Design Research in the Netherlands 2000

Introduction

The first Design Research in the Netherlands symposium was organised in 1995, with the specific aim to offer a forum for academics active in the widely varied field of design research. People studying architecture, industrial design, mechanical engineering, computer science, etc. took part in this meeting. In 1997, a follow-up with an accent on design education was organised under the title "Design Education in the Netherlands." On that occasion, design disciplines with a less research-oriented approach such as fashion design and graphic-design participated in the symposium as well.

We are proud to present the proceedings of the second Design Research in the Netherlands symposium, which took place on 24-25 May 2000. Again, the aim of the symposium was to gather academics in the field to discuss their research methods, findings, approaches, and positions. The organisers were very happy to have Mark D. Gross as keynote speaker for the symposium. Mark Gross has been involved in architectural design support with computer tools. His early work has been with, among others, John Habraken at MIT. Research areas include graphic constraint-definition, diagrams, concept design games, and user interfaces. The "Cocktail Napkin" project received widespread acclaim in the human-computer interaction for design field. Mark Gross is currently Associate Professor at the University of Washington, Seatle, where he directs the Design Machine Group.

Proceedings

These proceedings include two additional papers with respect to the preprints. The paper by Ad den Otter on information ecologies was presented at the symposium, and the paper by Beheshti, Tolman, and van der Veer was submitted afterwards to provide an overview of the Design and Building Informatics Group of Civil Engineering in Delft.

The articles included here are by no means a complete overview of all the design research activity that takes place in the Netherlands. To name a few, the departments of Structural Engineering, Computer Science, and Curriculum Development at Twente University, the Artificial Intelligence group of the Vrije Universiteit Amsterdam, and most design schools in higher education. Furthermore, there is an ongoing interest within industry to reflect about design and good design practice, although these findings are typically not communicated externally. Nevertheless, the papers gathered here provide a provisional map of design research activity in the Netherlands.

Four themes

Contributions to the symposium came from the following disciplines: Architecture, Civil Engineering, Technology Management, Industrial Design Engineering, Aerospace Engineering, and Information Technology. The papers have been organised into four themes: Theory, Process, Representation, and Computation. These themes are not absolute categories; they serve to identify main issues that are dealt with in the various papers.

Theme 1: Design theory

Design theory aims to provide a general framework within which design can be studied or results from research to be interpreted. Like design methodology, the results can be descriptive studies of design as it happens in practice, experimental set-ups or prescriptive studies of how design should happen and how the process should be organised. Generally speaking, design theory also deals with the appropriate (knowledge) structures for design. The first two papers touch on a basic question in the field: is it possible to make a general description of design that holds for all design disciplines, while being specific enough to be of value in any of these disciplines? The second set of three papers in this theme specifically focuses on the discipline of architectural design.

Beheshti, in his paper "Domains of Design Research", aims to provide a comprehensive map of the field in order to chart all advanced technologies that can be utilised in the design process. He first sets up a general structure and then subdivides design tools into the following categories:

1) General application tools that help with decision support.
2) General application tools that help describe specific aspects of design.
3) Basic tools for processing information.
4) Basic tools for reasoning about design.

The resulting taxonomy is of particular importance for exchanging experiences and research on advanced technologies among the various design disciplines.

Van Aken's motivation for a general theory of design lies in providing a context-free design theory for the Postgraduate Design Engineer studies in Architectural Design Management Systems (ADMS) at Eindhoven. ADMS falls under the Stan Ackermans Institute, which houses several studies for different disciplines. In his article, "Domain Independent Design Theory", van Aken distinguishes between three kinds of design:

1) The design of the design process itself.
2) The design of the object.
3) The design of the realisation process.

In particular the design of the design process has van Aken's special attention.

Bax and Trum are, as van Aken above, interested in designing the design process. Both authors have been actively engaged in describing architectural design by means of a taxonomy of concepts that comprehensively describes all aspects of architectural design. By also distinguishing between the dimensions Form, Function, and Time, they are able to describe any object in design in a generalised manner. In their paper, "A Building Design Process Model", Bax and Trum then set out to describe the design of the design process in terms of this theoretical framework. They establish a design process model that consists of eight steps and then elaborate each of these steps for architectural design.

Ad den Otter's paper, "Improvement of the Design Process", identifies a number of characteristic problems in architectural design and design teams. Information and Communication Technology generally are conceived to tackle these problems. However, den Otter notes some practical issues that block such development. Den Otter advocates a renewed attention to the managerial structures that play a role in design, and introduces seven formative aspects for a so-called "information ecology".

Mick Eekhout presents in "Design Methodology for Building Products", a prescriptive and detailed stepwise plan for designing new building components. This method, the "Organogram for Product Development" is structured in five phases:

- Design Concept.
- Preliminary Marketing.
- Prototype Development.
- Final Marketing.
- Product Manufacturing.

Each phase is further detailed in activities that need to be undertaken. In total, Eekhout discusses sixty-nine activities. The order is presented sequentially, but the author indicates where and how parallel processes can take place, and how the recursive nature of design is accommodated in the Organogram. Eekhout also notes that for some activities there also exist more specific methodologies, and states that the Organogram can function as the framework for these more specific methods.

Theme 2: Design process

The study of design processes provides the main body of knowledge of concrete design processes, and allows for further inquiry into methods, descriptive techniques, cognitive studies, and the development of tools. In this theme, the authors are mostly interested in precisely this descriptive research of the design process. The first two papers are from the discipline of Industrial Design, and the third from Architectural Design.

Henri Christiaans and John Restrepo in their paper, "Information Processing in Design", point to the importance of contextual information in the design process. They note difficulties in information processing due to time constraints, information load, and so forth. The authors claim that provision of better-suited information-handling tools can considerably help design and improve the quality of the design (and process). To illustrate this theoretical approach, they list four empirical research projects in which various aspects of contextual information and information processing are studied. Based on these findings, they are able to nuance their position and identify related further questions.

Jan Buijs presents an overview of the work done in the Design Methodology Group and the Management and Organisation Group of the Department of Product Information and Management in the Sub-Faculty of Industrial Design Engineering, Delft. The Design Methodology Group has a research tradition in design methods, protocol analysis, and research paradigms. The Management and Organisation Group has a research tradition in design in context; studying in particular design teams in practice. In his paper, "Developing NPD-Process Knowledge", Jan Buijs lists the research findings for both groups during the past five years.

Mieke Oostra, in her paper "Product Development and Design Research", discusses the findings in her Ph.D. work on how architects develop new building components. From interviewing and reconstructing actual cases, she identifies a number of themes and patterns that occur regularly. There are two main themes: Resources (such as product development budget, time, and information and facilities), and Constraints. There are three general groups of patterns: Motivation, Roles, and Strategies. Oostra elaborates these in a listing of specific patterns that were found in her case studies. They are further organised on the aspects of: Time, Money, Quality, Information and Communication, Organisation, and Atmosphere.

Theme 3: Design representations

The theme of design representations deals with the external representations such as drawings, sketches, and models that designers use in the design process. The papers in this theme deal with sketches and drawings, in particular as they are used in the discipline of Architectural Design.

In the "Prolegomena to the Recognition of Floor Plan Sketches", Alexander Koutamanis sets out to classify the basic graphic elements that make up sketches. This classification is informed both by architectural content on the basis on drawing-conventions as well as computer vision. The latter plays an important role when in a further stage of research sketches need to be recognised by CAD-tools. Koutamanis distinguishes first a number of dimensions that hold for most representations, and then describes a number of general higher level structures in architectural design, such as organisational lines, spaces, relationship lines and building elements, and positive and negative representation. After that, he outlines a number of graphic primitives: solid lines, multiple lines and bubbles, broken and dotted lines, blobs, textured and coloured surfaces, and annotations. He proposes that these can be used as a basis for automated sketch-recognition.

The second paper, "On Representation", by Alexander Koutamanis and Vicky Mitossi, deals with the concept of coordinating devices. A coordinating device is a structural relationship between a number of graphic elements that denote some architectural objects, for example, the way a door can be placed relative to a corner in a room. In this manner, information about the drawing can be inferred that goes beyond the straightforward function-space mapping in current systems. The authors aim to automate simulation on the basis of drawings in order to make performance predictions.

Theme 4: Design computation

Design computation deals with the computational support and description of design. This work is motivated by the recognition that ICT can improve design in many ways. Tools for design require an understanding of design (at least of the practical needs of the designer) and thus, developing tools can be an additional way to understand design. Papers on design computation are submitted from Aerospace Engineering, Computer Science, Industrial Design, Civil Engineering, and Architectural Design.

Date Rentema and Erik Jansen in "An AI Tool for Conceptual Design of Complex Products" report on an ongoing research project to develop advanced tools for conceptual design. The application area is the component configuration for aircraft in the early design stages. The assembly of these components and reasoning about their configurations is done in separate modules, using the techniques of Case-Based Reasoning, Rule-Based Reasoning, and Constraint-Based Geometric Modelling. The modules operate under a general system called "AIDA": AI-supported Design of Aircraft.

Paul Hekkert, David Keyson, Kees Overbeeke, and Pieter Jan Stappers describe in "The Delft ID Studio Lab" how the combined effort of four research groups in an interdisciplinary research lab yields new research directions for (computational) design support as well as cognitive research. The focus of research has shifted from (usually isolated) cognitive and perceptual-motor skills of the single designer to describing and supporting the experiential context comprehensively. This also includes novel research interests in the emotional aspects of products and the design process.

Reza Beheshti, Frits Tolman, and Peter van der Veer present the work of the Design and Building Informatics Group of the Faculty of Civil Engineering and Geosciences at Delft University of Technology in the paper "Design and Building Informatics Research". The group has been actively engaged in research fields such as new modelling methods, integrated method modelling, and the study of its effects in application. These are in particular elaborated in electronic project data modelling, modelling objects and processes in various life-cycle stages, dealing with multiple discipline views, and knowledge modelling and engineering. The authors present past performance and ongoing research projects of the group.

Henri Achten, Bauke de Vries, and Jos van Leeuwen present in "Computational Design Research" an overview of the work in Design Systems of the Department of Building and Architecture at Eindhoven University of Technology. The research work is coordinated in the VR-DIS research programme, which sets out to incorporate design- and engineering knowledge from all disciplines in the so-called VR-DIS platform. Virtual Reality is seen as an important enabling technology to convey this knowledge and these findings to designers in a natural and more accessible way. The authors present the past-performance of the group, achieved academic results and software prototypes, as well as currently running projects.

Conclusion

Design Research in the Netherlands 2000 provided a venue to discuss the current state-of-the-art in design research from many different perspectives, such as research method (theoretical, cognitive, computational, etc.), strategic approach (research by design, through experiments, by making design tools, etc.), design discipline, and so forth. From the papers, and discussions during the symposium, a number of observations can be made.

There is a growing interest in design from the field of management studies, and vice versa, design researchers are becoming again aware of the managerial aspects of the design process (see van Aken; Chapter 2, and den Otter, Chapter 4). As stated, this is not entirely new: the Management and Organisation Group of Industrial Design in Delft has always had a focus in this respect (see Buijs' overview in Chapter 7), and the term "designing the design process" has been a recurring theme in the Design Methods Group of Building and Architecture in Eindhoven. Furthermore, the notion has been present already in the classic studies of design by Broadbent, Gregory, and Jones.

For a solid scientific basis, it is necessary to define the concepts that describe the research discipline. Taxonomies are important structures in which the range of scientific vocabulary is established. Beheshti (Chapter 1) and Bax and Trum (Chapter 3) are active in this respect. The relationship of the terms of a taxonomy with the everyday practice of design is not without difficulty as designers often use their own vocabulary or tend to shift the meaning of words or introduce new terms. This 'play with words' could be important to prevent fixation, stimulate creative thinking, or to define a point of view that differs from the competition in the field. Research on these aspects would be welcome. However, the professional and academic competency of a designer should include a reflective attitude that adheres to a set vocabulary, such as is defined in taxonomies.

The 'classic' means of design research by protocol analysis, structured observations of designers in lab experiments, interview techniques, and so forth, are well-established and produce an essential body of knowledge about the design process. There is an active rethinking of the basic paradigms in this field of work (in particular at Industrial Design in Delft; see Chapter 6 and 7), there is ongoing research in new concepts that play a role in

design (Oostra's research for patterns and themes in Chapter 8), and formulation of design methods (the Organogram for Product Development by Eekhout in Chapter 5). More detailed investigation and extension of the basic elements of design is presented in Chapter 9 and Chapter 10 by Koutamanis and Mitossi.

Making tools for design is increasingly becoming a productive means in design inquiry. This trend is evident in the submissions presented here: the AIDA system presented by Rentema and Jansen (Chapter 11), the work of the ID Studio of Industrial Design Engineering (Chapter 12), the prototypes developed by Design and Building Informatics Delft (Chapter 13), and Design Systems Eindhoven (Chapter 14). Most of this work requires an understanding of design on various levels. By making prototypes for design support, this understanding can be enhanced and also revised after application of the tools in practice. This trend seems to be sufficiently different from the established distinction of 'descriptive' and 'prescriptive' studies of design, and warrants further attention and development in the future. In particular, research methodologies for this kind of research are still wanting and need to be further developed.

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