Systematic Method for Designers" (1965).

EDRA conference was organized by Henry Sanoff that same year, and continued annually, mainly in the U.S. Their research topics were concentrated on evaluative studies of architecture and environmental planning. The first collaborative studies for the investigation of user requirements were made by sociologists, psychologists, social psychologists, and design professionals, and began to develop research methods for the artificial. Also man-environment research (MER) began in various universities in the U.S., and new journals such as *Environment and Behavior* and the *Journal of Architectural Planning and Research* began to be published in the United States. Sometime later in Europe, the International Architectural Psychology Society (IAPS) was established, and served as the European counterpart of EDRA and MER.

Meanwhile, the Design Research Society (DRS) was founded in London in April 1966. Design Methods Group (DMG) and DRS started to publish the *DMG-DRS Journal* instead of the *DMG Newsletter* until 1979, when DRS started the *Design Studies* journal, edited by Nigel Cross since then. In 1980, the *Design: Science: Method Conference* was organized at Portsmouth, in which design research and the contribution of science to design were the subjects of discussion. The conference organizers put forward the question to all of the members of the Design Research Society, as did L. Bruce Archer in his paper in the conference entitled, "What Is Design Research that It Is 68 Different from Other Forms of Research?"[68]. At that same conference, the author of this paper presented the existing situation in design research. 69 That paper was published in *Design Studies*[69]. We tried to categorize the research areas in that paper such as profession-based theories, user-based theories, user-profession-based theories, theories dealing with building appearance, and theories dealing with the profession. Also, fundamental design research tools and techniques up to that time were classified in the same paper. The Design Policy Conference brought together increasing numbers of design researchers in 1982 at the Royal College of Art. That conference was the most comprehensive one of that period. The influence of British philosopher Karl Popper showed itself on the design theory building and scientific formulations of design research.

Four years later, between 1986 and 1993, the Institute of Design (ID) at the Illinois Institute of Technology began to issue the *Design Processes Newsletter*, edited by Charles Owen. That newsletter was concerned with design research approaches of ID, design management, and design policy. It contained articles on a variety of topics of interest to the design community. They were presenting the projects and the research works of their faculty, as a leading design research institution in industrial design in the world.

In the meantime, in official government organizations and in other international organizations such as National Bureau of Standards in the U.S., CSTB in France, the Building Research Station in England, the Center International de Batiment (CIB) in Holland, Government Research Centers in Sweden and Denmark, and in many other countries, user requirement studies began in the 1960s and continued up the 1980s. Research in Europe concentrated on housing design and performance problems, because there still was a great shortage of housing in Europe after World War II, and the prefabricated buildings were indispensable.

Prefabricated building design, and research on the coordinated building elements and the building layout optimization, were well-accepted research subjects in the universities as well as in the research centers. Building performance studies were initiated in government research centers and universities, mainly in engineering design, applying scientific methods to design problems in new housing construction. Various environmental characteristics of housing were subject to evaluation in these studies. In the U.S., during the Cold War, the government supported environmental studies on topics such as windowless buildings, and school environmental research (SER)[70]. Starting 70 in the 1960s, research areas such as acoustics, heat transfer, and climatic comfort in architecture were well accepted, and continued to develop.

Researchers began to produce interactive computer graphics systems. Wireframe and polygonal modeling schemes were developed. Mosley[71] developed one of the first layout optimization 71 programs for hospital operating units. Beginning in the 1970s, computer scientists became interested in systematic design methods and design science. They were trying to program and evaluate building performance to justify scientific design

[68] L. B. Archer, *Design: Science: Method* (1981).

[69] N. Bayazit, N. Esin, and A. Ozsoy, "An Integrative Approach to Design Techniques," *Design Studies*, 2:4 (1981).

[70] C. T. Larson, ed., SER2: *School Environmental Research*, University of Michigan (1965).

[71] L. Mosley, "A Rational Design Theory for Planning Buildings, Based on the Analysis and Solutions of the Circulation Problems," *The Architects' Journal*, (September 11, 1963): 525–537.

decisions. At the National Bureau of Standards in the U.S., the first International Congress on Performance Concept in Building was organized in 1972. It brought a new perspective to design research 72 in architecture. Thomas A. Markus[72] and Thomas Maver had been working on building performance at Strathclyde University. Thomas Maver, a computer-aided design programmer, started to work on the programming of environmental building performance evaluation programs. Also, Peter Cowan established the building research center at the University of Sydney in Australia. Building science and computer-aided design were well developed by the end of 1960s, and the beginning of 1970s. They still are leaders in the field of artificial 73,74,75,76 intelligence in design[73,74,75,76]. On the engineering 78 side, Morris Asimow[77], Thomas Woodson[78], 79,80,81,82 Vladimir Hubka[79,80], Vladimir Hubka and Ernst Eder[81,82] introduced a new generation of systematic design methods. As Vladimir Hubka and Ernst Eder wrote:

"The first evidence of change originates from the period of the Second World War, and from the reconstruction and construction period. [What] were the particular features of these situations which have caused the need for improvements? On one hand [there was] an unusual pressure toward performance in a highly developed industry, especially new and very demanding needs.... Up to [the] year 1967, we could only find some widely scattered and isolated groups or individual experts who proposed [a] certain solution for [the] improvement of [the] design work.

The next period after about 1967 until today and especially in the seventies, can be labeled as the prime time for the initial development of design science".

Vladimir Hubka organized the first International Conference on Engineering Design (ICED, a series since 1981) in 1967. Vladimir Hubka established "Workshop-Design-Construction, WDK", and called their approach "design science", which we can call a theoretical scientific approach to engineering design methods. They were the representatives of the European engineering designers. In their own words, they differentiate themselves from English-speaking researchers:

"Continental Europeans tend to being outward-looking and trans-national, but also more formal and systematic; English-speakers tend to become more insular and isolationist, with any "foreign" language as a perceived cultural barrier, but also more intuitive and casual, and less formal"[83]. 83

Vladimir Hubka and Ernst Eder both spent several years in industry, working and/or leading design teams. They defined design science in the same book as: "The term 'design science' is to be understood as a system of logically related knowledge, which should contain and organize the complete knowledge about and for designing".

English–speaking engineering design methodologists were Morris Asimow[84], John Christopher 84 Jones[85], Nigel Cross[86], L. Bruce Archer[87], T. T. 85,86,87 Woodson[88], Stuart Pugh[89], David Ullman[90], and 88,89,90 many others.

In the U.S. in 1984, Nam Suh, who was then the assistant director for engineering at the National Science Foundation (NSF), created the Design Theory and Methodology Program. Among his goals in creating this program was developing a science of engineering design and then establishing design as an accepted field of engineering research. From 1986 to 1988, this program was directed by Susan Finger, followed by Jack Dixon[91].

[72] T. A. Markus, ed., *Building Performance* (New York: John Wiley, 1972).

[73] J. Gero, *Computer Applications in Architecture* (London: Applied Science Publishers, 1977).

[74] J. Gero, "Artificial Intelligence in Design," *Proceedings of the Fourth International Conference on the Applications of Artificial Intelligence in Engineering*, Cambridge, UK (Southampton: Springer-Verlag, 1989).

[75] J. Gero, *Artificial Intelligence in Design '91* (Oxford, UK: Butterworth-Heinemann, 1991).

[76] J. Gero, *Artificial Intelligence in Design '94* (Boston: Kluwer Academic Publishers, 1994).

[77] M. Asimow, *Introduction to Design* (Englewood Cliffs, New Jersey: Prentice-Hall Inc, 1962).

[78] T. T. Woodson, *Introduction to Engineering Design* (New York: McGraw-Hill, 1966).

[79] V. Hubka, *Konstruktionwissenschaft* (Design Science in English translation), *VDI-Zeitschrift* 116:11 (1974): 899–905, and 1087–1094.

[80] V. Hubka, *Principles of Engineering Design* (Guilford, UK: Butterworth Scientific Press, 1982).

[81] V. Hubka and E. Eder, "A Scientific Approach to Engineering Design," *Design Studies* 8:3 (1987): 123–137.

[82] V. Hubka and E. Eder, *Design Science* (London: Springer Verlag, 1996), 49–66.

[83] Ibid., 50.

[84] M. Asimow, *Introduction to Design* (1962).

[85] J. C. Jones, *Design Methods: Seeds of Human Futures* (2nd rev. ed.), (New York: Reinhold Van Nostrand, 1992).

[86] N. Cross, *Engineering Design Methods: Strategies for Product Design* (Chichester, UK: John Wiley and Sons, 1994).

[87] L. B. Archer, *Technological Innovation* (London: Science Policy Foundation Special Publication Series, 1971).

[88] S. Pugh, "The Design Audit: How to Use It," *Proceedings of Design Engineering Conference*, (NEC, Birmingham: NEC, 1979).

[89] M. Asimow, Introduction to Design (Englewood Cliffs, New Jersey: Prentice-Hall Inc, 1962).

[90] D. G. Ullman, *The Mechanical Design Process* (New York: McGraw-Hill, 1992).

[91] S. L. Newsome, W. R. Spillers, and S. Finger, *Design Theory '88* (New York: Springer-Verlag, 1989).

Some of the design researchers and design methodologists were working in the field of computer-aided design, and developing their methods in relation to architectural and engineering design problems, applying the models of OR and systems analysis. These approaches caused some problems in the fields of design methodology and design research, because they were thought to be too restrictive in nature.

There was a close relationship between design research and the developments in the IT field, especially in cognitive sciences, and "artificial intelligence" (AI) and expert systems. Marvin Min-
92,93 sky[92 93] was one of the leaders in the application of cognitive science to AI. Studies on AI researchers affected the development of studies on designers, as experts. "Think-aloud" techniques and "proto-
94 col analysis"[94] were adopted by designers. Charles
95 Eastman[95] was a computer-aided design practitioner as well as a design theoretician. He published an article related to intuitive bathroom design and, for the first time, focused on the designer's behav-
96 ior. Donald Schön[96] at MIT opened a new paradigm in design research, and his book, *Reflective Practitioner*, did not seem to relate to computer science at first, but it actually was about the designing behavior of expert designers.

Immense efforts have been made, mainly by the scientists somehow related to computer-aided design, in the development of the cognitive aspects
97,98,99,100 101 of expert designers all over the world[97 98 99 100 101]. One of the first contributions to this field was by
102 Omer Akin[102], at the 1978 "Architectural Design: Interrelations among Theory, Research and Practice"
103,104 conference[103 104]. His Ph.D. thesis, "Psychology of
105 Architects"[105], at Carnegie Mellon University was one of the recognized research works and first publications in this field.

1980s and 1990s opened a new era in design research. Many U.S. departments of design began to establish new academic research units, which were brought about from the government's release of funds on design research, and the encouragement and demand by American industry. The "Ohio Conference on Doctoral Education in Design" in 1998 was one of the first research appeals to education in design (in industrial design and in graphic design) in the U.S. According to Buchanan:

"The *Proceedings of the Ohio Conference on Doctoral Education in Design* focus on the nature and current state of doctoral education in design around the world. This volume explores the foundations of design as a field of inquiry, the role of research in alternate models of doctoral education, the relationship between doctoral education and professional practice, and other issues that are central to the development of design as an emerging field of investigation. Included are discussions of many existing and planned doctoral programs
around the world"[106]. 106

Significant growth in all areas of design research took place during the 1990s. New professional demands on design research, and the new educational confrontations for restructuring knowledge changed the context of design. Universities around the world are developing models of doctoral education in design. Philosophies and theories of design are popular subjects for discussion. Foundations and methods of design research are being reevaluated. The form and structure for the doctorate in design still is under development. The relationship between practice and research in design has become an important focusing topic among the academic as well as the professional communities.

92 M. Minsky, "Steps toward Artificial Intelligence," Proceedings of the IRE 49 (1961): 8–30.
93 M. Minsky, *Semantic Information Processing* (Cambridge, MA: MIT Press, 1968).
94 K. A. Ericsson and H. A. Simon, *Protocol Analysis: Verbal Reports as Data* (Cambridge, MA: MIT Press, 1993).
95 C. Eastman, "On the Analysis of Intuitive Design Process" in G. Moore, ed., *Emerging Methods in Environment and Planning* (Cambridge, MA: MIT Press, 1970), 21–37.
96 D. A. Schön, *The Reflective Practitioner* (New York: Basic Books, 1983).
97 O. Akin, "An Exploration of the Design Process," *Design Methods and Theories*, 13 (1979): 115–119.
98 N. Cross, K. Dorst, and N. Roozenburgh, eds., *Research in Design Thinking* (Delft, The Nederlands: Delft University Press, 1992).
99 N. Cross, H. Cristiaans, and K. Dorst, eds., *Analysing Design Activity* (Chichester, UK: John Wiley & Sons Inc., 1996).
100 J. Gero, *Artificial Intelligence in Design* (1991).
101 K. Dorst, *Describing Design: A Comparison of Padigms* (Vormgeving Rotterdam: Grafisch Ontwerp en druk, 1997)
102 O. Akin, *An Exploration of the Design Process* (1979).
103 N. Bayazit, *Abstracts: Architectural Design: Interrelations among Theory, Research, and Practice* (1978).
104 N. Bayazit, *Papers: Architectural Design: Interrelations among Theory, Research, and Practice* (1979).
105 O. Akin, *Psychology of Architectural Design* (London: Pion Ltd, 1986).
106 *Doctoral Education in Design: Proceedings of the Ohio Conference*, (8–11 October, 1998).

Conclusion

The history of design research with reference to design methodologies, as well as design science, is a wide and comprehensive subject that needs additional extensive research. Only a brief review of research history on this relatively new discipline of design has been covered here. Generally, articles and book chapters concerning state-of-the-art reviews, the history of the discipline, or original conference proceedings and other documents were used in this paper.

Design research and its relevance to design methodology, as well as scientific research, are reviewed. Most design research studies were made in architecture because of the requirements of the societies after World War II. Scientific developments during the war, and the shortage of resources in postwar societies obviously necessitated and gave impetus to the creation of new ways to solve existing problems. Future studies in various design disciplines may benefit from the experience and progress in disciplines concerned with building as well as engineering.

Here, I tried to look at design research and its relevance to design methods and design science from a Turkish perspective. Mutual influences of information technologies and design research were the requirements of the era, although that is not mentioned in many relevant publications. Another area of studying design research is the utilization of the methods of disciplines in such areas as psychology, social psychology, management, economics, semantics, and ergonomics. Here, only main starting points have been indicated concerning the various disciplines.

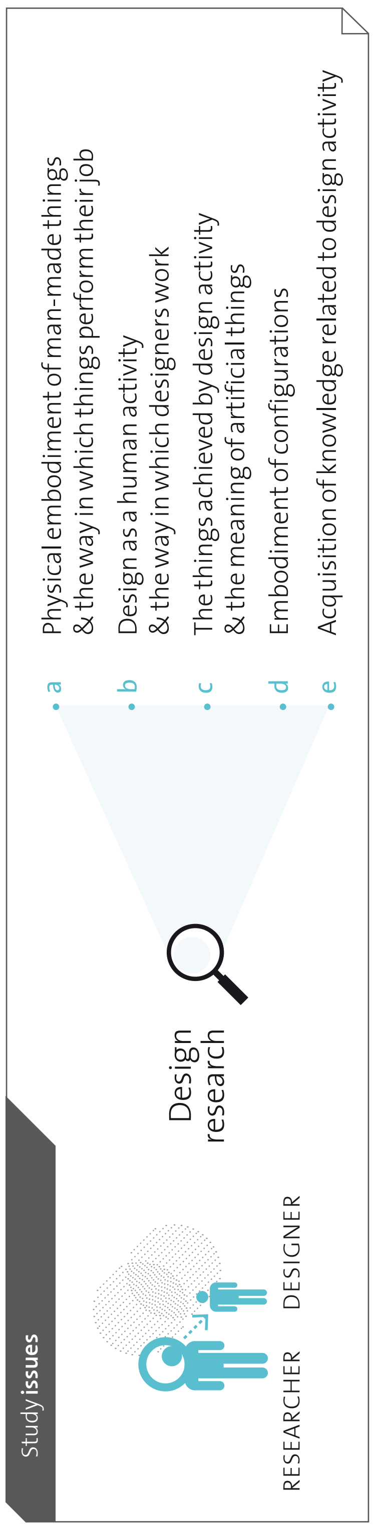
Epilog

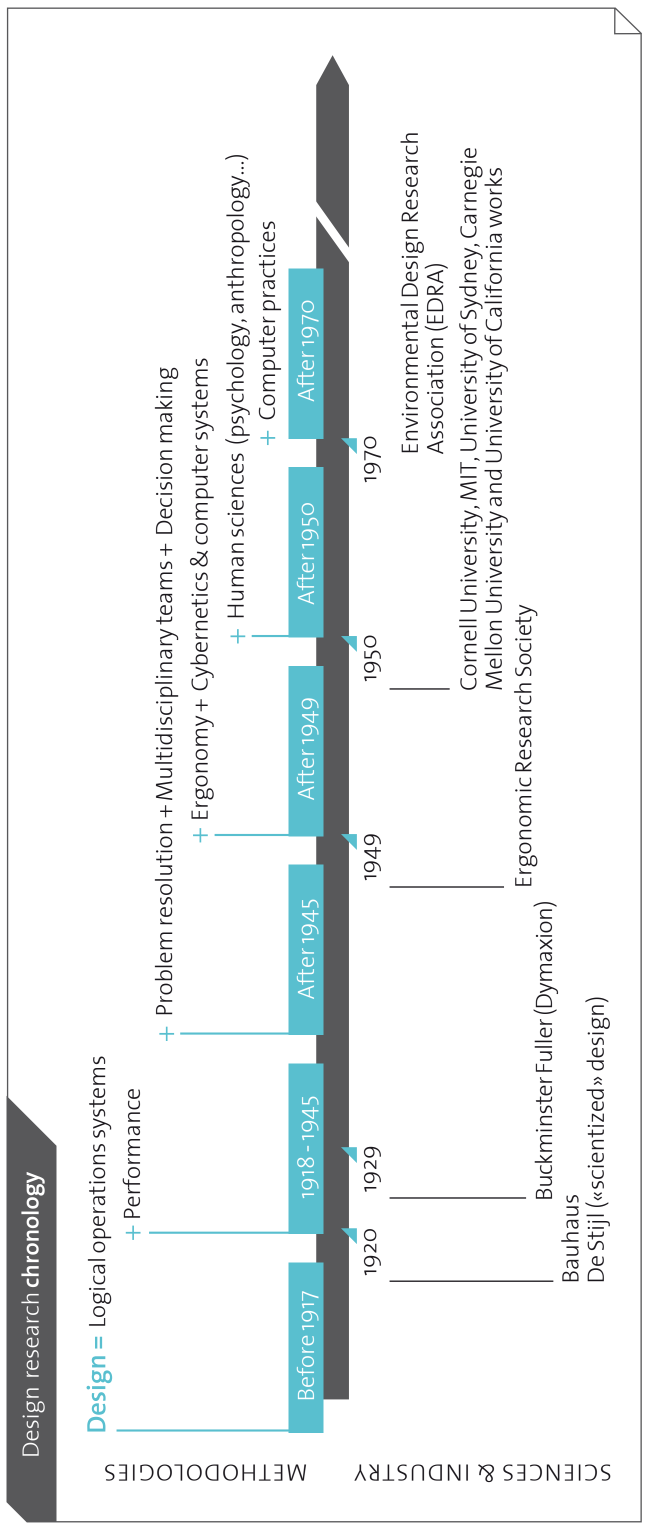
Academics in Turkey were following the developments in the UK and U.S. on design methodology and the scientific approaches to design because the Ph.D. was an obligatory stage of academic life by law in every field – even in architectural design. Consequently, the Architectural Design Methods Chair was established in the ITU Faculty of Architecture in 1973. In Turkey, architectural design methods was recognized by the National Central Authority of Universities as an academic discipline that same year. The first international conference on design in Turkey, "Architectural Design: Interrelations among Theory, Research, and Practice", was held at ITU in 1978 in collaboration with DRS
from the UK. Selected abstracts[107] and papers[108] of 106,107
this conference were published in the U.S. journal *Design Methods and Theories*. Even though it must be confessed that the idea and the intention were very good, the conference received few papers concerned with design research and its relevance to design practice; but it gave an impetus to further Ph.D. studies in architecture.

In 1982 in Turkey, the First National Design Conference also was organized in the ITU Faculty
of Architecture[109]. It was the first national design 109
conference in Turkey covering the disciplines of architectural design, engineering design, and industrial design.

107 N. Bayazit, *Abstracts: Architectural Design: Interrelations among Theory, Research, and Practice* (1978).
108 N. Bayazit, *Papers: Architectural Design: Interrelations among Theory, Research, and Practice* (1979).
109 N. Bayazit , M. Tapan, N. Ayiran, and N. Esin, *Tasarlama (Dizayn) I. Ulusal Kongresi Bildirileri* (Istanbul: Istanbul Teknik Universitesi Mimarlik Fakultesi, 1982).

Design research





REFERENCES

ALEXANDER, C., "State of Art in Design Methodology: Interview with C. Alexander" in *DMG Newsletter* (March 1971), p. 3-7.

ALEXANDER, C., "The Determination of Components for an Indian Village" in Conference on Design Methods, J. C. Jones and D. G. Thornley, eds. (Oxford University Press, 1963).

ALEXANDER, C., *Notes on the Synthesis of Form* (Cambridge, MA: Harvard University Press, 1964).

ALGER, J. R. M., HAYS, C. V., *Creative Synthesis in Design* (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964).

ALLEN, M. S., *Morphological Creativity: The Miracle of Your Hidden Brain Power* (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1962).

ARCHER, L. B., "A View of the Nature of the Design Research" in *Design: Science: Method*, R. Jacques, J. A. Powell, eds. (Guilford, Surrey: IPC Business Press Ltd., 1981), p. 30-47.

ARCHER, L. B., *Systematic Method for Designers* (London: The Design Council, 1965).

ARCHER, L. B., *Systematic Methods for Designers* (London: The Design Council, 1965).

ARCHER, L. B., *Technological Innovation* (London: Science Policy Foundation Special Publication Series, 1971).

ASIMOW, M., *Introduction to Design* (Englewood Cliffs, New Jersey: Prentice-Hall Inc, 1962).

BARZUN, A. J., GRAF, H. F., *Modern Arastirmaci* (translated into Turkish from the *Modern Researcher*), (Ankara: TUBITAK, 1993).

BAYAZIT, N. , M. Tapan, N. Ayiran, and N. Esin, *Tasarlama (Dizayn) I. Ulusal Kongresi Bildirileri* (Istanbul: Istanbul Teknik Universitesi Mimarlik Fakultesi, 1982).

BAYAZIT, N., "A Comprehensive Theory of Participation in Planning and Design (P&D)" in *Design: Science: Method*, R. Jacques, J. A. Powell, eds. (Guilford, Surrey: IPC Business Press Ltd., 1981), p. 30-47.

BAYAZIT, N., *Abstracts: Architectural Design: Interrelations among Theory, Research, and Practice* (1978).

BAYAZIT, N., *Abstracts: Architectural Design: Interrelations among Theory, Research, and Practice* (1978).

BAYAZIT, N., *Endüstri ürünleri Tasariminda ve Mimarlikta Tasarlama Metotlarina Giriß* (Introduction to Design Methods in Industrial Product Design and Architecture), [In Turkish] (Istanbul: Literatur Yayinevi 1994).

BAYAZIT, N., ESIN, N., OZSOY, A., "An Integrative Approach to Design Techniques" in *Design Studies*, 2:4 (1981).

BAYAZIT, N., *Papers: Architectural Design: Interrelations among Theory, Research, and Practice* (1979).

BAYAZIT, N., *Papers: Architectural Design: Interrelations among Theory, Research, and Practice* (1979).

BAYAZIT, N., Planlamaya ve Tasarlamaya Katılma, (ITU Mimarlik Fakultesi, 1982).

BEGLUND, E., *Bord* (Stockholm: Svenska Slöjdföreningen, 1957).

BEGLUND, E., *Skap* (Stockholm: Svenska Slöjdföreningen, 1960).

BEYER, G. H., *Housing and Personal Values*, Memoir 364 (Ithaca, New York: Cornell, University Press, 1959)

BRATTON, E. C., *Oxygen Consumed in Household Tasks* (Ithaca, New York: Cornell University Press, 1950).

BRATTON, E. C., *Some Factors of Cost to the Body in Standing and Sitting to Work Under Different Postural Conditions* (Ithaca, New York: Cornell University Press,1959).

BROADBENT, G., "The Development of Design Methods" in *Design Methods and Theories* 13:1 (1979), p. 41-45.

BROADBENT, G., "The Morality of Design" in *Design: Science: Method* (1981), p. 309-328.

BROADBENT, G., *Design in Architecture* (London: John Wiley and Sons, 1973), p. 115.

BROADBENT, G., WARD, A. (Eds.), *Design Methods in Architecture* (London: Lund Humphries, 1969).

C. Eastman, "On the Analysis of Intuitive Design Process" in G. Moore, ed., *Emerging Methods in Environment and Planning* (Cambridge, MA: MIT Press, 1970), 21–37.

CHERMAYEFF, S., ALEXANDER, C., *Community and Privacy: Toward a New Architecture of Humanism* (New York: Doubleday and Co. Inc., 1963).

CROSS, N., *Design Methodology and Relationship with Science* (1993).

CROSS, N., "A History of Design Methodology" in *Design Methodology and Relationship with Science*, NATO ASI Series, M. J. De Vries, N. Cross, and D. P. Grant, eds. (Dordrecht: Kluwer Academic Publishers, 1993).

CROSS, N., "Designerly Ways of Knowing: Design Discipline Versus Design Science" in *Design Plus Research, Proceedings of the Politenico di Milano Conference*, Silvia Picazzaro, Amilton Arruda, and Dijon De Morales, eds. (May 18–20, 2000), p. 43-48.

CROSS, N., *Developments in Design Methodology* (Chichester, UK: John Wiley & Sons, 1984).

CROSS, N., *Engineering Design Methods: Strategies for Product Design* (Chichester, UK: John Wiley and Sons, 1994).

D. A. Schön, *The Reflective Practitioner* (New York: Basic Books, 1983).

Design Methods and Theories Journal of DMG 20:2 (1986).

Doctoral Education in Design: Proceedings of the Ohio Conference (8-11 October, 1998).

Doctoral Education in Design: Proceedings of the Ohio Conference, (8¬–11 October, 1998).

EDEL, D. H., *Introduction to Creative Design* (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1967).

FORTY, A., *Objects of Desire: Design and Society, 1750-1980* (London: Thames and Hudson, 1986), p. 131-132.

FRAYLING, C., "Research in Art and Design" in *Royal College of Art Research Papers* 1:1 (1993/4).

GERO, J., "Artificial Intelligence in Design" in *Proceedings of the Fourth International Conference on the Applications of Artificial Intelligence in Engineering*, Cambridge, UK (Southampton: Springer-Verlag, 1989).

GERO, J., *Artificial Intelligence in Design '91* (Oxford, UK: Butterworth-Heinemann, 1991).

GERO, J., *Artificial Intelligence in Design '94* (Boston: Kluwer Academic Publishers, 1994).

GERO, J., *Computer Applications in Architecture* (London: Applied Science Publishers, 1977).

GIEDION, S., *Mechanization Takes Command* (New York: Oxford University Press, 1948).

GREGORY, S. A. (Ed), *The Design Method* (London: Butterworth Press, 1966).

HAMILTON, R. (Eds), "The Recent History of Post-Industrial Design Methods" in *Design and Industry* (London: The Design Council, 1980).

HARRISON, S. E., *Design of Bedsteads*, King Edward's Hospital, London, 1967).

HUBKA, V., EDER, E., "A Scientific Approach to Engineering Design" in *Design Studies* 8:3 (1987), p. 123-137.

HUBKA, V., EDER, E., *Design Science* (London: Springer Verlag, 1996), p. 49-66.

HUBKA, V., EDER., E., *Design Science* (London: Springer Verlag, 1996).

HUBKA, V., *Konstruktionwissenschaft* (Design science in English translation), *VDI-Zeitschrift* 116:11 (1974), p. 899-905, p. 1087-1094.

HUBKA, V., *Principles of Engineering Design* (Guilford, UK: Butterworth Scientific Press, 1982).

IGMA, *Arbeitsberihte zur Planungsmethodik 1: Bewertungsprobleme in der Bauplanung* (Stuttgart/Bern: Karl Kramer Verlag, 1970).

IGMA, *Arbeitsberihte zur Planungsmethodik 4: Entwurfsmethoden in der Bauplanung* (Stuttgart/Bern: Karl Kramer Verlag, 1970).

IGMA, Arbeitsberihte zur Planungsmethodik 6: Nutzbeteiligung an Planungprozessen (Stuttgart/Bern: Karl Kramer Verlag, 1972).

J. Gero, *Artificial Intelligence in Design* (1991).

JERRARD, B., NEWPORT, R., TRUEMAN, M., *Managing New Product Innovation* (London, Philadelphia: Taylor & Francis, 1999).

JONES, J. C., "How My Thoughts about Design Methods have Changed During the Years" in *Design Methods and Theories: Journal of DMG and DRS* 11:1 (January– March, 1977).

JONES, J. C., *Design Methods: Seeds of Human Futures* (New York: Reinhold Van Nostrand, 1992).

JONES, J. C., THORNLEY, D. G., *Conference on Design Methods* (Oxford University Press, 1963).

K. A. Ericsson and H. A. Simon, *Protocol Analysis: Verbal Reports as Data* (Cambridge, MA: MIT Press, 1993).

K. Dorst, *Describing Design: A Comparison of Padigms* (Vormgeving Rotterdam: Grafisch Ontwerp en druk, 1997).

KIRA, A., *The Bathroom* (New and expanded edition), (Ithaca, New York: The Viking Press, 1966).

KNOWLES, E., *Postures and Other Physiological Responses of the Working Surfaces in Household Ironing* (Ithaca, New York: Cornell University Press, 1943).

KUGL, S., *God, Bostad I dagt och I morgon*, (Stockholm: Bostads, 1964).

LANGDON, F. J., "The Design of Mechanized Offices" in *The Architects' Journal* (May 1 and 22, 1963).

LANGFORT, M., *Personal Hygiene Attitudes and Practices in 1000 Middle-Class Households* (Ithaca, New York: Cornell University Agricultural Experiment Station (New York State College of Home Economics, 1965).

LARSON, C. T. (Ed), SER2: *School Environmental Research*, University of Michigan (1965).

M. Minsky, *Semantic Information Processing* (Cambridge, MA: MIT Press, 1968).

MANNING, P. (Ed), *Office Design: "A Study of Environment, Department of Building Science"*, University of Liverpool (Liverpool: Pilkington Research Unit, 1965).

MARGOLIN, V., BUCHANAN, R., *The Idea of Design: A Design Issues Reader* (Cambridge, MA: The MIT Press, 1995).

MARKUS, T. A. (Ed), *Building Performance* (New York: John Wiley, 1972).

MEAD, M., *Cultural Patterns and Technical Change* (UNESCO, 1955).

MINSKY, M., "Steps toward Artificial Intelligence" in *Proceedings of the IRE* 49 (1961): 8¬–30.

MOSLEY, L., "A Rational Design Theory for Planning Buildings, Based on the Analysis and Solutions of the Circulation Problems" in *The Architects' Journal*, (September 11, 1963), p. 525-537.

N. Cross, H. Cristiaans, and K. Dorst, eds., *Analysing Design Activity* (Chichester, UK: John Wiley & Sons Inc., 1996).

N. Cross, K. Dorst, and N. Roozenburgh, eds., *Research in Design Thinking* (Delft, The Nederlands: Delft University Press, 1992).

NEWSOME, S. L., SPILLERs, W. R., FINGER, S., *Design Theory '88* (New York: Springer-Verlag, 1989).

NOBLE, J., "How and Why of Behaviour: Social Psychology for the Architect" in *The Architects' Journal* (March 6, 1963).

O. Akin, "An Exploration of the Design Process," *Design Methods and Theories*, 13 (1979): 115–119.

O. Akin, *An Exploration of the Design Process* (1979).

O. Akin, *Psychology of Architectural Design* (London: Pion Ltd, 1986).

PASK, G., "The Conception of a Shape and the Evolution of a Design" in J. C. Jones and D. G. Thornley, eds., *Conference on Design Methods* (Oxford: Pergamon Press, 1963).

PUGH, S., "The Design Audit: How to Use It" in *Proceedings of Design Engineering Conference*, NEC, Birmingham: NEC, 1979).

RITTEL, H., *The DMG 5th Anniversary Report* (1972).

RITTEL, H., *The DMG 5th Anniversary Report* (1972).

SIMON, H. A., "Rational Choice and the Structure of the Environment" in *Psychological Review* 63 (1956), p. 129-138.

SIMON, H. A., *The Sciences of the Artificial* (Cambridge, MA: MIT Press, Third Edition, 1999).

SIMON, H. A., *The Sciences of the Artificial*, 1968.

ULLMAN, D. G., *The Mechanical Design Process* (New York: McGraw-Hill, 1992).

WOODSON, T. T., *Introduction to Engineering Design* (New York: McGraw-Hill, 1966).

Céline Mougenot

From France to Japan: An International Experience in Post-Doctoral Research on Design, Cognition and Creativity

CÉLINE MOUGENOT

Abstract

As a PhD graduate from Arts et Metiers ParisTech in 2008, I headed to Japan for a two-year post-doctoral project on design cognition and creativity at the University of Tokyo. When I describe my current research project, "Studying Design Creativity", I am often asked by Japanese people why I chose to work in their country. In fact, the Japanese are still not convinced that they can be as creative as people in the West! But the reasons for coming to the Land of the Rising Sun are obvious: Japan pioneered research in design science and is still a fascinating place for anyone interested in design. *Collection* reports my experience as a young design researcher in Japan.

From France to Japan: An International Experience in Post-Doctoral Research on Design, Cognition and Creativity

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Background in CAD consulting

I was first trained as a design engineer at INSA Lyon and hired by Dassault Systemes, the leading producer of computer-aided design (CAD) software worldwide. This position consisted of providing design professionals with methodological best practices for CAD, depending on their design specialty and skills, e.g. industrial design. But at that time, designers had to adapt to the complicated software components that were developed by computer engineers, who were fairly ignorant of the design process. Besides, CAD-software was mainly used in routine design tasks and designers' creativity was not really supported by these computer-tools.

Visiting Student in Japan

To better understand the creative design process, I specialized in design research through a master's program in design at the Technological University of Compiegne (UTC), France. Supervised by Anne Guenand, my research project aimed at designing an interface for a music-file browser, based on affective computing, tangible interaction principles, and *kansei engineering*. The goal was to involve the users in an interactive and tangible user experience and thus to elicit a high-level of emotional response. This project was finalized during a 4-month stay at Chiba Institute of Technology in Japan, thanks to an exchange agreement signed by the French and Japanese universities.

A presentation of this project was given at an international design conference in Taiwan[1]. 1
Research conferences are exciting events where several days are dedicated to listening to presentations, meeting renowned specialists from all over the world and discussing ideas with people who share the same research interest. The participation in this conference reinforced my will to pursue a career in design research.

PhD Thesis in Design

From January 2006 to December 2008, I carried out my PhD research at Arts et Metiers ParisTech, under the supervision of Pr. Ameziane Aoussat and Pr. Carole Bouchard. The context of my research was "TRENDS"[2], a project funded by 2
the European Union with a 2,5 M€-budget. Several academic and industrial partners from various fields such as design, psychology of design or computer science were joining forces to develop image-retrieval software similar to Google, but specifically aimed at supporting inspiration in design (unlike Google).

Designing products is a human activity which involves specific cognitive skills, subjectivity, and emotions. In order to support designers' creativity, design tools have to be developed with a deep knowledge of designers' cognitive activity and cognitive specificities.

In fact, to stimulate their creativity, most designers collect images of precedents, i.e. existing artifacts; however, the link between these images and the design concepts proposed by designers is still not really understood. Investigating this creative process brings not only insight on design activities, but also insight on human creativity in general.

In practice, the project consisted of observations, interviews, and "experiments" with professional designers at FIAT and Stile Bertone in Italy. The research hypothesis was that images could be categorized into sectors, i.e. types of product (automotive, fashion, architecture...). Remote sectors, i.e. sectors far from the designer's own specialty, would lead to fruitful analogies and better support creativity than images showing products from the designer's own field. To quantify the impact of inspirational images, designers' sketches that came out of the creativity session were assessed by design experts based on their level of novelty and practicality.

One of the main findings was that visual inspiration from remote sectors allowed designers to provide more creative design solutions than inspiration from their own sector. This output was implemented in the development of TRENDS image-search software, through an image database structured into sectors.

Figure 1: Post-doc fellows, funded by the Japanese Society for the Promotion of Science (I'm the second from the left, in the back).

Post-Doc Research in Japan

For about a decade, there has been an increasing interest in design cognition and design thinking. It is now widely recognized that designing is a unique human activity and scientific study of design not only helps to support design practice and education but also brings knowledge about human abilities like creativity, visual reasoning, perception, emotion and so on.

In Japan, research in design science is well-established, quite advanced, and generously funded. Thus, after my PhD project was completed, I decided to pursue my research in Japan. My project on studying design creativity was accepted by Pr. Katsumi Watanabe, a well-recognized researcher in cognitive science affiliated with the University of Tokyo; then, after a competitive selection held every year by the Japanese Society for the Promotion of Science (JSPS), the project was awarded a fellowship for foreign post-doctoral research and generous funding for two years.

My research is aimed at studying design creativity with the tools of cognitive sciences (response analyses, eye-tracking, brain activity measurements ...). This type of interdisciplinary research in design and cognitive sciences is rapidly expanding, with labs in South Korea (KAIST), Australia (Key Center for Design Computing and Cognition), The Netherlands (TU Delft) and others leading the way.

This research field is developing its structure through the creation of networks such as the Design and Emotion Society (D&E) or through the organization of international events like KEER2010 (Kansei Engineering and Emotional Research). Although Japan is one of the pioneers in design-and-emotion research, this field is now attracting researchers from all over the world.

3 Good for knowledge! Good for design![3]

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1 IASDR (International Association of Societies of Design Research) is one of the main international conferences in design, it is organized every 2 years (next IASDR conference in 2011).

2 Trends Research Enabler for Design Specifications.

3 For more information on design research or on research in Japan: celine.mougenot@gmail.com.

COLLECTION

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