

# Studying Design Problems

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## 1. Introduction

This paper reports on a research project that has been running at the Eindhoven University of Technology. First at the department of Philosophy (within the Faculty of Management and Innovation Sciences) and later at the Designed Intelligence research group at the Faculty of Industrial Design. The paper will set out, briefly, by discussing the original starting points of the project (section 2), and it will go on to describe the core steps in the intellectual journey that the project has turned into.

The subject of study was the structure of design problems, and the philosophical notion of ‘underdetermination’ has taken as a possible fruitful concept to make some inroads into this huge and uncharted territory. The project was, naturally, started with the studying of relevant literature and the making of an inventory of our knowledge on design problems (as ill-structured problems, as underdetermined problems) and of the way in which the design methodology has dealt with design problems, in the broader context, of the modeling of design processes (section 3). This has not turned out to be a very fruitful approach to the issue of design problems. Therefore, an interest was developed in some other theories on how designers deal with their problems, specifically focusing on describing design problems as situated problems (section 4).

The inherent subjectivity of design situations has led to a study in how we could capture and describe the way a designer builds up a view of the situation, and responds to this situation. A fairly coarse, but interesting approach to characterizing and describing the way designers build-up a view on a design situation was found in the work of Dreyfus, where he models the levels of expertise in which a designer operates (section 5). In the last section we will summarize our conclusions on the study of design problems, reflecting on the role that philosophical investigations can play in Design Methodology, and sketch proposals for further research into design problems and design expertise (section 6).

## 2. Starting point: studying ‘Design and Underdetermination’

The idea for starting this research project was born out of the need to provide a link to design methodology for the NWO program ‘The Dual Nature of Technical Artefacts’. This NWO program is jointly run by Delft University of Technology and Eindhoven University of Technology. The overall aim of this research program is to develop a coherent conceptualization of technical artefacts:

*In our thinking, speaking and doing we employ two basic conceptualizations of the world... On the one hand, we see the world as consisting of physical objects interacting through causal connections. On the other hand, we see it as consisting of agents who intentionally represent the world and act in it.... Correspondingly, technical*

*artefacts have a Dual Nature: they cannot exhaustively be described within the physical conceptualization, since this has no place for their functional features, nor can they be described exhaustively within the intentional conceptualization, since their functionality must be realized in a physical structure that is adequate to it...*' (Kroes and Meijers, 1999)

The core of this philosophical research program is an analysis of the link between physical structure and the functions of artefacts. One of the ways to inform this analysis is to study the process in which designers and engineers connect function and structure in the design process. A special area of interest within this domain is the way in which designers and engineers deal with the inherent *underdetermination* of design problems. The concept of underdetermination also plays an important role in the philosophy and methodology of science – underdetermination was selected as an area where the methodology of design and the methodology of science might cross each other's path in an interesting way.

But what do we mean with 'underdetermination' in the context of design? Design activities can be seen as the reasoning from a set of requirements and intentions to a new bit of reality, consisting of a (physical) structure and an intended use. This process of reasoning is abductive: there is no closed pattern of reasoning to connect the requirements and intentions with a form and mode of use (Simon 1973; Rittel 1972; Cross 1999). Design problems are thus fundamentally underdetermined in the sense that the set of requirements and intentions can never be stated in such a way that the creation of its solution can be a deductive process. This underdetermination actually takes two forms: as stated, a functional description can never be complete, and secondly, 'Function' and 'Form' belong to fundamentally different conceptual worlds. But despite these fundamental problems, designers nonetheless, somehow, overcome this underdetermination of design problems in their design processes. This is a gradual process, involving many steps, which are performed in patterns ('design strategies').

This research project investigates how designers overcome the underdetermination of design problems. It takes place within the realm of Design Methodology, and is, thus complementary to the core NWO program, which is philosophical in nature. For the researcher, a design methodologist of the empirical bend, one of the main interests in embarking on this ambitious project was to explore how philosophers deal with design related issues, and investigate how the two fields of Philosophy and Design Methodology can be connected to one another, or maybe complement each other in a way that is inspiring and fruitful to both fields.

### 3. The structure of design problems

The first hurdle we have to take, in the study of underdetermination, in design is that the notion of underdetermination itself is a negative one: it describes the absence of connections, the lack of a structure in a design problem. How can we find a good way to describe something that is not there? Do we need to describe the structure or unstructuredness? The study, initially, concentrates on exploring the *structure* of design problems, as design problems have always been something of a blind-spot in Design Methodology: the focus in Design Methodology has almost exclusively been on the support of the *process* of designing. But any method for aiding design activities necessarily contains statements or assumptions from all three 'dimensions of design activities': the dynamics of a design process, the designer and the design problem (Dorst 1997). Within Design Methodology, the nature of design problems has been described as 'ill-structured,' or even 'wicked' (Rittel et al. 1984), but little more has been said. Some process-focused design methods however, seem to incorporate strong assumptions about what design problems are (e.g. concerning the independence of sub-problems, the objectivity of problems, the possibility to

create an overview of a design problem, etc). We know that this blind spot for design problems is hampering the development of design methodology. Design problems may be weak in structure, but it is really important to find out what structure they have as a starting point for the construction of taxonomic design problems. Such taxonomy will help Design Methodology to attain a much-needed new level of precision in its descriptions and prescription (i.e. if we have a well-established taxonomy of design problems, we could also start defining which design method or design technique would be appropriate to use by solving a particular type of design problem...). If we can find a way to trace the structure of design problems, we can then match that to the way designers tackle those problems, then this will lead to a much closer description and a much better understanding of the way designers work, and *why* they take the actions we see.

Our initial investigation into design problems focuses on two questions:

1. What can we find in Design Methodology about the structure of design problems? This will focus on the existing descriptions in Design Methodology of design problems as ‘ill-structured problems,’ as ‘underdetermined problems’ and on the way design problems are treated within the two paradigms of Design Methodology. This will lead to the second research question:
2. How can we further develop (i.e. combine) these approaches into a comprehensive study of structure design problems? As mentioned, we will take the (philosophical) notion of underdetermination as a starting point for these investigations.

### Underdetermination

In Design Methodology literature, we find very little about underdetermination as such (the term is not in common usage), but studying the statements about design problems in research papers and textbooks, we can conclude that one of the problems designers face in tackling their design problems is this, because design problems are not completely determined, but also not completely free (Dorst, 2001). Most design problems in fact seem to have a threefold nature:

- They are partly *determined* by ‘hard’ (unalterable) needs, requirements and intentions. A designer will have to reserve time in the early part of his design process to unearth these ‘hard facts’ by information gathering and analysis, and live with these specifications. This information can be seen as a necessary input at the start of the design process, and this type of interaction can very well be described and modeled within the rational problem-solving paradigm.
- But a major part of the design problem is *underdetermined*. The interpretation of the design problem and the creation and selection of possible suitable solutions can only be decided during the design process on the basis of proposals made by the designer. These proposals thus entail both the possible interpretations of the design problem and possible solutions to those problems.
- Part of the design problem can be considered *undetermined*, in the sense that the designer is to a large extent free to design according to his own taste, style and abilities (it is, of course, not the case that the designer would never have to defend these aspects of the design to others, but in these areas the designer is dominant, in the sense, that he also provides the criteria on which this aspect or part of the design is to be judged).

### Ill-structured problems

A second way of describing design problems, that is much more explicitly discussed in Design Methodological literature, and can even be said to loom large over our thinking about design, is the idea that design problems are ‘ill-structured.’ In his seminal paper ‘The structure of ill-structured problems’ (1973), Herbert Simon also starts out his description of ill-structuredness by looking for positive structure. He defines well structuredness by six criteria:

- There is a definite criterion for testing any proposed solution, and a merchandisable process in applying the criterion.
- There is, at least, one problem space in which can be represented the problem state, the goal state, and all other states that may be reached, or considered, in the course of attempting a solution to the problem.
- Attainable state changes can be represented in a problem space, as transitions from given states to the states directly attainable from them.
- Any knowledge that the problem-solver can acquire about the problem can be represented in one or more problem spaces.
- If the actual problem involves acting upon the external world, then the definition of state changes and of the effects upon the state of applying any operator reflect with complete accuracy in one or more problem spaces the laws that govern the external world.
- All of these conditions hold in the strong sense that the basic processes postulated require only practicable amounts of computation, and the information postulated is effectively available to the processes-i.e. available with only practicable amounts of search.

Lawson (1990), Roozenburg (1991) and others have held that design problems don’t adhere to the first two basic criteria for well-structuredness, and therefore cannot adhere to the others either.

### Design problems and the paradigms of Design Methodology

We will now explore the way ill-structured problems have nevertheless been described by Simon in the context of his view of designing as a rational problem solving process.

The main paradigm of design methodology, in which design is seen as a *rational problem solving* process, was introduced by Simon in the early 1970s. In this paradigm, design is viewed as a rational search process: the design problem defines the ‘problem space’ that has to be surveyed in search of a design solution. Problem solving theory is concerned with the ways in which people or artificial systems arrive at solutions to problems they encounter. This theory can be captured by four propositions:

- A few gross characteristics of the human Information Processing System are invariant over task and problem solver.
- These characteristics are sufficient to determine that a task environment is represented as a problem space, and that problem solving takes place in a problem space.
- The structure of the task environment determines the possible structures of the problem space.
- The structure of the problem space determines the possible programs that can be used for problem solving. (From: Simon 1969; 1992).

If this theory is valid for design, design problem solving will also take place within a problem space that is structured by the structure of the task environment, which in it’s turn determines the ‘programs’ (strategies or methods) that can be used for designing. In a later paper Simon

addressed some of the difficulties that might arise in applying the rational problem solving approach to design by defining design problems as ‘ill-structured problems.’ Ill-structured problems are to be tackled in an ‘immediate problem space.’ This is part of the total problem space, which is deemed too large, ill-structured and ill-defined to be described. The immediate problem space is addressed and put together by an (unspecified) ‘noticing and evoking mechanism.’ The basic ‘design’ problem-solving process would however be basically the same as in other kinds of problem solving. With the exception that the goal of a design process is to arrive at a solution that is ‘good enough,’

*‘we satisfy by looking for alternatives in such a way that we can generally find an acceptable one after only moderate search.’*

A radically different paradigm was proposed fifteen years later, by Donald Schön (1983), who describes design as an activity involving *reflective practice*. This constructionist theory is a reaction to the problem solving approach, specifically made to address some of the shortcomings Schön perceived in mainstream design methodology. Schön’s starting point is his feeling that the paradigm of technical rationality hampers the training of practitioners in the professions. He believes that the design-component of the professions is underestimated, and that the nature of human design activities is misunderstood. He shows that in the training programmes of professional schools, that recognize design as a core activity, design knowledge is defined in terms of generalities about design processes and declarative knowledge is needed to solve design problems. No attention is paid to the structure of design problems and the crucial problem of linking process and problem to a concrete design situation. This ‘action-oriented,’ often implicit knowledge, cannot be described within the paradigm of technical rationality. But Schön insists that this kind of knowledge is vital for action-oriented professions like design. He does recognize, however, that this implicit ‘knowing-in-action’ is difficult to describe and convey to students. What can be thought about, and taught is the explicit reflection that guides the development of one’s knowing-in-action habits. This he calls *reflection-in-action*.

One of the basic assumptions of the theory of technical rationality is that there is a definable design problem to start with. Schön remarks that:

*‘... Although Simon proposes to fill the gap between natural sciences and design practice with a science of design, his science can only be applied to well-formed problems already extracted from situations of practice...’*  
(from: Schön 1983)

Schön, on the other hand, does not make any such assumptions about the design problem. The description of design, as a reflective conversation, concentrates on the structuring role of the designer, setting the task and outlining possible solutions all in one ‘framing’ action. The strength of this framing action determines the amount of structure in the task. In reflective practice, design tasks may be analysed and subdivided into a number of different ways, and there is no *a priori* way to determine which approach will be the more fruitful. Therefore, design task and solution are always and inherently developed together. Schön thus seems to ignore the possible structure that design tasks and solutions might have, although he gives a table of ‘Normative Design Domains’ in ‘The Reflective Practitioner’. These ‘Normative Design Domains’ could provide a categorization for the description of design tasks, but unfortunately these domains are not connected to the core theories of reflective practice, and they are never mentioned again. Schön’s failure to link the theories of reflective practice to a model of design tasks means that descriptions of design activities within this paradigm can not benefit from any structure that might be present in the design task. Design problems are then ill-structured, because the designer treats them as such.

#### 4. Design problems as situated problems

Both these paradigms can be used to describe a design process. In some cases, the rational problems solving paradigm is more appropriate, in other cases the reflective practice paradigm will do more justice to what the designer is doing (Dorst 1997). This is not a very satisfactory conclusion: design gets something of a dual (schizophrenic) nature, and the relationship between the two fundamentally different ways of looking at design is not really clear. Any taxonomy of design problems that is based upon these paradigms will reflect this uneasy schism. Moreover, any *a priori* taxonomy of design problems will focus on describing different structures of reasonably determined problems. This is inevitable, because any taxonomy is based on the patterns in the network of connections between sub problems. This will not get us very far. To really capture design, we also need a taxonomy of underdetermined problems. But neither the rational problem solving approach nor the reflective practice approach gives us a foothold for that. To answer this question we will have to delve a bit deeper into the nature of underdetermination, and develop an approach in describing design that takes the situated nature of design problems into account.

In their paper, Dorst and Cross (2001) - have tried to find a way out of this dilemma by using an empirical study to take another step back. There is an assumption that underlies both paradigms, and that is that design is basically a reasoning process going from problem to solution. Within the *rational problem-solving* paradigm, the problem is objectively knowable. In the *reflective practice* paradigm the problem, in the guise of a *frame*, is a creation of the designer himself, who creatively interprets the ambiguity of the outside world. These images of design can be refined on the basis of empirical studies. If we take a closer look at design it seems to be a much more gradual process, like an evolution. It seems that creative design is not a matter of first fixing the problem (through objective analysis or the imposition of a frame) and then searching for a satisfactory solution concept. Creative design seems more to be a matter of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration of analysis, synthesis and evaluation processes between the two notional design 'spaces' - problem space and solution space. In creative design, the designer is seeking to generate a matching problem-solution pair, through a 'co-evolution' of the problem and the solution. The designer is busy adjusting both the design problem and the design solution. Our observations confirm that creative design involves a period of exploration in which problem and solution spaces are evolving and are unstable until (temporarily) fixed by an emergent bridge, which identifies a problem-solution pairing. This process can be described in detail, from the *rational problem solving* paradigm as well as the *reflective practice* paradigm. If we do this, the two ways of describing design will actually be very much alike. The only issue that really divides the two paradigms of design then are the two different epistemologies that they represent, positivism and constructionism (phenomenology).

This description of design as the co-evolution of problem and solution again points us toward the idea that in describing design, we cannot pre-suppose that there is something like a fixed 'design problem.' But if that is the case, can we still describe design if we let go of the idea that it is a process running from 'a problem' to 'a solution'? Again, we have to take a step back and look at the origins of our thinking about design, and revisit the implicit assumptions that might be bothering us...

The Rational Problem Solving paradigm and the Reflective Practice paradigm have both been developed in the 60's and 70's, largely inspired by developments in AI and the cognitive sciences. The epic endeavor to build intelligent computer systems focused on the ability of such a

system to solve ill-structured problems within an open context, somewhat comparable to designing. The systems were based on a Rational Problem Solving approach, representing the ‘relevant aspects’ of the world and setting up formal procedures that manipulate these representations to solve a problem. This approach has failed (Dreyfus 1992). Alternative approaches are now developed that are inspired upon the situatedness of problem solving activity (Varela 1991; Winograd 1986; Suchman 1987). We will, now, explore whether the consideration of design as a situated problem solving will help us get closer to a description of what structure design problems have. A fundamental choice that is associated with situated problem solving is that we are first and foremost interested in what design problems are to the designer, seen through the eyes of the designer, in the design situation. This means that we concentrate on the ‘local’ design problem that a designer faces, and bracket the ‘overall’ design problem as something of an abstraction (for now). So we will also have to confront the vagueness (i.e. lack of overview) and subjectivity that is involved in local design actions and decisions. Seen from this perspective, ‘the design problem’ as such does not really exist as an objective entity in the world. There is an amalgamate of different problems that centers around the basic challenge that is described in a design brief. This amalgamate of problems is partly there to be discovered by the designer in the design process, and part of it has to be *made* by the designer.

The process of ‘approaching a design problem’ or ‘dealing with a problematic situation’ becomes the vital clue to understanding what design problems are. The latter formulation is important: for much of the design project the problem solving steps can be quite logical, routine and implicit, without a real choice for the designer. Dreyfus holds that real problematic situations are the results of a ‘breakdown’ in this normal, fluent problem solving behavior (the problem becomes ‘at hand,’ in Heidegger’s terms (see Varela 1991)). These ‘breakdowns’ then are the moments of real choice. It thus becomes very important to distinguish and describe the nature of these breakdowns, the critical situations in design (Frankenberger 1996). These breakdowns are the points that Schön describes as ‘surprises,’ the turning points in the designer’s reflective conversation with the situation. In the solution of these breakdowns ‘objective’ or ‘subjective’ interpretation can play a role. This is where the existing (but possibly implicit or unknown) structure of the design problem and the structuring actions of the designer meet. A well-structured problem ‘leads’ the designer (through deduction, or abduction with a clearly dominant result) to an ill-structured problem requires something like a framing action. These fundamental issues show that the study of the structure of design problems is not a straightforward affair at all. And that we just cannot develop a meaningful ‘objective’ taxonomy of design problems if we can be convinced by Dreyfus and others that it doesn’t exist, that there is never a (complete) representation of the design problem in the head of the designer. The only thing now left for us to study is the ‘local’ network of links that a designer considers while tackling a design problem in the design situation. The subjective nature of this local network of problems means that we need to have a model of how designers approach a problematic situation. In the next section we will discuss a model of design expertise that could be the basis for this.

## 5. Levels of expertise

To explore the levels of expertise we now turn to a lecture by Hubert Dreyfus (2002; 2003), in which he pointed out that the nature of the problem that is considered in a problem-solving situation depends on the level of expertise of the problem solver.

Dreyfus distinguishes seven distinct levels of expertise, corresponding with seven ways of perceiving, interpreting, structuring and solving problems:

- A *novice* will consider the objective features of a situation, as they are given by the experts, and will follow strict rules to deal with the problem.
- For an *advanced beginner* the situational aspects are important, there is sensitivity to exceptions to the 'hard' rules of the novice. Maxims are used for guidance through the problem situation.
- A *competent* problem solver works in a radically different way. He selects the elements in a situation that are relevant, and chooses a plan to achieve the goals. This selection and choice can only be made on the basis of a much higher involvement in the design situation than displayed by a novice or an advanced beginner. Problem solving at this level involves the seeking of opportunities, and of building up expectations. There is an emotional attachment, a feeling of responsibility accompanied by a sense of hope, risk, threat, etc. At this level of involvement the problem solving process takes on a trial-and-error character, and there is a clear need for learning and reflection, that was absent in the novice and the beginner.
- A problem solver that then moves on to be *proficient* immediately sees the most important issues and appropriate plan, and then reasons out what to do.
- The real *expert* responds to specific situation intuitively, and performs the appropriate action, straightaway. There is no problem solving and reasoning that can be distinguished at this level of working. This is actually a very comfortable level to be functioning on, and a lot of professionals do not progress beyond this point.
- With the next level, the *master*, a new uneasiness creeps in. The master sees the standard ways of working that experienced professionals use not as natural but as contingent. A master displays a deeper involvement into the professional field as a whole, dwelling on success and failures. This attitude requires an acute sense of context, and openness to subtle cues. In his/her own work the master will perform more nuanced appropriate actions than the expert.
- The world discloser or '*visionary*' consciously strives to extend the domain in which he/she works. The world discloser develops new ways things could be, defines the issues, opens new worlds and creates new domains. To do this a world discloser operates more on the margins of a domain, paying attention to other domains as well, and to anomalies and marginal practices that hold promises for a new vision of the domain.

Most of these levels are recognizable to anyone involved in teaching design. The definitions of the levels are still sketchy, and not all the steps may be described unequivocally (this is very much work in progress). The most important step to focus on in this paper is the one from advanced beginner to competent designer that can be recognized in design education too (Dorst 2003). This is where involvement and reflection come in to change the problem solving process. This is also where there is a radical shift in the perception and interpretation of the problematic situation: we move from a detached view of an 'objective' reality to the involvement and active interpretation of a situation. These fundamentally different ways of looking at problematic situations can actually co-exist in a design project: nobody is an expert on all aspects of design, on some problems we might be novices, at others we might be competent, or experts. Designers display rule-following behavior, as well as the interpretation and reflection that characterize higher levels of expertise at work.

The nature of the design problem as seen by the designer thus depends on the level of expertise of the designer in solving the problem. This makes the level of expertise potentially a central notion in the description of design practice: the choice of paradigm for describing and supporting design processes depends on the level of expertise that the designer has. The rule-following behavior of the novice and the advanced beginner needs to be described within the framework of the Rational Problem Solving paradigm. The behavior of the competent designer and higher can be described using both paradigms; with the Reflective Practice paradigm becoming more relevant the closer we are to expert behavior.

## 6. Conclusions

### Studying design problems

In this paper we have explored ways to describe the structure of design problems. In doing this we have moved away from making *a priori* taxonomy of design problems, because that inevitably focuses on describing the structures of reasonably determined problems. For design, this will not get us very far: design problems are largely underdetermined or possibly undetermined. To really capture what happens in design practice, we need to consider the problems as situated problems, as they are seen through the eyes of the designer. Thus the original research question has shifted from the development of taxonomy of design problems, to a description of critical design situations. This involves the study of the breakdowns that can occur in the flow of design problem solving, and the designer's response to these breakdowns. To describe this response we can turn to the paradigms of design methodology and to the co-evolution model of design processes.

But these are just descriptions of what happens in a design situation. To really *understand* why a designer tackles a problematic situation in a certain way we have to turn to a model of design expertise. This is where all the elements we need for a close description of design problem solving behavior that have been explored in this paper connect. The levels of expertise potentially have the power to coherently describe the ways in which designers perceive, interpret, structure and solve design problems. The primitive model of design expertise that was presented in this paper needs to be developed further, and validated by empirical research.

### Towards a research programme on design expertise

The classic remark, at the end of almost every scientific paper, is that 'more research is needed.' That is putting it very mildly, in this case: we have hardly begun. This model of design expertise opens up a whole field of design studies, concentrating on describing and defining the properties of the designers and their development in design training and practice. There are several directions for the further development of this design expertise model. We can distinguish three main questions/directions for research:

- We should explore the different kinds of reflection and problem solving that take place on every level of expertise. For instance, the kind of problem that is perceived by the designer at the first level of expertise (how can I use my methods?) is quite different from that on the second level (when should I use this particular method/rule of thumb?). The reflection that takes place on the novice-level deals with the rules themselves, the reflection for the advanced beginner centers on the applicability of a rule in a specific design situation.

- This can then help us define and study the transitions that link the different levels of expertise. What does a designer need to learn to get from one level to the next? How can he/she do that? What problems stand in the way of learning the next set of skills? It has been observed before (Dorst 2003) that the acquisition of design skills is not a gradual process, but that it goes in leaps and bounds. But what are the conditions for such which leaps to occur?
- A third stream of research should be focused on the aspects of design learning that might not be captured so easily in this skill-based learning model: the development of the declarative and process-knowledge of the designer, and the acquiring and use of ‘design prototypes.’ These aspects of design learning should then, if possible, be used to extend and enrich the general, skill-based learning model of design expertise that we have described in this paper.

There are several means we can use to attack these issues. An extensive literature survey is in order, spanning several disciplines. There is much more theoretical work on expertise development to be found in educational research and in the field of educational psychology. On the empirical front, a detailed longitudinal study needs to be set up. We need to actively follow students in their education, tracing their development from the actual work that they are doing. In this way we would not have to depend on the students being able to verbalize these points in their self-evaluation, and wait until they do so. Designers in practice could be interviewed and other research techniques could be used to trace their development in the ‘higher’ steps of the expertise development model. In addition to this longitudinal study, cross sectional research could support more in-depth analysis of a specific level of expertise or a specific transition within the model. If we can get a grip on the development of design expertise, this could lead to a number of new developments in design education. A model like this could lead to the development of testing methods that would enable us to more precisely target the position and learning possibilities for every student, at every point in their studies. Design exercises could be made much more specific, opening up the possibility for a much more efficient learning process. Design methods and design tools could be provided to the design student at exactly the right time to foster the next step in their development. The further development of a model of design expertise could thus lead to the development of new, more specific methods and tools for design practice and design education.

The development of such a model is one of the inspirations that will be used for the research programme of a new Design Research group, to be set up at the Faculty of Industrial Design at Eindhoven University of Technology.

### **Explorations in Meta Design Methodology**

The close cooperation between philosophers and design methodologists during this project has lead to a number of observations on the position of both fields. The most important one is that Design Methodology can indeed benefit from philosophical reflection upon its own fundamentals and assumptions. One could defend the thesis that Design Methodology, as a more or less mature field of research and inquiry, now has reached a stage where we need these philosophical explorations in meta-design methodology. We will now present some observations as examples of such meta-methodological reflections.

The first observation deals with the difference and between descriptive and prescriptive models of design, and their possible relationship. In design methodology one can distinguish a number of approaches towards the object of study. Design methodologists analyze designing:

they do *empirical research* in which they observe actual design cases; they construct *descriptive models* that capture aspects of actual designing; and they *develop theories* aimed at understanding and explaining designing. Moreover, design methodologists aim at improving designing: they *normatively evaluate* designing by distinguishing between successful and less successful cases of designing; they develop *prescriptive methods* and *models* for successful designing; and they develop *tools* to help designers use these prescriptive methods and models. These approaches are not independent from one another. Models and theory often guide empirical research on actual designing. And theories of designing may contain evaluative elements about designing.

Some meta-methodological observations can be made. First, one should note that analysis and improvement of designing are in general different projects since the latter necessarily presupposes a normative evaluation for singling out successful design cases whereas the former does not. Descriptive models, for instance, apply equally to successful design cases *and* to less successful ones. A prescriptive model can thus clearly not be a descriptive one as well since then less successful design cases conform also to the prescriptive model.

Secondly, if one wants to connect both projects by, for instance, motivating improvements of designing with an analysis of actual design cases, one should be aware that at some point a normative evaluation of designing has to come in. One can put such norms in by hand or one can include them in one's theory of designing. A theory of designing seems in fact a natural place to include a more normative approach; a proper understanding of designing seems to include an understanding of the differences between successful and less successful designing.

When one looks back into the history of design methodology, it can be noticed that the real-life development of the field indeed did not follow a clean meta-methodological route through the different approaches. Much of the work done in design methodology of the 1960's, 70's and 80's was concerned with the construction of prescriptive models and design tools. These prescriptive models and tools were based upon experiences of designers in everyday professional practice and upon the methods that had already been developed by professional designers. Design methodology served to systematically reflect on these experiences and methods, and to construct meta-models of designing. Later, from the early 1990's onwards, design methodology was enriched by a substantial body of empirical research into designing, first in laboratory settings and later also in practice. Through systematic observation design methodologists improved the rigor of their observational and descriptive basis, but they still focused their reflection and modeling on prescriptive models, methods and tools.

This description of design methodology may be a caricature (exceptions come to mind) but we would argue that there is a lack of interest in theories aimed at *understanding* and *explaining* the how and why of the observed design activities, and a rush from observation and description to prescriptive modeling and the construction of design tools. Consequently it is often unclear how the normative evaluation of designing enters work in design methodology that connects observation and description with prescription.

A second meta-methodological observation can be based upon the paper by Houkes et al. (2002). The account of designing that is given in that paper, is meant as a *rational reconstruction of design*: it is based on descriptive models of actual designing but also explicitly adds elements – use plans – and a norm – rationality – to those models in order to provide richer and normative modeling of designing. And because it is advanced as a reconstruction, it is immediately clear that this richer and normative modeling is not purely descriptive anymore; the account is committed neither to the claim that the description of designing by means of these added elements is true of all actual cases of designing – actual designers may never have deliberated about their work in

terms of use plans – nor to the claim that actual design cases comply to the norm – designers may in real life proceed quite irrationally. Moreover, if recommendations about how to improve designing are formulated by means of the reconstruction – say, by recommending that designers should explicitly consider the use plans of the artefacts they design – it is also clear where the presupposed norms are originating from.

The task of coming up with a theory of designing is ultimately one for design methodology itself. But philosophy can help with stabilizing concepts and with relating descriptive and prescriptive work, and thus contribute to a more stable and clearer understanding of the design activity.