

The Design Methodology Group Faculty of Industrial Design Engineering TU Delft

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1. INTRODUCTION

The Delft faculty of Industrial Design Engineering has a five-person group working on Design Methodology. Organizationally this group is linked to the department of New Product Development, section innovation management.

This research group has been internationally active for quite some time—it must be one of the oldest and biggest in Holland. The development of and reflection on design methods is seen as one of the key areas of research in our faculty. We are also very much involved in developing and monitoring the design teaching.

The key scientific events of the last few years were the organizing of two workshops on Research in Design Thinking. A theoretical workshop was held in 1991 and a special workshop on protocol analysis in 1994. The faculty has co-organized the ICED '93 conference in Den Haag, with our methodology group as a main contributor.

Two widely used textbooks for design methodology teaching (in industrial design and in engineering) have been written by members of our group, Norbert Roozenburg and Nigel Cross.

2. SPANNING DESIGN METHODOLOGY

But this five person group seems small when you compare it with the task before us: our mission is to span (or at least keep track of) the whole width and depth of Design Methodology. The growth in design methodology is clearly outrunning the growth in our group.

But currently, our activities do run from empirical studies in design psychology (Christiaans, Cross and Dorst), theoretical formulation of design knowledge (Roozenburg) and computational models of design (Kruger) to the development of design support systems.

The research projects in these fields have at least one thing in common: we are all trying to structure the different parts of design reality by making models of it.

These models are the stepping stones to develop and refine prescriptive methods for design, to improve design teaching (with the aid of a well-developed design psychology), and to help develop computer tools supporting the design ability. Four of us are developing these models of the design process on the basis of empirical research, i.e. protocol analysis of design projects, which has become a speciality of ours.

But the research projects are very much tied to the people—the projects have are too diverse to be summarized in a short introductory note like this. The small biographies below will provide more detail on all of the projects.

3. PEOPLE AND PROJECTS

3.1 Henri Christiaans

Henri H.C.M. Christiaans is a psychologist by training. His research activities into design during the last eight years have focused on the following topics: the connection between the design process and the creativity of the design result, the information processing during the design process and the role of argumentative knowledge in communication processes of design teams.

- *The knowledge base of the designer* (Christiaans and Venselaar): The aim of this study is to understand how the knowledge base of the (novice) designer affects the quality of the design. The studies done so far focus on the relationship between acquisition and use of knowledge in designing by novice design students, and the quality of their products. Three main knowledge components were measured: domain-specific basic and design knowledge, and general process knowledge. The studies described here suggest a close relationship between the amount of general process knowledge mentioned by the novices and the perceived quality of the designed product.

- *Information transfer* (Van AnDEL & Christiaans): This is an investigation into the question how problem solvers select relevant information and how they represent and retrieve expert knowledge. Designers cannot meaningfully identify and search for relevant information without the orientation of a solution concept. This study is concerned with the question under what conditions information from external sources is more accessible for designers, and influences the design output. Information is gathered which appears to come from two sources—knowledge from everyday, incidental experience or as a result of intentional learning by deriving information from the presentation of specific design related material. Through experiments with design students the effects of various methods of information transfer are studied.

- *The role of argumentative knowledge* (Trousse & Christiaans): One of the limitations of the current systems in complex problem solving is that hardly any attention is paid to the discursive activities performed. In general, every designer solving a problem starts a communication process and thus a process of argumentation. For a better understanding of problem solving activities it seems valuable to analyse the process within an argumentation linguistics framework. On the basis of such a framework more valid and reliable specifications for the development of real cooperative knowledge-based design support systems could be derived.

3.1.1 Recent publications:

Christiaans, H.H.C.M. (1993). *Creativity in design*. Utrecht: Lemma.

Christiaans, H.H.C.M. & Van Anandel, J. (1993). The effects of examples on the use of knowledge in a student design activity: The case of the 'flying Dutchman'. *Design Studies*, 14 (1), 58-74.

Cross, N., Christiaans, H.H.C.M. & Dorst, K. (1994). Design expertise amongst student designers. *Art & Design Education*, 13 (1), 39-56.

Trousse, B. & Christiaans, H.H.C.M. (in press). Design as a topos-based argumentative activity. In Dorst, K., Christiaans, H.H.C.M. & Cross, N. (eds) *Analysing Design Activity*, Wiley, Chichester.

3.2 Nigel Cross

Nigel Cross is Professor of Design Methodology at the Faculty of Industrial Design Engineering, and also Professor of Design Studies at the Design Discipline, Faculty of Technology, The Open University, UK. He is Editor-in-Chief of the international research journal, *Design Studies*, published quarterly by Butterworth-Heinemann in cooperation with the Design Research Society.

Nigel Cross has academic and practical backgrounds in architecture and industrial design. He is well-known for his research in computer-aided design, design methodology and design education. His current principal research interest is in analysing the cognitive activities of designers. He was involved in organizing the two workshops on 'Research in Design Thinking' held at TUDelft in 1991 and 1994.

3.2.1 Books:

- Design Participation* (editor), Academy Editions, London, 1972.
- Man-Made Futures: Readings in Society, Technology and Design* (co-editor with D. Elliott and R. Roy), Hutchinson Educational, London, 1974.
- The Automated Architect: Human and Machine Roles in Design*, Pion, London, 1977.
- Developments in Design Methodology* (editor), Wiley, Chichester, 1984.
- Design and Society* (co-editor with R. Langdon), The Design Council, London, 1984.
- Engineering Design Methods*, Wiley, Chichester, 1989.
- Engineering Design Methods: Strategies for Product Design* (2nd edition), Wiley, Chichester, 1994.
- Research in Design Thinking* (co-editor with K. Dorst and N. Roozenburg), Delft University Press, Delft, 1992.
- Design Methodology and Relationships with Science* (co-editor with M. J. de Vries and D. Grant), Kluwer, Dordrecht, 1993.

3.2.2 Papers:

- Design as a Discipline: Designerly Ways of Knowing, *Design Studies*, Vol. 3, No. 4, 1982.
- Styles of Learning, Designing and Computing, *Design Studies*, Vol. 6, No. 3, 1985.
- The Nature and Nurture of Design Ability, *Design Studies*, Vol. 11, No. 3, 1990.
- Modelling the Design Process in Engineering and in Architecture (with N. Roozenburg), *Journal of Engineering Design*, Vol. 3, No. 4, 1992.
- Science and Design Methodology: a review, *Research in Engineering Design*, Vol. 5, No. 2, 1993.
- Design Expertise Amongst Student Designers (with H. Christiaans and K. Dorst), *Journal of Art and Design Education*, Vol. 13, No. 1, 1994.

3.3 Kees Dorst

Kees Dorst has been trained as an Industrial Design Engineer. He has worked in a number of design consultancies, working on some 50 products. He has given lectures on a number of design and art schools in Holland.

He has also been working on a PhD in Design Methodology in Delft, comparing the paradigms of current design methodology on the basis of empirical data.

The two main paradigms—a positivistic one, seeing design as a process of rational problem solving and a constructionist one, taking design as a process of reflection-in-action—tackle fundamentally different aspects of the design activity. In this study, the descriptive value of these approaches is estimated by looking at their ability to trace *integration* in detailed design processes. The thesis should be finished by the middle of 1995.

Another main line in his research is developing the use of protocol analysis for studying design activity. A major event of the last year was the organizing of the international protocol analysis workshop 'Analysing Design Activity' in september 1994. He is main editor of the book of commissioned papers to result from that workshop, and the guest-editor of a special issue of the journal *Design Studies* on the subject of protocol analysis (april 1995).

3.3.1 Recent publications:

- Roozenburg, N.F.M., Dorst C.H., Some guidelines for the development of performance specifications in product design. *ICED 91*, Zürich: Heurista (1991)
- Christiaans H.H.C.M., Dorst C.H., Cognitive models in industrial design engineering: a protocol study *Design Theory and Methodology, DTM '92*, ASME, NY (1992)
- Cross N.G., Dorst C.H., Roozenburg N.F.M., (eds) *Research in Design Thinking*, Delft University Press, Delft (1992).
- Dorst C.H., The structuring of industrial design problems, *proceedings of the ICED'93 conference*, Heurista, Zuerich (1993)
- Bos A.C. and Dorst C.H., Marketeer & Ontwerper: naar een nieuwe rolverdeling. *Tijdschrift voor Marketing*, nov 1993.
- Cross N.G., Christiaans H.H.C.M, Dorst C.H., Design Expertise Amongst Student Designers *Journal of Art & Design Education* Vol 13 no 1, (june 1994)
- Hinte E. van, Samenspel—het ontwerpproces wordt complexer, *Items*, november 1994.
- Dorst C.H. and Dijkhuis J., Comparing Paradigms for Describing Design Activity, *Design Studies*, (april 1995)
- Dorst, C.H., Christiaans, H.H.C.M. & Cross, N.G. (eds) *Analysing Design Activity*, Wiley, Chichester (1995)

3.4 Corine Kruger

Corine Kruger has a masters in social sciences with specialisation in artificial intelligence, scientific methodology, and cognitive psychology. She has worked for Bolesian (specialized in the development of knowledge based systems) and CAV (specialized in Multi Media productions). She has almost finished a PhD thesis on a computational model of Industrial Design Engineering.

The goal of her research project is the development of a design system in the domain of Industrial Design Engineering on the basis of empirical studies of the human design process. The empirical study involded a protocol study. The data gathered were interpreted in the frame work of COMMONKADS (a knowledge based system development methodology). On the basis of the analysis of the empirical data a conceptual model of the Industrial Design Engineering process in COMMONKADS has been developed. This conceptual model is implemented in Prolog at this moment. The design system, SYNSYS, will simulate the Industrial Design Engineering process, and will function as a means to test the conceptual model.

3.4.1 Publications:

- Kruger, C., (1990), Een interpretatiemodel voor ontwerptaken (An interpretation model for design tasks), Masters Thesis, University of Amsterdam, SWI, Amsterdam.
- Kruger, C., (1990), Naar een expertsysteem voor ontwerpers (Towards an expert system for designers), Masters Thesis, University of Amsterdam, SWI, Amsterdam.
- Kruger, C (1991), Models of design based on empirical data to support the development of design systems, internal report, Faculty of Industrial Design Engineering, TU Delft, Netherlands.
- Kruger, C, and, Wielinga, B (1993), A KADS model for the industrial design task, proceedings of 3rd KADS meeting, Munchen, Germany.
- Kruger, C (1993), Cognitive aspects of re-use in industrial design engineering, proceedings of IJCAI '93, Chamberry, France.
- Kruger, C, and, Wielinga, B (1994), Knowledge acquisition in Industrial Design Engineering; an empirical study (Idea-generation methods), proceedings of KAW'94, Banff, Canada.
- Kruger, C, Analysis in the conceptual stage of the design process, proceedings of ITD94, Moscow, Russia.
- Kruger, C, Information selection strategies, to be published in the proceedings of ICED'95, Praag.

3.5 Norbert Roozenburg

Norbert Roozenburg studied Industrial Design Engineering (Industrieel Ontwerpen) and is associate professor at the Delft Faculty of Industrial Design Engineering, being involved in lecturing and research on design methods and theories. He worked for Total Design in Amsterdam as product designer and project manager and as assistant director of the Eindhoven Academy of Industrial Design, responsible for the education programmes in industrial design and fine arts.

He is editor of *Design Studies*, *Research in Engineering Design* and the Wiley book series *Product Development: Planning, Designing, Engineering*.

Research: Design and Science; A study into the significance of scientific knowledge and scientific method for designing artefacts. The aim of this study is to clarify the relationship between science and product design in order to foster a more realistic view on the significance of both design and science for product development.

From a methodological point of view designing material artefacts and scientific investigation are different activities, which pursue different goals and apply different methods. However, in practice, there is a strong interplay between the two. Yet, the nature of this interaction is not well understood.

The relationships between design and science have been studied—from different angles—in the philosophies of science and technology and in the history and sociology of science and technology. Most of these studies focus on the relationships between research in physics and technical inventions. That is, they focus on the front-end of R&D. In this project the interplay between science and design during the second half of R&D is being studied. It focuses in particular on the new product development process in which well known or new technical possibilities, or even new inventions, are being developed into useful and commercially viable products. In particular an answer is looked for to three questions:

- 1 What is (can be, should be) the role of scientific *knowledge* in product design?
- 2 What role is (can be, should be) played by scientific *method* in product design?
- 3 Can design be seen as a science, and if so, what is (should be) the nature of that science?

3.5.1 Recent publications:

- Roozenburg, N.F.M. & J. Eekels, *Product Design: Fundamentals and Methods*. Chichester, Wiley, 1995 (forthcoming).
- Roozenburg, N.F.M., On the pattern of reasoning in innovative design. *Design Studies*, 14 (1993) 1, 4-18.
- Cross, N., K. Dorst and N.F.M. Roozenburg (eds.), *Research in Design Thinking*. Delft University Press, 1992.
- Roozenburg, N.F.M. & J. Eekels, *Produktontwerpen; structuur en methoden*. Utrecht: Lemma, 1991.
- Roozenburg, N.F.M. & K. Dorst, Some guide-lines for the development of performance specifications in product design. In: *Proceedings of the International Conference on Engineering Design (ICED 91)*, Zürich, August 1991. Zürich: Heurista, 1991.
- Roozenburg, N.F.M. & N. Cross, Models of the design process—integrating across the disciplines. *Design Studies*, 12 (1991) 4, 215-220.
- Eekels, J. & N.F.M. Roozenburg, A methodological comparison of the structures of scientific research and engineering design. *Design Studies*, 12 (1991) 4, 197-203.
- Roozenburg, N.F.M. & J. Eekels (eds.), *Evaluation and Decision in Design*. Zürich: Heurista, 1990 (Schriftenreihe WDK 17).