INTERNATIONAL DESIGN CONFERENCE - DESIGN 2006
Dubrovnik - Croatia, May 15 - 18, 2006.

DESIGN 2006

STRATEGIC ASPECTS OF DESIGN METHODOLOGIES: UNDERSTOOD OR UNDERRATED?

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Keywords: design methodologies, strategy, acceptance

1. Introduction

Globalization increases the competitive pressure on products as well as enterprise processes. Distributed development, for example, increases the complexity of organising and realising collaboration and communication. Enterprises try to fulfil these intensified requirements, among other things, by trying to achieve a more clearly defined process. They provide their employees with detailed descriptions of the entire value chain and/or the complete product developing process, and these descriptions are then considered binding. The introduction and use of design process models suggested in literature as "design methodologies" or "design methods", as the basis for such a detailed company specific description often represent a problem for companies [Pawlakowitsch 2003]. Sheldon pointed to the positive result of the application of design methods, but did not mention design methodologies at all [Sheldon 2005]. Although in particular the interlinking of methods could be addressed by the application of design methodologies, this offer does not seem to be accepted in practice. An empirical study by Pannenbäcker shows that the best-known design methodology was familiar to half the respondents but only used by half of these [Pannenbäcker 2001].

2. Problem definition and objective

The potential of design methodology (DM) does not seem to be recognised or is underestimated and so far only little used, although:

- numerous prescriptive generic descriptions of processes in the form of DM are available (overview see [Pahl, Beitz, Feldhusen, Grote 2003]) and these have been taught for years,
- designers want assistance for solution finding [Pannenbäcker 2001].

However, the fundamental problem of determining the effectiveness and efficiency of DM is well-known and has been discussed for a long time (e.g. [Jordan 1985]) and this remains an important issue of design research (e.g. [Bender 2004]).
The goal of the paper is to discuss and to analyse the problem of user acceptance, continuing the first analysis of the potential of DM [Schmidt-Kretschmer, Blessing 2005a] to promote understanding of strategic aspects of DM.

3. Methodology

Within this project, we found it helpful to regard DM as a product – one which is introduced, determined and explained by numerous publications. Workshops within companies have also often met with good resonance from industry participants [Pahl 1991] according to the result of the study of Pannenbäcker [Pannenbäcker 2001].

Our investigation started with the clarification of aspects of user acceptance to prepare an empirical study about the strategic aspects of design methodologies and methods. Available literature on empirical investigations was analysed and reasons for the acceptance problems identified through:

- the examination of requirements from the users of DM (the designers) and the objectives of the product "DM" as stated by the authors,
- estimations by design scientists about user acceptance and problems with the application of DM,
- results of descriptive studies about the effectiveness of DM.

The comparison of requirements and objectives gave a first indication of potential user acceptance problems. The experiences of the authors of DM and the results of descriptive studies were used to clarify potential weak points of DM. Based on these, a simple model of strategical aspects was drawn up.

4. Identification of acceptance problems

4.1 Requirements of the users and objectives of the authors

The clarification of user acceptance has substantial influence on solving the contradiction between the need and the actual use of DM [Schmidt-Kretschmer, Blessing 2005a]. Therefore the requirements and expectations of the potential DM users and the objectives of the product "DM" are to be considered. Although numerous statements about requirements and expectations from users are available (e.g. [Jordan 1985; Pannenbäcker 2001; Birkhofer 2004], these often have not been investigated in detail. Therefore the list of requirements in Table 1 is not complete. Some of the requirements may sound unrealistic; nevertheless they represent the voice of the user.

Table 1. Comparison of requirements on and objectives of DMs

Requirements - Methodology support in design should:	Objectives - Improvement of: holistic view	communication	work sequence	solution finding	controlling of design process	teaching / learning of design
require as little effort for learning and training as possible						x
be easy to use						x
solve problems "in no time"			x			
produce convincing results for complex problems				x		
be integrated in the existing design environment	x					
support teamwork as well as individual work	x					
support compatibility of methods	x	x				
structure work sequence	x		x			
…						

The identification of the objectives was difficult, because authors often do not explicitly list the objectives of their design methodologies. This implies that they are also hard to find for potential users and thus may influence the acceptance. Furthermore, the link between the objectives and the various

elements in the methodology was often not clearly described. To cluster the objectives in the six classes shown in Table 1, only the objectives explicitly mentioned by the authors were used.
A comparison of the requirements and objectives allows the identification of the principle ability of DMs to realise user requirements. Table 1 shows that more detailed investigations into the requirements and expectations of the user of DM are necessary in order to understand the current acceptance problems.

4.2 Statements about the user acceptance of DM by design scientists

Statements about and estimates of the effectiveness and efficiency of DM and of the user acceptance of DM can be clustered as shown in the first column of Table 2. They were mainly made by design scientists, among them also the authors of DMs [Ehrlenspiel 1998, Birkhofer 2004] and usually do not cover the view of the enterprise. The confrontation of the objectives and requirements of Table 1 with the statements of the design scientists are shown in Table 2. Although Table 1 suggests that the objectives overlap with the requirements and thus the requirements on DM should have been met by the DMs, this is not confirmed by the results in Table 2. The problems with DM relate to all objectives and requirements, but no solution seems to have been found yet, despite the fact that the problems have been known for many years.

Table 2. Comparison of problems with and objectives and requirements of DM

	Objectives - Improvement of:						Requirements - Methodologicical support in design should:							
Problems with DM identified or estimated in literature:	holistic view	communication	work sequence	solution finding	controlling of design process	teaching / learning of design	require as little effort for learning and training as possible	be easy to use	solve problems "in no time"	produce convincing results for complex problems	be integrated in the existing design environment	support teamwork as well as individual work	support compatibility of methods	structure work sequence
terminology unclear	x	x						x					x	
training effort too large						x	x		x					
evaluation of process unclear					x									
too large degree of abstraction by generically approach	x									x				
embodiment design underrepresented				x							x			
time consumption not considered			x											
division of labour not considered		x	x									x		x
representation unclear	x							x						

4.3 Statements about the acceptance of DM from descriptive design research

Acceptance of DM is related to the effectiveness and efficiency of DM. Several empirical investigations addressed the effectiveness of DM, but explicit, scientifically well-founded statements are scarce. Few studies show an overall advantage of using DM. Advantages are usually found for particular activities or specific stages of the process. Many researchers conclude that it is likely that the advantages of using DM only manifest themselves over time, due to training effects, to the possibility to reuse documentation from earlier projects, and to the length and complexity of real

design projects as compared to short assignments solved in empirical studies At present, only a few studies are available that address the long-term effects of the use of DM, i.e. studies on the effects of DM which exceed the time horizon of one project (e.g. [Schmidt-Kretschmer, Blessing 2005b]). The acceptance of users will be affected by the lack of evidence of positive effects on the overall project, given the observed additional effort in the earlier stages, when a DM has just been introduced.

4.4 Conclusions

The assumption about the potential of DM to have a positive effect only in cases of repeated application leads to a different view of the identified objectives, requirements and problems and further interesting questions. The validation of this assumption could change the value of and general view on DM (including its representation and marketing). Therefore, empirical studies about DM should also take into account possible long-term effects, even in short-term investigations. This might include combining results from various studies or building up results of others studies. In this way, more and more effects, impacts and relationships between effects can be considered and gradually conclusions drawn with respect to long-term effects [Blessing, Chakrabarti2002]. The validation of the long-term effects also puts new requirements on research management, since such investigations usually exceed the duration of a research project, in particular that of a PhD project.
Looking at the objectives of DM as shown in Tables 1 and 2, it is noticeable that long-term effects are not described explicitly. Long-term effects are not considered either in the remarks of the design scientists about the user acceptance or in the requirements of the users. None of the objectives, requirements and problems take long term-effects into account, nor are they explicitly stated as an advantage by the authors of DM, see Table 1. Potential users do not have a chance to judge the use of DM under this aspect. The long-term effects will change the view on almost all the stated problems. Furthermore these effects are essential for justifying any investment of time and money.
In summary, despite a fundamental strategic orientation of all DM, the long-term effects:

- are not considered explicitly in the objectives posed by the authors
- are not considered in the majority of empirical investigations, and
- obviously cannot be taken into consideration for the evaluation of DM by the users.

5. Proposed solution

The investigation was extended into other research disciplines by replacing the term “long-term effects” with “strategic effects”. Using this new perspective, DM and its sub-processes can be interpreted as strategical processes, and solutions from the discipline of strategic management could be used, e.g. solution for better implementation of strategic processes. DM can be seen as a strategic process or measure within the context of design, when using a broad definition of the term "strategic" [Schmidt-Kretschmer, Blessing 2005a]. The term "strategic" qualifies something holistic, relates to long-term effects, has a very high value in the hierarchy of purposes and goals, and is the opposite of "operational". Within this broad definition, the difference in boundary of the terms method and methodology is of subordinate relevance for the following considerations, i.e. at this level they can be treated in the same manner.

Hypotheses

The above problem of user acceptance leads to the formulation of the following hypotheses:

H1: The evaluation of the effectiveness and efficiency of DM on the basis of its first application leads to incorrect conclusions, if strategic aspects are not considered.

H2: The explicit presentation of the strategic aspects of DM has a positive effect on the expectations and acceptance of the users.

For the evaluation of both hypotheses, it is necessary to be able to measure the long-term qualitative or quantitative effects. This requires operational definitions of the strategic aspects and their relationships. A first step was the generation of a simple model, Figure 1, which distinguishes between operational and strategic procedures and from which further research questions and tasks can be derived. The model is based on two extreme (theoretical) positions: an approach based on 100%

operational procedures and an approach based on 100% strategic procedures. The approach can relate to any process, no specific process size is supposed. This theoretical view of independent strategic and operational activities simplifies and supports the analytic approach used in our research.

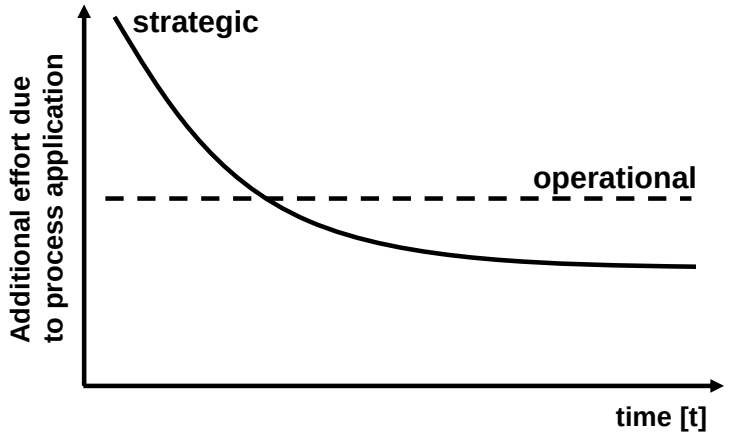

Figure 1. Model for the explanation of strategic aspects

The curves represent the additional effort for applying a particular process, such as DM, i.e. the curves do not include the product-related effort necessary to develop a product. The x-axis represents the time without any quantification, i.e. it is possible to regard one or more activities / projects / phases / procedures.

It is assumed that a strategic procedure always requires more effort for its first application, than an operational procedure, since the process must be organised, which is normally created and implemented by the designers. The time-independent level of effort for operational procedures assumes that the product-related work on a problem is not affected by experience or learning effects (within this extreme theoretical position), which would reduce the effort. After some time, the curve of the strategic procedure falls below the level of effort for the operational procedure, which implies the expectation of positive long-term effects. It is also conceivable that the curves never intersect. In this case, it should be clarified whether the additional expenditure for the strategic procedure justifies itself. The identification of possibilities to lower the initial strategic curve or realise an earlier crossing point, will suggest potential strategic aspects to address, such as implementation effort, genericity, reusability, similarity, that have to be investigated in further investigations.

6. Conclusion

Long-term effects or strategic effects of design methodologies have not taken into consideration until now, neither in objectives nor in comments on DM. Results of the field of the research of strategic management are usable, if DM is seen as strategic measure. The possibility of adoption of the results of the field of strategic management has to be tested to generate distinct recommendations for a better implementation and usability of DM. Furthermore a closer cross-linking between the disciplines could make DM more well-known beyond the system boundaries of design research. In a first step, fundamental concepts were defined, a representation model was discussed and possible strategic aspects of DM were specified. In the past DMs have been offered to the users "under value". without consideration of the strategic aspects, Finally the shown investigations lead to research questions which have to be clarified in a next step and if necessary by appropriate descriptive investigations:

- How can strategic advantages be proven?
- Can the qualitative representation model be quantified?
- When should designers proceed operationally or strategically?

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