

STRUCTURED REFLECTION FOR IMPROVING DESIGN PROCESSES

I.M.M.J. Reymen and D.K. Hammer

Keywords: design process, reflection process, design session

1. Introduction

Given the increasing complexity of technical artefacts, the multi-disciplinarity of design teams, and the high demands of the market, continuous improvement of design processes is a necessity. The effectiveness and efficiency of design processes has already been improved by, among others, introducing new concepts for structuring and managing the design process (for example, concurrent-engineering methods) and by introducing concepts for concentrating on important aspects of the product lifecycle (for example, Design-For-X methods). Our objective is to stimulate designers to improve their own process by reflecting on their design process. Reflection has already proven to be useful for improving, for example, the learning process of managers, as described in [Daudelin 1996]. Studying the usefulness of reflection for designing received, however, little attention. Important starting points are given in [Lauche 2001], [Reymen 2001], [Schön 1983], [Valkenburg 2000], and [Wallmeier et al. 2000].

The goal of this paper is to explore possibilities of reflection for improving design processes. More specific, we investigate the possibilities of structured reflection; we define structured reflection as reflection that is performed on a regular basis and that is performed in a systematic way. The exploration is mainly based on experiences of the authors with a preliminary method for supporting structured reflection on design processes, described in [Reymen 2001]. The next section discusses the possibilities of reflection for improving design processes. In Section 3, the added value of structured reflection is indicated and a model that integrates structured reflection into a design process is described. Recommendations for further research are given in Section 4.

2. Reflection on design processes

We start this section by defining reflection on a design process. For this purpose, we first need a definition of a design process. We consider a *design process* as a sequence of design situations, changed by design activities and changes in the design context. A *design situation* at a certain moment is defined as the combination of the state of the design process, the product being designed, and the design context at that moment. In our view, *reflection on a design process* aims at answering essential questions like “Am I solving the essential problems or am I busy with sub-optimisations?”, “Does the result feel satisfactory or are further iterations necessary?”, “Is my way of designing effective and efficient?”, “Is my design process appropriate for the problem?”. We define reflection on a design process as an introspective contemplation on a designer’s perception of the design situation and on the remembered design activities. Reflection on a design process is thus defined as a combination of reflection on the perceived design situation and reflection on the remembered design activities. A design situation offers a static perspective on the design process; design activities offer a dynamic perspective on the design process. Together, these two kinds of reflection can help to reach the goal of reflection on a design process, namely to plan suitable next design activities in the design process;

suitable design activities are activities that are performed effectively and efficiently given the design goal at that moment. The definitions are illustrated in Figure 1.

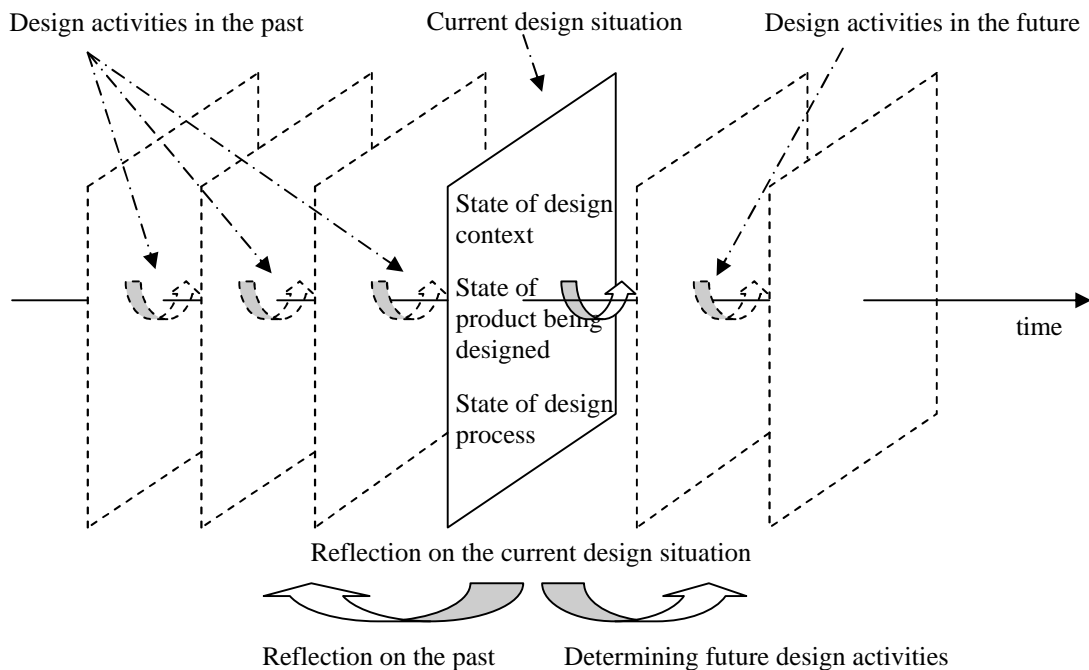


Figure 1. Reflection on a design process

In our eyes, reflection on a design process has the following advantages: Reflection can help designers to learn from their experiences. Reflection is vital in any learning process; this is, for example, illustrated in the experiential learning cycle in [Kolb 1984]. Through learning, reflection on a design process can be a step towards the improvement of the process, its results, and the proficiency of the individuals as well as the team performing the process; current as well as future design processes can be improved. Reflection may help to become more conscious about the performed activities. *Looking back* can help to analyse what went good and wrong and why this happened. *Looking forward* means thinking about further developments of the product being designed and about the activities that are necessary for this purpose. After these activities have been performed, reflection can again take place: In this way, evaluation of the past activities in the light of the current design situation and the goal of the design process can be the basis for defining a new set of design activities. By executing this cycle, designers can learn from their experiences about the design process, from the specific product being designed, and from the interaction with the design context.

Reflection on a design situation can, for example, produce information (1) about the difference between the current state and the desired state of the product being designed, which is useful for checking whether all important aspects have been taken into account; (2) about the difference between the current and the desired state, which is useful for judging the progress of the design process; and (3) about important factors in the design context, which is useful for determining future interactions with the design context. By reflecting on the design situation, implicit choices can be made explicit. This can improve the communication between designers and stakeholders and can result in a better integration and co-ordination of different aspects of a design situation. From *reflection on the performed design activities* one can, for example, learn which activities were not successful for reaching the design goal. This can result in improved decisions about the activities to be performed. Reflecting on interactions with the design context and on its changes can help to get more insight into the actions that influence the design activities. Summarising, *reflection on a design process* can contribute to a steeper learning curve of designers, to a smoother design process, and to an improved product being designed.

3. Structured reflection

In our view, structured reflection has the following characteristics: (1) It is reflection performed on a *regular basis*. Regular reflection helps to detect and correct deviations from the design goal early. To perform regular reflection, the structure of the design process must permit and even stimulate regular reflection. (2) It is reflection performed in a *systematic way*. In this way, the chance of overlooking important aspects is decreased. In the next subsections, we discuss a model that integrates structured reflection into a design process, based on [Reymen 2001]. We start, in Section 3.1, with defining structure in a reflection process, namely by introducing a twin-peak model. In Section 3.2, a concept for structuring the design process, namely a design session, is discussed. Section 3.3 presents a model that integrates a reflection process into a design process in such a way that reflection can be performed on a regular basis and in a systematic way.

3.1 The twin-peak model

We describe a *reflection process* as a process that consists of three main steps that are called preparation, image forming, and conclusion drawing. These steps are related to the steps of the basic design cycle [Roozenburg et al. 1994], to the mechanism of reflective practice, as described in [Schön 1983], and to the stages of a reflection process described in [Daudelin 1996]. The preparation step and the image-forming step investigate the past and the present state; the conclusion-drawing step starts from the results of the first two steps and looks forward to determine the next activities. We believe that the effort made during a reflection process should have the structure of the twin-peak model depicted in Figure 2. The first peak is formed by the preparation step. Then, a rest is necessary to let the mind (unconsciously) think about the results of the first step. The image-forming and conclusion-drawing steps form the second peak. Note that the break between preparation step and image-forming step is not present in the concepts developed in [Reymen 2001]. It is introduced here because we believe that it simulates ‘natural’ reflection processes in which some incubation period is necessary before conclusions can be drawn. In the remainder of this section, a description of each of the steps is given for application in a design process.

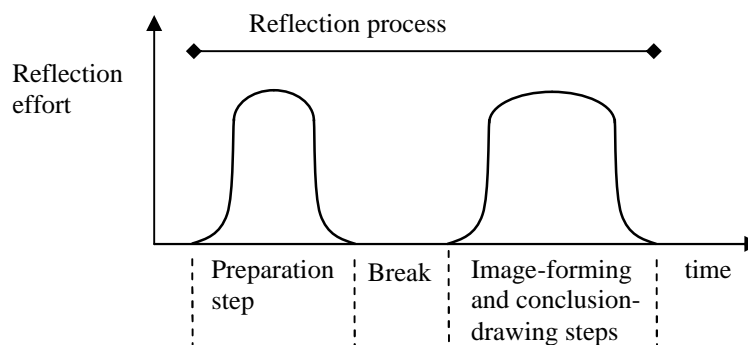


Figure 2. Twin-peak model of a reflection process

Preparation step: The preparation step consists of preparing initial questions, collecting the necessary facts, and analysing the facts critically in relation to these questions. Questions can concern the current and the desired state of the product being designed, the design process, and the design context. These questions are typically related to important viewpoints of stakeholders, like functionality, quality, cost, time-to-market, marketing issues, business issues, and organisational issues. The facts are the relevant aspects of the design situation and the relevant design activities. The following evaluation criteria can be important for a critical analysis: coherency, completeness, consistency, reliability, and validity of the facts. The goal of the preparation step is to get an overview of the design situation and the performed design activities and to analyse it in a systematic way. For this purpose, forms and checklists can be used, as described in [Reymen 2001].

Break between preparation and image-forming step: During the break, things that are not directly related to reflecting or designing should be performed. Designers can also communicate with other design-team members or stakeholders for completing or checking their overview of the design

situation and the design activities. We assume that during this break, the reflection process continues, but in an unconscious way. The next two steps are based on the information collected and analysed during the preparation step, on changes that happened during the break, and on new ideas.

Image-forming step: The goal of the image-forming step is the formation of an image of the design process as a whole. The image of the design process includes an image of the product being designed, the performed design activities, and the design context. To reach this goal, the designer has to lean back for a while, make a selection and synthesis of the facts, and view the facts from several viewpoints. The latter is important in order to get an as complete as possible image.

Conclusion-drawing step: During the conclusion-drawing step, the image of the design process and the goal of the design process are taken into account to determine the next activities in the design process. Questions like “What does the image teach me?”, “Why is the situation like that?”, “What must be changed?”, “What can I learn from the experiences?” have to be formulated and answered.

Summarising, a reflection process starts with a set of relevant questions. Subsequently, relevant facts are transformed into an image, which is then analysed to come to answers to the initial questions. The first step and the last two steps are performed in a completely different way. The preparation step can be sustained by software support because it is mainly analytic; rationality plays an important role. The image-forming and conclusion-drawing steps can only be performed by humans and are more holistic and synthetic; creativity and intuition are most important here. The break between the preparation step and the image-forming step is necessary to separate these completely different activities. An advantage of the proposed reflection structure is that it balances rationality and intuition.

3.2 Design sessions

In accordance with the definition of structured reflection, explicit reflection on a design process should be performed regularly during a design process. In [Dorst 1997], it is described that a designer, when designing, is inside his/her design process (thrown into a situation) and not always in the position to consider the process critically and rationally. A designer that wants to reflect on the design process must step out of the ‘designerly way of thinking’ [Cross 1994] every now and then. Based on these observations, it is important to reserve time for reflection explicitly. However, because reflection is different from common design activities, certain moments are more appropriate than others. Reflection only at the beginning and end of a whole design process is often too superficial. Currently, design processes are usually structured as a series of design phases, separated by milestones. In [Reymen 2001], it is concluded that also a design phase is too long to support regular reflection. However, the period between two reflections may also not be too short. A design process is creative and too many interruptions make it inefficient. Splitting a design phase into a number of design sessions is a compromise.

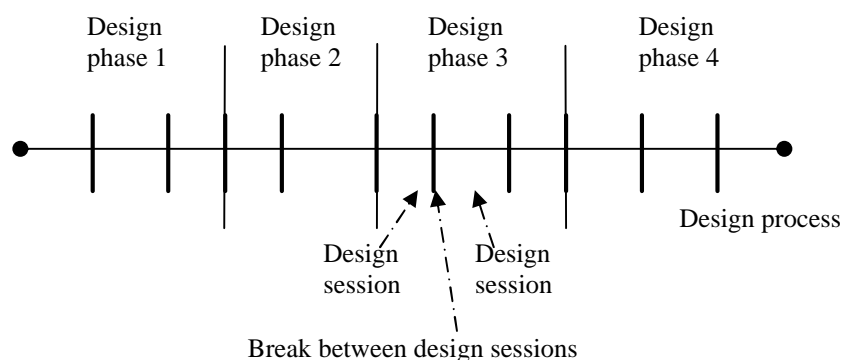


Figure 3. Design sessions structuring a design process

A *design session* is defined as a period of time during which one or more designers are working on a subtask of a certain design task; for example, a number of hours, days, or weeks. Breaks between design sessions can be coffee or lunch, interactions with colleagues and stakeholders, meetings, periods spent working on other projects, weekends, holidays, or others. Design sessions can thus have different lengths and designers can determine the duration of a design session themselves. The concept of a design session is illustrated in Figure 3.

3.3 Integrating the concepts

In order to integrate reflection into a design process, the proposed structure of a reflection process (the twin-peak model) and of a design process (design sessions) can be combined. As illustrated in Figure 4, we propose to devise a reflection process over two design sessions. At the end of a session, the preparation step should be performed. When the preparation step is finished the session ends and a break is made. A new session starts with the continuation of the reflection process, namely the image-forming and conclusion-drawing steps. These steps should determine the focus and direction of the new design session and generate ideas for design activities to be performed. During the core of the design session, the design activities can be performed.

In summary, the preparation step of a reflection process ensures that the conclusions drawn at the end of a reflection process are based on a systematic fact collection and analysis. The concept of design sessions ensures that reflection takes place on a regular basis. The latter differs from [Schön et al. 1996], where reflection is proposed only when a ‘surprise’ occurs.

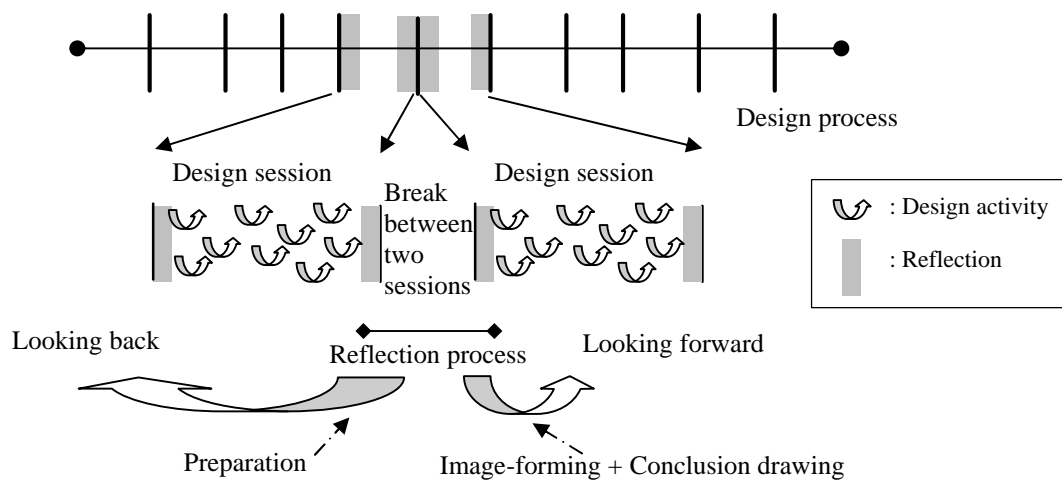


Figure 4. A model that integrates structured reflection into a design process

4. Conclusions

In this paper, we explored the possibilities of structured reflection for improving design processes. The advantages can be summarised as follows: *Reflection* helps designers to learn from their experiences, to integrate and co-ordinate different aspects of a design situation, to judge the progress of the design process, to evaluate interactions with the design context, and to plan suitable future design activities. In addition, *structured reflection* can help designers to take balanced design decisions that are based on both rationality and intuition. Structured reflection has the advantage that reflection is performed regularly during a design process and that it is based on a systematic approach. This should help to detect and correct deviations from the design goal early and to decrease the chance of overlooking important aspects and viewpoints. Altogether, structured reflection should result in an increased effectiveness and efficiency of design processes.

The paper also describes a model that integrates structured reflection into a design process. It can be seen as a starting point for supporting structured reflection on design processes in practice. Further research should start with investigating the current practice of reflection on design processes. Both individual and team reflection processes should get attention. Literature in related disciplines like psychology, philosophy, social sciences, and management science can offer new insights about reflection processes, which can improve our model. Further research should also concentrate on developing concrete support for stimulating and sustaining designers in reflecting about their design process. Checklists are a simple possibility to do this, as proposed in [Reymen 2001]. Training sessions in which the necessary skills and attitudes are learned (like being critical and daring to question implicit assumptions) are also important.

References

- Cross, N., "Engineering Design Methods: Strategies for Product Design", John Wiley & Sons Chichester UK, 1994. (2nd ed.)
- Daudelin, M., "Learning from Experience through Reflection", *Organizational Dynamics*, American Management Association New York USA, Vol.24, No.3, 1996, pp 36-48.
- Dorst, C., "Describing Design: A Comparison of Paradigms", Ph.D. Thesis, Delft University of Technology Delft The Netherlands, 1997.
- Kolb, D., "Experiential Learning", Prentice-Hall London UK, 1984.
- Lauche, K., "Heedful Action, Reflection, and Transfer in the Design Process", *Proceedings of the 13th International Conference on Engineering Design*, Vol.1, Culley et al. (eds.), Professional Engineering Publishing London UK, 2001, pp 267-274.
- Reymen, I., "Improving Design Processes through Structured Reflection: A Domain-independent Approach", Ph.D. thesis, Technische Universiteit Eindhoven Eindhoven The Netherlands, 2001.
- Roozenburg, N., Eekels, J., "Product Design: Fundamentals and Methods", Wiley Chichester UK, 1994.
- Schön, D., "The Reflective Practitioner: How Professionals Think in Action", Basic Books New York USA, 1983.
- Schön, D., Bennett, J., "Reflective Conversation with Materials", in *Bringing Design to Software*, Winograd, T. (ed.), ACM Press New York USA, 1996.
- Valkenburg, R., "The Reflective Practice in Product Design Teams", Ph.D. Thesis, Delft University of Technology Delft The Netherlands, 2000.
- Wallmeier, S., Badke-Schaub, P., Stempfle, J., Birkhofer, H., "Empirical Diagnoses and Training in Design Departments", *Proceedings of the Third International Symposium on Tools and Methods of Competitive Engineering*, Horvath et al. (eds.), Delft University Press Delft The Netherlands, 2000, pp 439-450.

Dr.ir.arch. Isabelle M.M.J. Reymen
Technische Universiteit Eindhoven, Stan Ackermans Institute
L.G. 1.70, P.O. Box 513, NL-5600 MB Eindhoven, The Netherlands
Tel. +31 (0)40 247 4283
Fax +31 (0)40 246 5342
Email: I.M.M.J.Reymen@tue.nl