When and How Do Designers in Practice Use Methods?

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Abstract Designers in practice do not use methods as explicitly as design teachers and researchers expect it. Observing good experienced designers one often can discover methodical skills and intuitive systematic approaches. Methods—as they are taught in design courses at the university—can only be found in the daily routine, when it is demanded by the management, e.g., in the companies' design project guideline.

1 Design Departments Have to Come up with Good Solutions in a Short Time

The overall goal of a design department in industry is very easy: Coming up with good solutions in a short time.

This demand is easily understand, but for the targets "good" and "short" designers have to struggle all the time. Each single decision in the design process is a compromise between good and short (fast). To find the best compromise, it is common sense that a systematic approach is helpful (Pahl et al. 2007; VDI-Richtlinie 2221 1993; Wolf 2011). Design research has developed numerous tools and methods for this purpose. In design classes, many of these tools and methods are taught and practiced. A company with a powerful design department tries to support their designers with an agreed design process model and by providing a set of selected tools and methods which are rated useful for various design situations in the company.

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2 Project Management and Toolbox of Methods

The company, the author is working for, supports a systematic approach among other things by a standardized plan for a design project and by a toolbox of methods. A 70 pages booklet called "design guideline" describes the project plan. The so-called quality gates and milestones are the core of this project plan (see Fig. 1). The project team passes the Quality Gates (QG) together with the steering committee of the respective design project. The project team carefully prepares all requested documents for these meetings. Standardized checklists are used to cross the quality gates efficiently.

As a part of the project plan, some methods are applied since they are required to pass the quality gates

- project draft (description of the technical content, resources, budget, and schedule)
- requirement list (technical requirements translated from the market needs)
- product specification (description of the preferred solution)
- review plan (when to discuss which topic with whom)
- qualification plan (how to ensure the functional performance of the product)

The approval of the project draft is the formal start of a design project. Requirement list and product spec are widely accepted methods taught in design classes. The review plan proved to be useful to enhance designers to discuss their ideas and solutions with the appropriate colleagues at the right time (Frankenberger 1997). With a qualification plan, one tries to systematically ensure the functional performance of a product. The so-called qualification engineers support designers to select and apply a suitable method for a particular step in a design project.

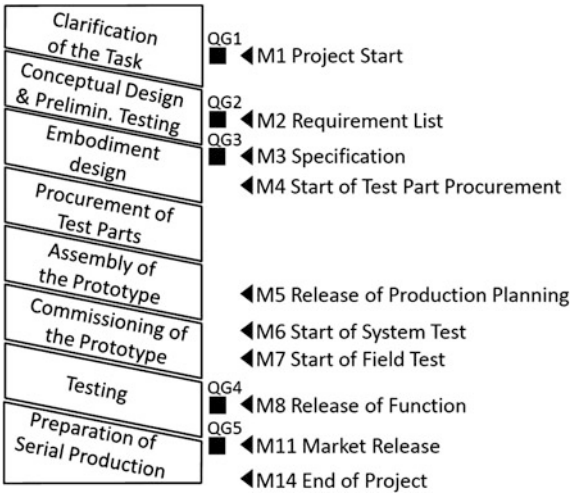

Fig. 1 Project plan for design projects (simplified)

Despite the doubtless benefit of these few methods (Jänsch 2007; Pahl et al. 2007) and the support by the qualification engineers, the actual application is often experienced arduous and time consuming (Geis et al. 2008; Jänsch 2007). It subjectively does not appear efficient (Birkhofer et al. 2005) and the author can confirm the resistance to methods of many possible users described by Geis et al. (2008). The strict demand of the management and the company's documentation system proved to be the most important drivers for an explicit use of methods.

The above-mentioned "tool box of methods" is a collection of methods which are rated useful by designers and managers in design projects in the past. These methods are described in the companies' intranet (see Fig. 2).

Experts are available to support the application of the tools and methods. Courses in these methods are offered as part of the companies' internal education program. The tool box contains, so far, the following parts:

Method	Task/Goal	Outcome	Contact Person/ Expert
project planning in R&D	Planning and steering of projects with PPMS and QlikView	The project is reasonably planned	J. Smith 1234
systematic definition of requirements	development objective matches the market requirements	Customer value and acceptance testing for each requirement documented in the requirement list	H. Spec 2345
solution finding methods (intuitive and discursive) and evaluations methods	generating a pool of ideas for solving of problems and contradictions	the superior concept is chosen and can be realised	E. Wallace 1345
risk management	comprehensively assuring crucial and complex developments	Documentation and evaluation of systematically identified risks.	J. Risky 3456
testing methods for designers	efficient planning, performing and analysing of tests	Efficient test procedure with clear objective and documentation of results	R. Testing 4567
design of experiments	Understanding complex relations with little effort of experiments	Functional relations of the command variables of the process are established.	S. Carter 5678
Methods of Simulation	Evaluation of concepts and functional demonstration without parts of "steel and iron"	best concept identified, problems discovered early, effort of experiments reduced.	M. Brown 6789
endurance validation	forecast of endurance based on in-house tests. time advantage by the use of time-lapse tests	Components resist the loads in practice in the long run	R. Valid 7870
reliability management	Increasing the availability by reducing incidents and breakdowns	The customer expectations concerning availability are met	J. Green 8901
design review guideline	quality intensification of technical solutions and design processes	The ideal solution is going to be realised. Tasks and responsibilities are documented.	S. Oliver 9012
value stream optimization	Making processes transparent and identifying weak points	Transparent and efficient processes by elimination of waste	G. Value 9123
systematic process of problem solving	Refining interpersonal and methodical skills	Efficient collaboration in teams and systematic problem solving	R. Valid 7870

Fig. 2 Methods portal of the companies' intranet

- project planning
- systematic definition of requirements
- solution finding methods (intuitive and discursive)
- evaluation methods
- risk management
- testing methods for designers
- design of experiments
- endurance validation
- reliability management
- design review guideline
- value stream optimization
- systematic process of problem solving

In addition, the qualification engineers scan further available methods. If designers or managers see a benefit of such methods, the qualification engineers try to adapt them to the companies' needs. Together with the designers, they plan and facilitate the necessary steps in order to apply established and new methods in an efficient way.

3 Influence of Project Management and Design Education

The above-mentioned methods are a small selection of the ones described in educational books and guidelines for designers (Pahl et al. 2007; VDI-Richtlinie 2221 1993). Almost all designers the author is working with have at least a basic education in systematic design and design methods. For this reason, it is difficult to find out how they would work without the systematic background (Jänsch 2007). On the other hand, in practice, designers develop their own "methods" unknowingly and implicitly when they instinctively aim to become more efficient, as described in (Ehrlenspiel 1999). A common approach one can observe in practice is the multiple correction of a first solution idea. This is described, e.g., in Dylla (1991) and Ehrlenspiel (1999). It appears as the opposite of abstraction: finding a quick solution for a design task, being happy and perhaps proud to make progress and then—instead of calling this first idea into question or looking for other solutions—just correcting it in several aspects (function, cost, manufacturing, etc.). Observing the daily routine, it is impressive, how often this "natural approach" is used and how seldom designers use their methodical possibilities explicitly (Birkhofer et al. 2005; Günther 1999; Jänsch 2007; Wolf 2011).

Methods and outcomes from design research which are *not* required to pass the companies' quality gates can hardly be found in the daily work of the observed design department. Frequently, designers—above all students and beginners—intend to use methods for solution finding. Behind this intention, the author assumes the hope to be creative solely because of using such methods. Nevertheless, an actual use of a distinct method like brainstorming, method 635 or

even morphological matrix is astonishingly rare despite the fact these methods are well known and they are comprised in the mentioned "toolbox of methods."

On the other hand, there is a class of methods with a completely different reputation: simulation and calculation of crucial parts and mechanisms is standard in the company. Such "tough" methods to improve the embodiment design are generally seen to be efficient. Their usefulness appears to be obvious, since an optimized layout can be achieved much faster using these analyses methods than relying on estimation, experience, and test. From this aspect, simulation and calculation methods are very different compared with methods to improve the design process itself. In the observed company, a particular department for simulation and calculation supports the designers on a very high level. Designers appreciate this service and use it intensively.

Designers in the analyzed company see the project management guideline as the most important system to lead through the design process. A strong demand of the companies' management underlines this. Apart from the requirement list, controlling resources, cost, and schedule dominate the approach of the project management guideline.

4 Lessons Learned

Designers in industry improve rapidly their knowledge in construction material, production, machine elements, strength characteristics, etc. According to other references (Birkhofer et al. 2002), the author got the conviction that methodical skills do not evolve in parallel.

An explicit application of design methods and supporting tools can be seen almost only when it is demanded by the management or the companies' documentation system (Wolf 2011). Designers—and the author includes himself in this criticism—only seldom manage to overcome the hurdles of working as they did as students: being keen to follow a systematic plan, abstracting and looking for the right method for the actual task at hand. The most promising supporting factors in terms of using methods and approaching systematically seem to be the following:

- being demanded by the management
- having the wish to improve the own procedure
- having the personal experience that it saves time
- knowing realistic and convincing examples from the own working field (López-Mesa 2003)
- making oneself aware of the actual benefit after having applied a method
- ease of use (Birkhofer et al. 2002; Geis et al. 2008; Jänsch 2007; Jänsch and Birkhofer 2004)
- knowing for which problem the method is appropriate and for which not (Jänsch and Birkhofer 2004)
- being able to adapt the method to the actual problem (Birkhofer et al. 2005)

Some of these supporting factors give an idea on how to introduce methods: Making designers aware of the importance of reflecting the own procedure. Finding convincing examples for the benefit of using methods is a much bigger challenge than it seems to be. Post-method learning helps to become aware of the benefit and the limits of a particular method.

Another lesson the author learned in practice is the inspiring effect of solving concrete design tasks collaboratively in a well-working team. Such sessions proved to be organized easily. Designers enjoy the working atmosphere of struggling together for a good solution. Doing this frequently evolves a culture of mutual confidence which is important to encourage the participants outlining the weak points of their preferred ideas (Wolf 2011).

In such design reviews, CAD models presented with a beamer are helpful to give an overview and introduction on the design. For detailed discussions, this medium has turned out to be too volatile. Large printouts of CAD models and drawings simply attached to the wall emerged to be much more helpful for the interaction between the participants. Usually, the presenting designer carefully selects the most helpful views and sections in advance. This procedure is more efficient than doing it life within the CAD system during the design review. Furthermore, paper sheets do not disappear during a design session. So everyone can sketch, comment, and highlight crucial points. And everything is documented for a wrap-up. The CAD models projected with a beamer can be a helpful addition but not supplementing the paper.

It is self-evident that a rough documentation is helpful for the discussion. But most designers usually do not like this. Again the management must claim a documentation which should be done in a visible and easily readable manner for all participants during the design session.

Such simple design reviews are fun and they very often lead to commonly achieved results which are obviously much better than the sum of the solutions of the single designers. Therefore, design sessions turned out to be attractive for designers.

5 Platform Needed

Industry wants to improve the design process in practice. Academia wants to understand the design approaches in practice and needs realistic opportunities to analyze it and to test tools and methods. The international workshop “Impact of Design Research on Practice 2013” (IDRP13) in Munich for the participants from industry was a very valuable interaction—above all among the colleagues from industry. It turned out, that we have similar questions and similar approaches. Nevertheless, an exchange of best practices and the profound discussion among each other and with the design researchers was widening the horizon and inspiring.

For designers in industry, a platform for discussion and exchange with people from other companies has turned up to be meaningful. Design researchers could

chair such a platform. They can help to open the minds and to questioning the frequently continued and hardened convictions and habits in design practice. The common aim is to find out the most relevant and promising results of research that make design practice more efficient and attractive.

Design researchers can use such a platform to get insights in actual design processes. Here we face the difficulty of confidentiality. Companies are sensitive as far as innovation projects are concerned. A discussion and publication of the design process as such is usually uncritical. Collaboration on interesting—and therefore confidential—projects needs confidence among the involved people. A high level exchange platform will lead to a network, which overcomes mistrust and leads to win–win projects for industry and academia. Experienced designers, perhaps former design researchers who now have technical responsibility in a design department can moderate. In addition, the author proposes design researchers to accompany important design projects from outside the company. At first sight, this distance does not seem to be useful. But with such an approach, one easily can analyze relevant design projects—even crucial ones—instead of studies. In addition, one is able to analyze a design process without interfering it. The platform can be the base of struggling for the best way of collaboration in a concrete situation in order to respect the interests of all partners.

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