DESIGNERS NEEDS ANALYSIS FOR ASSISTING THE SELECTION OF DESIGN METHODS

Nathalie Lahonde 1, Jean-François Omhover 1, Améziane Aoussat 3 1

(1) : Arts et Metiers ParisTech – Product Design and Innovation Laboratory
151 Bd de l’Hôpital, 75013 Paris, France
+331 44 24 61 97/+331 44 24 63 59
E-mail : nathalie.lahonde,jean-francois.omhover,ameziane.aoussat@ensam.eu

Abstract: Design methods play an important role in the optimization of product design process. They allow designers to structure and rationalize their activities, they help them to reduce development time, minimize errors and improve quality of products. Nevertheless, many studies report their lack of use in practice. This is not a new phenomenon and yet, no appropriate answer has been proposed to overcome this problem. There seems to be a consensus in the scientific community that a system which supports designers in the selection of design methods should answer the needs. In this paper, we propose an original approach to understand precisely their expectations. Thus, 22 interviews with full time designers have been carried out. A new guide for assisting designers in their choice of appropriate design methods will be developed based on the results of the application of this qualitative method.

Key words: design methods ; optimization ; design process ; selection ; need analysis.

1- Assisting the choice of design methods

1.1 – Importance of the selection

Design methods are inseparable from product development. First, they allow designers to structure and rationalize the design process. Therefore, the use of design methods is a conventional maturity indicator for innovative project. Indeed, methodologies for supporting processes are sometimes quoted as key factor to improve the product design process. Moreover, design methods contribute to the whole strategy of the product design development. This is what Cross calls “design strategy” [C1]. In particular, design methods improve the performance of the enterprise by optimizing costs, quality and time.

One of the objectives of engineering design is to develop new methods and to provide them to enterprises. Braun and Lindemann use the term “transfer” to illustrate the transition from academy to industry [BL1]. This transfer can be decomposed into three steps : 1- Selection : design methods are chosen depending on the need of the project. 2- Adaptation : design methods are adapted to the specific project. 3- Application : design methods are deployed. Several surveys reported the little use of methods in industries. In [GB1], Geis et al. indicate that this bad transfer is the consequence of the lack of support in the selection of appropriate design method. Thus, the difficulty of the selection leads to methods being underused. As a conclusion, the selection of design methods is a crucial task. Then, helping designers in their choice of appropriate design methods may lead to the success of the product development process.

1.2 – Assisting the selection

There is a need for a guide to know which method to use in a specific case. Few systems already exist in order to support the selection of design methods. These guides are communicated through various ways: scientific books specialized in engineering design, articles in journals and conference proceeding, etc. Historically, the first guides were based on the decomposition of the design process: for each phase, a set of design methods were recommended. Today, these guides still represent the majority of existing guides. Another way for guiding the selection of design methods is to characterize methods with attributes. Method attributes could be defined as any information or property which enables to characterize a method. For instance, attributes could be the inputs/outputs of a specific method (see the input/output chart of Jones [J1]). Attributes could also be the type of methods (creativity technique, multi-criteria decision making methods, etc.), the nature and the quantity of resources (time, human, material) and so on. For an extensive literature review of existing guides, see [LO1]. The existing guides vary a lot in their form, coverage of the process, etc. In spite of this variety, they seem to not answer the need of the users. In the next sections is detailed the methodology used to understand how designers choose their design methods in practice and what are their expectations.
2- Methodology

This step aims to collect information about activities of the designers concerning the selection of design methods. More specifically, we want to:

- Validate the need of a system which helps designers to select design methods;
- Define precisely who will be the future users of the assisting system;
- Specify their expectations.

In order to achieve this goal, different profiles of designers were interviewed with help of semi-directed interviews.

2.1 – Sample

In this paper, we analyse the results of interviews carried out with a sample of 22 full-time designers. People selected had diverse profile (years experience, field of expertise, size of their enterprise).

Table 1 and Figure 1 sum up the profile of the 22 interviewees. Because one of the participants had a mixed profile, we split the number in 2 parts. We deliberately interviewed a lot of people with engineering background because this field is very broad (engineering in mechanics, electronics, informatics, etc.).

<table>
<thead>
<tr>
<th>Years of Experience</th>
<th>Product Design</th>
<th>Ergonomics</th>
<th>Engineering</th>
<th>Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;x&lt;5</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5&lt;x&lt;10</td>
<td>1,5</td>
<td>6</td>
<td>0,5</td>
<td></td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>1</td>
<td></td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Profile of the 22 interviewees.

Figure 1: Size of enterprises.

2.2 – Interviews

We realized a literature review which allows us to consider results of previous studies focusing on the selection of design methods. As far as we knew, no studies approached this problem interviewing directly designers on this activity. Thus, using a qualitative method such interview to understand the need of designers concerning their activity in the choice of design methods is our original approach.

Thus, we chose to conduct semi-directed interviews with designers. This methodology had been preferred to others because of its flexibility which allows interviewees to express freely their point of view.

Semi-directed interviews are based on a guide realized and tested before the experiment.

The specific guide built for these interviews deals with four topics:

- Topic n°1: the interviewer asks the designer to find in his memory design project achieved for which he collaborated. The project must be recent in order to guarantee the precision of the answers. The information collected here do not bring real added value for the analysis. But, remembering project allows designer to put himself in situation and to prepare him to further questions.
- Topic n°2: we go deeper into the design methods and tools used during the project. This point is rich in analysis because, from the answers, we ask designers if they used any sources of information to help them in the selection of these methods; who was responsible for the definitive choice; when this selection occurred during the project; etc.
- Topic n°3 deals with the difficulties encountered concerning the choice of design methods and tools; the way of capitalize the new methodological experience developed during the project and the possible optimizations to apply for this kind of project.
- Finally, the need for a guide which helps designers in their selection of design methods is dealt in topic n°4.

For each topic, several questions were prepared in case quantity of information was judged to be insufficient. Interviews lasted between 30min and 1h.

In order to be able to exploit after the experiment information exchanged during the interview, the discussion was recorded with help of an usb key. This material, coupled with classical equipment, were analyzed.

3- Results

In this section are displayed the results of the 22 interviews. First, we present the number of design methods quoted, then the sources of information used to help designers in their decision taking, the person who is responsible of the choice, and finally the justifications and the difficulties encountered.

3.1 – Design methods chosen

It appears that a large quantity of design methods and tools are used during product development projects. After the 22 interviews, more than 60 methods were quoted. There are very heterogeneous (in terms of objective and expected results, number of participants, etc.) and have frequency of use extremely different. For example, Functional Analysis has the higher frequency of use with 18 quotations out of 22 projects. Half of design methods quoted were used in one project out of 22.

Here, it seems obvious that design methods cannot be used in a systematic way on all projects. Thus, it is necessary to select with extreme cautious design methods that fit well in a particular project.
3.2 – Sources of information

The future system has to be a source of information and a guide which assists designers in their selection of specific design methods. Thus, the question which concerns the sources used by designers in the beginning or during the project in order to collect information and guide their choice of methods is very important.

3.2.1 – Different sources of information

14 different sources of information have been quoted sum-total during the interviews. Among them, some are predominant, such as experience feedback (the designer uses his previous experience to refine the choice), expert advice (people ask advice to specialists to have a direction) or design process model (industries have often developed their own models of design process that includes steps, deliverables and methods and tools to utilize). Other sources are marginal like wikipedia or database.

After a first analysis, we could notice that the frequency of quotation of a source depends on the profile of designer. Indeed, as illustrated Figure 2 and Figure 3, we could distinguish sources of information used by novices designers and those used by experts.

![Figure 2: Classification of sources of information with frequency of quotation: novice profile.](image)

![Figure 3: Classification of sources of information with frequency of quotation: expert profile.](image)

Because of their lack of experience, novices tend to mix a lot of sources of information (11 different sources quoted by novices against only 5 for experts). In the case of novices, the source of information with the maximum of quotation is the appeal to experts. In case of designers with an expert profile, they mostly use the experience feedback as a majority. The “model” is used in both cases and is also well quoted. Another important source of information for novices is the lessons whereas for experts, it is a toolkit that they have built by themselves (they are familiar with the advantages, disadvantages, constraints and limits of each methods and tools belonging to their toolkit).

Finally, it seems important that the system memorizes the model to be used by the designers because it gives a common structure to all the participants of a project. We could notice that novices in design methods tend to scatter when searching for information whereas experts compose their own methodology from their own background. In definitive, it appears that an assisting system to help design in their choice of design methods is more appropriated for novices than experts.

3.2.2 – Nature of information searched

All persons interviewed quoted two sources of information minimum (3.6 sources on average ; 1.5 of standard deviation). Several reasons justify this observation. It concerns in particular the nature of information searched.

First of all, it clearly appears that it has no marked distinction between a source used to deepen a method and another one used to compare methods and select a particular one. Indeed, in order to choose a method, the designer has to first understand its specificities and conditions of use. Thus, not only the system would propose descriptive information to allow user understand well the method, but also, prescriptive information to assist designer in their choice and recommend the use of certain methods.

Secondly, none of the sources provides a complete description of design methods. Indeed, the nature of the information expected by designers is very large : they seek not only theoretical information but also practical data about methods. It seems difficult to gather all this information in a single document. Some sources are more adapted for a theoretical research (such as norms or scientific book). Conversely, some sources are more adapted for a practical research (such as expert advice or pragmatic book). During the interviews, it clearly appears that theoretical and practical information are important for the choice. Thus, the future system will have to gather both.

Finally, designers want to mix different sources in order to confirm previous results and to be sure of the objectivity of the information collected. Finally, in some particular cases where the selection of a method is a very challenging task, designers want to test and compare results extracted from different sources to be sure to make the best choice. Thus, it is important that the system contains only objective information (no bias resulting from personal convictions).

3.2.3 – Additional constraints

Norms have been quoted only once. Thus, they seem to be ill-adapted for this kind of research. Indeed, the important details of a method which allow designers to understand its conditions of application are overwhelmed in a dense description. Thus, it is important for the system to be concise and to bring only information which help designers in their choice.

Moreover, norms are paying so there are not easily to obtain. Thus, the future system has also to be accessible.
3.3 – Responsible of the choice

The question which concerns the responsibility of the choice of the design methods seems to be obvious first. But the reality is much more complex. Indeed, we present in this section that the person who chooses the method is not necessarily the person who applies it. This has consequences on the perimeter of the future system.

3.3.1 – The person who chooses is the person who applies the method

This is the easiest case. Here, it seems logical that the person who applies the method is the one who chooses it. But in practice, it is much more complex. Indeed, design is a multidisciplinary domain. So, it is usual that the application of a particular method is collective. Thus, a consensus must be found between the members of the team. Moreover, even if the application of a specific method is individual, it is known that the results of method A (supposing that this method will be applied by designer A) are the inputs of method B (applied by designer B). If a variant of method A is preferred, this would modify the accuracy of the results and thus, the quality of the application of method B. Thus, it is possible that designer B negotiates the choice of method A with designer A.

3.3.2 – The person who chooses is not the person who applies the method

The case where the person who chooses the methods is not those who applies it is much more usual that seems to be. For example, a designer belonging to a structure such as a large industrial group, may not have the choice of the method to be applied. Indeed, it is usual that design process of certain societies is carrying out with help of model. These models are standards imposed to designers in order to rationalize the process in terms of steps, deliverables exchanged, design methods and tools to be applied. This exempts designer to choose the methods. In this case, the designer has no breathing space in the selection of design method.

Another case concerns the relationship between a designer and his client. When the client expresses his need, the designer anticipates what method will fit well with the need. Given that each method has different impact in terms of number of participants to gather, time to spend for the application strictly speaking of the method but also for the treatment of the data collected, accuracy of the final results, etc. a dialogue has to be established between both stakeholders in order to converge toward a common vision and to be agree on what method has to be used. In this case, the designer has breathing space in the selection of design method. But he has to justify his choice not to say negotiate it.

3.3.3 – The role of the stakeholders in the choice

Design methods and tools are an integral part of a cultural base of a structure (societies or laboratories). Thus, it is important for designer to be capable to justify even negotiate his choice if he don’t respect this cultural aspect. This section highlights the role of the stakeholders which could be client, other members of the teams, etc.

3.4 – Time of the selection

Design methods must be selected before the beginning of the project. This is due to the necessity for the manager to forecast the resources (human, temporal, material) whose will need in order to reach the objectives. In few cases, it is possible to make readjustments on the design methods to be used during the project. But it has to be only minor modifications. Indeed, it would be difficult to substitute a method by another one which resources would not be anticipated.

But a design project is characterized by its degree of innovation. It may be low (incremental innovation) or high (radical innovation). In both cases, designer is set against to something new. In spite of these uncertainties related to design projects, it is necessary to anticipate design methods that would be used.

These observations highlight the conflict between on one hand, the necessity to plan the sequence of the project and to specify the design methods to be used ; on the other hand, the context of design project and its inherent uncertainties.

Thus, the system would recommend design methods that have to be used before the beginning of the project, in spite of uncertainties.

3.5 – Difficulties

A novice in design methodologies may feel difficulties on different levels. This section presents the three main difficulties addressed during the interviews with the 22 participants :

- What method fits well with a particular project ?
  This question refers to the problematic of the selection of design methods.

- Who have to contribute to the application of the method ?
  This concerns the multidisciplinary nature of the design project and the problematic of the constitution of the team.

- In what moment the selected method has to become integrated ?
  Here is highlighted the temporal integration of the method and asks the question relative to the network of methods.

Moreover, the interviewed persons who felt difficulties during the selection of design methods highlighted the loss of time and the temporal cost related to the research of information.

Thus, the future system would allow user to buy time in his research of information in order to define what method has to be used, at what time and with whom.

3.6 – Need for an assisting system

Except for three persons who require more proofs on the feasibility of this kind of system to be convinced, all interviewers answered positively to the question of the interest of system which assists designers in their selection of design methods. The responses are illustrated Figure 4.
The interviewers expressed two distinct needs concerning the assistance for the choice of methods. In general, when carrying out research to precisely know what method has to be used in a particular case, the designer focus on a specific step of the design process. For example, a designer who has to deliver an idea book to his client has to conscientiously select creative techniques. This focusing research do not exempt designer from having a global point of view on the project. Indeed, from a particular method results certain degree of accuracy or type of formalism. For example, direct interviews give designer more accurate data than questionnaire; the information contained in the first house of quality from QFD are differently displayed than in Functional Analysis. In both cases, it impacts the evolution of the project. Thus, the future system has to answer to these two different needs. Not only, it must allow designer to carry out a punctual research which focus on a particular type of methods or a specific step, but also, it has to provide a more general view of the design process and take it into account in its wholeness.

4- Establishment of the requirements

In order to structure the requirements for the system, we used the Functional Analysis. This method allows building a common representation of the future system and to define the main orientations.

4.1 – Expression of the requirements

The fundamental need summarizes the essential purpose of the product with a user point of view. It is deducted from three questions

1- Who is the user of the system?
2- What or who the system is based on?
3- What is the objective?

In order to answer to these questions, it is necessary to go by the results of interviews conducted beforehand. According to the results of the interviews, it seems clear that novice designers are the main target of our future system. The term “designers” relates to all persons contributing to the development of a product in the earliest steps of the design process. A designer may be an engineer (with particular specialty such as mechanics, electronics, informatics, etc.), but also a product designer, an ergonomist or a specialist in product marketing. They could belong to one of the following categories: student, professor, consultant, project manager. We consider that a “novice” is a person who has not the mastery of a particular design method. According to [R1], it is possible to identify three levels of performance: skill-based, rule-based and knowledge-based. In our paper, a novice is characterized with the first level (skill-based). Thus, a novice designer could equally be a student in design methodologies, a professor with specialty in design who wants an introduction in other discipline (such as ergonomics), a consultant in design in the beginning of his career, a recently qualified manager project. According to the results of the interviews, expected functionalities are the same for any profile of user. The raw material of the system is the design methods and tools which will be used for developing the product. For define the terms “methods” and “tools”, we will refer to the definition of [C1]. According to Cross, design methods is a broad term which includes methods, tools, techniques, aids, etc. A design method has two main characteristics: first, they formalize certain procedure of design; secondly, they externalize the thinking of the designer.

In fine, the future system will helps novice designers to selection appropriated design methods and tools.

4.2 – Challenging the requirements

To make sure that the requirements are sustainable and to valid definitely the need, we have to answer to these three other questions:

1- Why the system exists?

We have now numerous elements to answer this question. Today, several conclusions could be observed: first, designers feel difficult when selecting the design methods appropriated to their projects; secondly, it exists a gap between the quantity of methodologies available and their use in practice. Thus, the future system will assist designers in their selection of appropriated design methods, and help researchers to transfer their results in industries.

2- What is the final objective of the system?

Helping designers in their selection of design methods and tools will allow them to structure the design process. The ultimate goal of this system is the optimization of the product design process.

3- What could be the reasons for the evolution or the death of the need?

Given that the expanse of this system is very broad, numerous evolutions could be foreseen. The objective of this system is that the user, a novice designer, evolves toward a profile more expert. Today, we have not plan to integrate this modification in the first version of the system because the target is the novices. But it could be an axis for improvement for a second version. Another axis of improvement could be the opening of the target with other profiles of users. Indeed, non designer profile such as buyer could be interesting with this system. It would allow them to anticipate the added value of a new design method or tool and to evaluate the return of investment.

As far as we are concerned, we think that the death of the need for an aiding tool that helps designers to select appropriate design methods is not possible. Indeed, this kind of system is a complement of other training such as personal training.
Finally, considering the answers of the three questions, we consider that the need is validated.

4.3 – Life Cycle Analysis
Designing a product (material or immaterial) requires analyzing all phases of the life cycle.
Thus, we have to determine life cycle phases of the product and to detail phases that are in use and those that are not. In the case of the development of a system that helps designers in the selection of design methods, two phases are important: the phase of use and the maintenance.

4.4 – Design specifications
The main function of the future system is to assist designer in his selection of design methods adapted to a particular project. This step is fundamental in order to design the design process or to build the “design strategy” as called Cross in [C1].
Novice designers are the main target users for this application (see 4.1). With the term “adapted”, we suggest that it exists a link between the characteristics of methods and the characteristics of a particular project (a method is adapted to a specific project context). This link with on one hand the problem dimension (the project context) and on the other hand the solution dimension (the methods) will be based on accurate description of the context and methods with the help of attributes. Attributes could be defined as any information which enables to characterize a context and a method.
The number of design methods integrated in the system would be enough in order to ensure the flexibility and the adaptability of the process in a particular context. Moreover, given that the types of activity in design are very broad, the design methods recommended be the system would reflect this heterogeneity. It would be interesting that the system helps designers to capitalize previous experience. Indeed, we saw the importance of experience feedback in the selection of design methods. The role of the design process model is also very important. It ensure constituency between members of the design team. It is necessary that this model would be recorded in the system. The nature of information searched by designer is very heterogeneous (descriptive, prescriptive but also theoretical and practical). Thus, the system would answer to this need for different type of information.
The analysis of the interviews highlighted the role of the stakeholders in the choice. Thus, it is important that the system support the designer in his justification and negotiation of the selection. Additional constraints such as accessibility, usability would be taken into account in order to fit the need of designers.

5- Conclusions and future work
From this research, we highlight the existence of a need for guides which assist designers in their choice of design methods. This need is particularly important for novices who are the main target users for the future system. The analysis identified several constraints and main functions expected by the target users. This provides insight into how to structure and develop the guide so that it fits with designers’ wishes and ways of working. However, further detail is needed, which we hope to gain from future work.

We therefore plan to extend the study to include designers from a better balance of disciplines and industrial sectors. With more participants, we will able to investigate whether there are differences between responses from different design disciplines and if there are distinctive results from diverse industrial sectors. We hope to achieve greater understanding of how designers choose their design methods in practice. This will enable the development of more effective guides supporting the designers in their selection of adapted design methods.

6- References

Acknowledgement
We would like to thank all the volunteers who agreed to take part in this experimentation.