DESIGNING FOR THE UNKNOWN: A DESIGN PROCESS FOR THE FUTURE GENERATION OF HIGHLY INTERACTIVE SYSTEMS AND PRODUCTS

Caroline HUMMELS and Joep FRENS

Technische Universiteit Eindhoven, Department of Industrial Design, Designing Quality in Interaction Group, Den Dolech 2, Eindhoven, The Netherlands

ABSTRACT

Highly intelligent systems, products, and related services lie at the core of our department of Industrial Design in Eindhoven. Based on the foundations of our department we identify three implications for the design process; our preferred design process is flexible and open, it values design action as a generator of knowledge and is driven by a student's vision on the design opportunities that are afforded by emerging intelligent technology. We critically reflect on two existing influential paradigms of design methodology, i.e., the 'rational problem solving' process and the 'reflective practice' and find that both paradigms do not comply with our preferred process. They share a sequential approach to gathering information; a formal analysis phase precedes the creative conceptual phase. Moreover, the first paradigm considers design action to be an activity that implements information instead of an activity that generates information. We present an open and flexible reflective transformative design process that highly regards design action as a generator of knowledge next to analysis. Moreover, the process supports students to transform the world, and integrate knowledge, skills and attitudes, next to offering moments of reflection.

Keywords: design process, competency-based learning, reflection on action, parallel design process, reflective transformative design process

1 INTRODUCTION

In 2001, the University of Technology Eindhoven started the department Industrial Design. Based on discussions with industry, the department decided to concentrate on the design of intelligent systems, products and related services, which addresses aspects such as adaptive behaviour, context-awareness and highly dynamic interaction.

Another striking aspect of the department is the competency-based educational concept. We give students, or 'junior employees' as we call them, a professional role to create solutions within a professional setting. Competency-based learning gives equal weight to knowledge, skills and attitudes, and stimulates students to learn by doing. Within our department, a competency is defined as an individual's ability to select, acquire, and use the knowledge, skills, and attitudes that are required for effective behaviour in a specific professional, social, or learning context. So, it offers a holistic view of design.

We noticed that our foundations, i.e., intelligent systems, products and related services, and competency-based learning, have implications for the design process we want to teach our students. In this paper we propose a design process that fits our foundations. We first identify the implications of our foundations for the design process and we critically reflect on two influential paradigms of design methodology. Finally, we present our reflective transformative design process.

2 IMPLICATIONS OF OUR FOUNDATIONS FOR THE DESIGN PROCESS

When looking at the department's focus and the learning concept, we see three implications for the design process, which we discuss subsequently.

2.1 Person- and context dependent

Competency-based learning is a highly person- and context-dependent process. A different context asks for different competencies and different students will prefer different competencies and develop them differently. Therefore, our students create their own programme. They can choose assignments and modules that best match their learning goals and required competency development of that semester. Moreover, they work on projects with different clients and experts which tunes their competency development. The person- and context-dependent character of the education model asks for a diversity of design processes or flexibility within the process, in order to support students to find their preferred way of creating design solutions within a certain context.

2.2 Integration knowledge, skills and attitude

Competency-based learning gives equal weight to knowledge, skills and attitudes, and stimulates students to learn by doing. It is about learning and performing through practical application, while simultaneously acquiring theoretical skills. The nature of design beautifully intertwines the different types of knowledge with different human skills, in this case cognitive, emotional and perceptual-motor. For example, design uses formal scientific notations (based on mathematics) as well as knowledge that is harder to formalise (e.g. aesthetics and creativity). Moreover, knowledge can be obtained through the analytical skills of the designer (e.g. analysing user behaviour), as well as through the synthetic skills of the designer (e.g. building physical models). Consequently, the design process(es) we offer the students should be holistic and give equal weight to knowledge, skills and attitudes throughout the process

2.3 Transforming the world

The technology that is so rapidly and innovatively created by the technology providers of the world is potentially capable of transforming our world, but not in ways that we (can) know of beforehand. So instead of educating students for analyzing the needs of users in existing product ecologies we aim towards a more radical goal: we want to educate students who are able to apply these new technologies in ways that are new and daring, driven by a design vision of how our world could be, and validated afterwards by solid user research. In short, we want to educate people who are able to transform our world, preferably in beautiful ways, instead of solving problems. This requires a central place for creating a vision in the design process that we teach our students, and it requires support for exploring opportunities instead of solving problems.

2.4 Concluding

In sum, the implications of our foundations for the design process can be summarized in a characterization of our preferred process. Our preferred design process is a flexible and open design process where design action is explicitly acknowledged as an essential generator of experiential knowledge for future products that transform our world.

3 RATIONAL PROBLEM SOLVING VERSUS REFLECTIVE PRACTICE

Dorst (1997) compares two influential paradigms of design methodology, namely one in which design is seen as a rational problem solving process (Simon, 1970; Roozenburg and Eekels, 1991), and one in which design is seen as an activity involving reflective practice (Schön, 1983). When looking more closely at these paradigms and especially the related design processes, we see that there is a discrepancy between these processes and our preferred process as described in section 2. Let us briefly explain the design processes within these two paradigms [for detailed information about the paradigms we refer you to Simon (1969), Schön (1983) and Dorst (1997)] and discuss the (mis)match with our preferences.

3.1 Rational problem solving

This approach, which was introduced by Simon (1969), can be described as '*... the search for a solution through the vast maze of possibilities (within the problem space) ... Successful problem solving involves searching the maze selectively and reducing it to manageable solutions.*' (Simon, 1969 in Dorst, 1997). In order to find these solutions, the designer goes through the basic design cycle which uses four design activities:

Analyse > synthesise > simulate > evaluate

We see several discrepancies when contrasted with our preferred process. Firstly, the design process is a rational search process, which undervalues the perceptual-motor and emotional skills of the user, or at least makes them secondary to the cognitive skills. The model is based on obtaining formal design knowledge, which leaves little room for knowledge that is hard to formalise. Secondly, not only is the (formal) analysis phase separated from the (creative) conceiving phase, but the analysis phase also precedes the conceptual phase. Although the process is iterative (the designer makes several loops of these four steps), the process is sequential and fixed. It doesn't allow for flexibility and personal freedom. Thirdly, although Simon stressed the ill defined and unstructured character of the design task, which we also consider important, he starts with a confined problem space, which doesn't comply with our search for transformation. According to this process, a designer can know beforehand, the width and breadth of his design challenge and its solution domain.

On the positive side, one can say that the process incorporates natural moments of reflection. For example, in the beginning of the synthesis phase, the designer is stimulated to diverge and develop many solutions, reflect on these ideas and thereupon converge and finally work towards one solution. As can be expected, these moments of reflection are guided by the requirements set within the analysis phase, which is again too limiting for our approach.

3.2 Reflective practice

Schön introduced in 1983 the reflective practitioner to stress the importance of the training of practitioners in the profession and to link the design process and task in a concrete design situation. The implicit 'knowing-in-action' is important, but this, hard to formalise, knowledge is difficult to teach. Therefore, he introduces reflection-in/on-action, in order to train and guide the 'knowing-in-action' habits. In this process the designer goes through four steps:

Naming (the relevant factors in the situation) > framing (the problem) > moving (towards a solution) > evaluating (the moves).

Given the importance Schön attaches to implicit 'knowing-in-action', this approach is strongly embraced within our department. It integrates knowledge, skills and attitude. Unfortunately, the design process is rather global and it appears to offer insufficient support for our students to develop their vision and stimulate reflection. The moments of reflection are triggered by surprise during the process, which is not enough, especially for freshmen, because they have to develop their 'knowing-in-action' habits. Moreover, the design process is still sequential starting with the naming and framing, which is related to the analysis phases of the basic design cycle. So, in that sense, the analytical skills still prevail, and although the design task is unique and context-dependent, the process as such is still not flexible.

3.3 Concluding

In sum, both paradigms have positive and negative aspects for our specific use. The two paradigms share a sequential approach to gather information; a formal analysis phase precedes the creative conceptual phase. Moreover, especially in the first process, design action is regarded as something that implements knowledge instead as something that generates knowledge.

4 THE REFLECTIVE TRANSFORMATIVE DESIGN PROCESS

Based on the preferences and problems described in section 2 and 3, we propose a design process that addresses four main principles, namely the three described in section 2, that is supporting flexibility and individuality, integrating knowledge, skills and attitudes, and supporting transformation, and one principle described in section 3, i.e., creating moments of reflection. In what follows we first explain the model and these principles after which we provide an operationalisation of the model in terms of streams of information that come together in the reflective transformative design process.

4.1 The model

The design process exists of five activities that take place within the societal setting, but without a specific order (see figure 1). Dependent on the person, context, or phase within the design process, the student determines where he starts, how often he swaps from one activity to another (although we stimulate frequent changes), and the order of activities. This way the process supports flexibility and individuality. Moreover, every time he switches activities an opportunity for reflection occurs (grey lines). This could help novices in design to train their reflective practice.

The central activity of the process is ideating, integrating and realising interaction solutions between users and systems in a context of use (central circle). In this continuing process the designer gains insight into the design opportunities. During the process these insights are physicalized and result into a final solution. The development of these solutions is guided by a vision (top circle), in our case a vision about transformation from our current reality to a new one through an intelligent system, product or related service. We encourage students to search for innovative solutions that are meaningful and valuable for users and our society. Among other things that means that students need to develop a sense of the ethical aspects of what it means to intervene in people's lives.

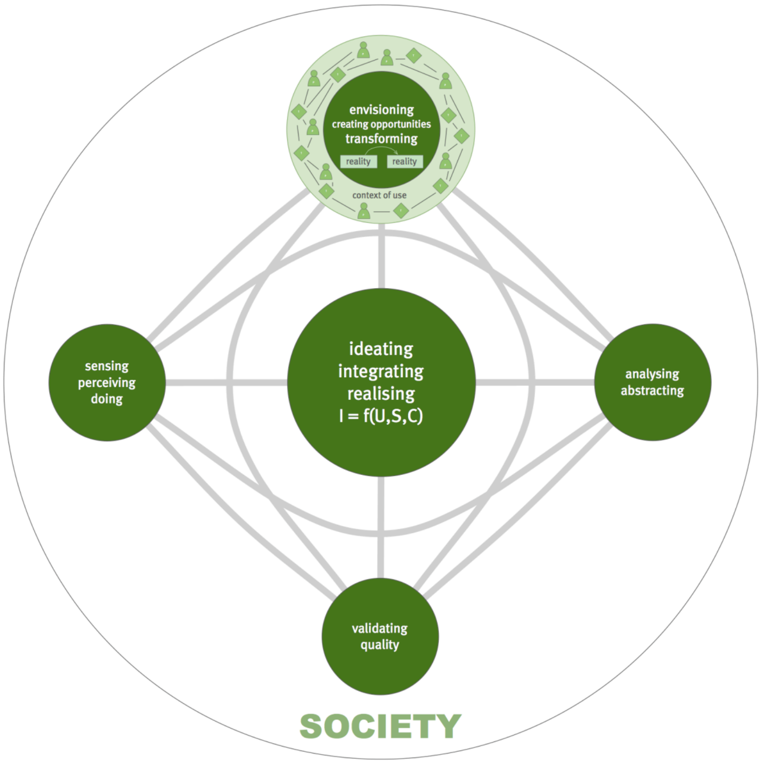

Figure 1 The reflective transformative design process

Because meaningfulness and value are person- and context-related issues, we believe that the solutions have to be tested in society (bottom circle). In order to validate the quality of the vision and the solutions, experiencability of the solutions is crucial, by the designer himself but also by others in the real setting.
The two remaining circles show the two types of skills the designer uses to develop solutions thus integrating knowledge and skills, i.e., the cognitive skills of the designer (right circle) as well as the perceptual-motor and emotional skills (left circle).

4.2 Integrating knowledge, skills and attitude: streams of information

Developing and realising design solutions in the centre of this model can be seen as a process of taking decisions based on too little information. It is the enormous breadth of the solution domain and the interdependence of individual solutions with each other and the design brief and vision that makes it impossible to determine beforehand if a decision is the right one. We feel that it is more appropriate to consider design decisions conditional. That is, a designer makes decisions to the best of his/her experience and knowledge. These decisions are not necessarily correct decisions, though it is possible that further insight into the design challenge invalidates a decision, forcing the designer to rethink certain solutions and come up with more appropriate solutions.
We view the design process as a process where insight into the design opportunity and solution domain is achieved by continuous information gathering. In our design process there are two drives for information gathering. The first drive is information gathering to direct the design decisions through a vision (the top circle in figure 1), the second

drive is information gathering to validate design decisions (the bottom circle in figure 1). These drives are incorporated within two strategies that generate information and that reciprocally provide focus for each other:
The first strategy revolves around design action (left circle in figure 1). It produces experiential information that feeds into the connecting circles. To be more specific, the information that is spawned by design action takes the form of visualisations/ physicalisations that naturally feed into the middle circle as integrations of a designer's knowledge, skills, and attitude. At the same time these visualisations/physicalisations act as reference points for the ever-growing design vision and as input for validation. Finally, design action provides focus for, and steers further analysis.
The second strategy revolves around analysis (the right circle in figure 1). It produces a more formal kind of information that (again) feeds into the connecting circles (see figure 1). Common sources for this formal information include (but are not limited to) literature and contextual inquiry. The information can be used to direct or to corroborate design decisions from the middle circle (see figure 1). Also, the formal information provides focus for, and steers further design action.

5 CONCLUDING

We regard the designerly skills instrumental in creating the future generation of subtle, nuanced and beautiful interactive product proposals. Yet, because we aim to design for the unknown we explicitly aim for an open model that gives students grip on the design process yet leaves room for innovation.
In this paper we have critically reflected on existing paradigms of design methodology in light of the foundations and focus of our department of Industrial Design. Based on this reflection we have proposed a new reflective transformative design process that highly regards design action as a generator of knowledge. Consequently, we discard the sequential approach (i.e., analysis before design action) of common design methodologies. As an alternative we propose a parallel process where analysis and design action reciprocally give focus to each other.

REFERENCES

[1] Simon, H.A. *The sciences of the artificial.* (MIT Press, Cambridge MA, 1969).
[2] Roozenburg, NFM and Eekels, J. *Product Design: Fundamentals and methods.* (Wiley, Chichester, 1995)
[3] Dorst, K. *Describing design: a comparison of paradigms*. (PhD Thesis, Delft University of Technology, The Netherlands, 1997).
[4] Schön, D.A. *The Reflective practitioner.* (Basic Books, New York, 1983)

Dr Ir Caroline HUMMELS
Technische Universiteit Eindhoven
Department of Industrial Design
Designing Quality in Interaction Group
PO Box 513
5600 MB Eindhoven
The Netherlands
C.C.M.Hummels@tue.nl
+31 40 247 5192