

Students' Approach to User Needs Analysis


by


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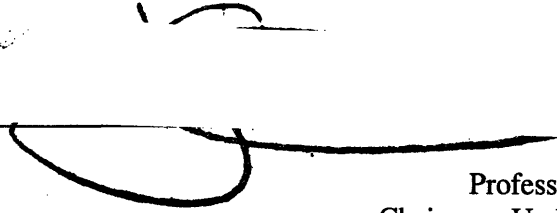
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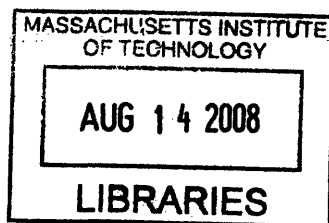
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Abstract

Various methods exist to help engineers and designers determine user needs as part of the user-oriented design process. Many of these methods are taught in engineering design classes throughout the country. By following the progress of 18 groups of student teams in a product design project-based class at MIT, it is found that students' awareness of these user-needs methods is critical, as students are more likely to use a method based on their familiarity with the method than their opinion of the method. While many student teams choose methods that are easy-to-use, such as interviews, those teams that choose methods based on their appropriateness found more insightful user-needs information. In addition, through several case studies, it is shown that the teams that choose the more appropriate methods are then more likely to use the gathered user needs and incorporate them into well-designed products. Thus it is important in engineering design education to familiarize students with the breadth of tools and methods available to them through every stage of the process, and reinforce the importance of using the appropriate methods in design.

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Introduction

User needs identification and analysis is an important stage of the product design process. However, this step is often overlooked by many engineers because it is difficult for them to recognize the benefits of user needs analysis. In addition, numerous methods have been developed to help designers to understand and consider the needs and desires of end users, but many have had limited uptake in design practice (1). One goal of design research is to formulate approaches that will help practicing engineers and designers produce better design results more efficiently and with fewer resources. Thus it is necessary to better understand how students perceive user needs analysis and evaluate how the subject is currently taught in design classes in order to develop better engineering design education programs. This is a difficult task since the product design process is long and influenced by many factors. It is also difficult to measure progress and outcomes quantitatively.

In a previous study, it is shown that when designers learn more about a particular design method, they generally find it useful rather than not useful, and that the issues of training and education are important to making design methodologies gain acceptance (1). Here, we focus on the early stages of user-oriented design. Specifically, we study the progress engineers and designers use to evaluate user needs in the design process.

Previous research about need-finding and customer interaction have used the lessons learned by students in an engineering design class to formulate measures of user analysis in engineering design (2). Here, using a similar class-based approach, we follow students' progress in ESD.40, a semester-long product design and development class

taught by Prof. Maria Yang and Patrick Hale in the Engineering Systems Division at the Massachusetts Institute of Technology. Students in the class are mostly practicing engineers and designers before coming to the graduate program at MIT – they are an ideal group from which to study engineers’ and designers’ approach to the design process.

In addition to teaching product design through classroom lectures, the course allows students participate in a semester-long, team-based design project. The sixty-eight students in the class work in groups of three to five to conceive, design, and prototype a physical product during the 13 weeks of the semester. The first half of the class is focused on product planning, identifying customer needs, and concept generation; and the second half of the class is focused on specific concept design and manufacturing.

Because we are studying the students’ process of identifying user needs, we use and analyze data collected from the first half of the spring 2008 ESD.40. Specifically, each group is asked initially identify three user groups that it is interested in by doing market research and user-needs analysis. With further research, testing, and feedback, each team chooses a specific concept to develop. Students are evaluated on their previous experience and perception of user needs methods (such as interviews, surveys, buglists, and field studies) at the beginning of the semester using a user needs familiarity pre-survey. They are also continuously evaluated throughout the user needs analysis stage of their design projects using timesheets, forms, and reports. The goal is to have a comprehensive set of data in the form of reports, surveys, and logs that allows us to study the specific design process that each team undertook.

Here, we analyze the data from the first half of the class. However, it is generally difficult to quantify the use of the design process. In this study, we use both quantitative and qualitative measures. Quantitative measures are used to give rough estimates of students' backgrounds and opinion of user methods. Then, we use qualitatively examine the process each team goes through in choosing the appropriate methods to determine user needs. Several case studies are presented in this paper as examples of good and poor design practices.

Specifically, the data are analyzed to show how students perceive and use various user needs methods, and how user needs analysis education impact the students' work in the design process. Previous studies have shown varying differences between the cognitive behavior of experts and novices, and differing ways in which designers use cognitive behavior in problem-solving (3). It is important to elucidate these differences in understanding the design process.

In particular, we address these points:

- Students' experience with user-needs methods – Which user methods are students aware of and which do they find useful?
- The impact of previous experience on the choice of user methods – How does a student's initial familiarity and liking of various user methods affect which method the student chooses to use to determine user needs?
- Education of user-needs methods – How does the material presented in class affect the choice of user-needs methods in the design process? Are there more effective ways of teaching user-needs methods in product design?

- Other factors that impact the use of user methods – How important are the time available for user interactions and convenience of each method?
- The effect of the choice of user methods – How does the choice of methods relate to the information that students gather? How does it relate to the final outcome of the product?

By better understanding engineers' thought process in selecting and using user methods, it is possible to develop and improve the teaching of user-based design processes that result in products that cater to users' needs. The design tools should be integrated with engineer's product design curriculums. The findings from this study would also be applicable in industry, where design teams should be given the appropriate training, resources, and time for proper user needs analysis.

Methods

Data were collected from students in ESD.40 through reports and surveys throughout the spring 2008 semester. At the beginning of the semester, each student took a User Needs Familiarity Pre-Survey. This survey measures the student's familiarity and affinity to these user-needs methods before they entered the class: interviews, surveys, wants and needs analysis, card sorting, group task analysis, focus group, field studies, user feedback testing, and buglist. The familiarity and affinity scores for each method are determined from the students' survey responses as listed in Table 1a and 1b. Note that for the familiarity score, responses "Have used this in a work-related project and found it useful" and "Have used this in a work-related project and found it not very useful" are

both converted to a score of 3 because they represent the same level of awareness of a method.

Response	Score
Not familiar with this	1
Familiar with this but have never used in a work-related project	2
Have used this in a work-related project and found it useful	3
Have used this in a work-related project and found it not very useful	3

Table 1a: Familiarity score

Response	Score
Like	3
Neutral	2
No Opinion	2
Dislike	1

Table 1b: Affinity score

The methods-used data is extracted from user reports that are submitted by each team. These are required assignments for the teams. Two types of reports are submitted by each team: (1) User Interaction reports, which document every one of the team's interactions with a potential customer to understand user needs, and (2) the User Opportunity report, which summarizes the three user opportunity groups identified by each team, including how they identified the user group. The methods used by each team are collected from these reports. All correlation measures are calculated using the Pearson correlation.

After knowing which methods each team used, the correlation between students' previous experience and methods chosen is not obvious. In particular, because many

teams used interviews to determine user needs for their products, there is a limited number of other method uses for our study. Thus we decided to look closer at teams that choose other methods with case studies. Case studies are performed on a selected number of teams to determine their motivation for choose specific projects. The teams are chosen based on the types of user-methods they used, the quality of their projects, and the ability of their reports to demonstrate specific aspects of the design thought process. The method of reviewing the teams is somewhat subjective, but care is taken to evaluate each team with the same metrics, both in terms of the process and the outcome. Here, we present in depth the work and their effects of a team that properly approached to user needs analysis and one that approached it poorly.

Results and Discussion

Student's Previous Experience

Method	Familiarity	Liking	Correlation	p-value
Interviews	2.54	2.64	0.52	0.00
User Feedback Testing	2.52	2.78	0.31	0.01
Wants and Needs Analysis	2.51	2.67	0.38	0.00
Surverys	2.37	2.31	0.30	0.01
Focus Group	2.37	2.55	0.40	0.00
Field Studies	2.31	2.72	0.38	0.00
Group Task Analysis	2.30	2.57	0.63	0.00
Bug List	1.85	2.33	0.54	0.00
Card Sorting	1.52	2.01	0.28	0.02

Table 2: Previous experience

The students' average familiarity and affinity scores for each user method from the user-needs pre-survey are shown in Table 2, sorted by familiarity. Given that many of the students are practicing engineers, it is not surprising that they are most familiar with the methods of interviews, user feedback testing, and wants and needs analysis. An

average familiarity score of over 2.5 for these methods indicate that a majority of the students have had work-related experiences with the methods. Card sorting and buglist have low familiarity scores.

The methods that students liked the most are user feedback testing, field studies, and needs and wants analysis, in that order. The ones that they liked the least are card sorting, buglist, and surveys. Note that overall, the affinity scores are between 2 and 3, meaning that students generally have neutral to positive feelings towards the user methods.

The Pearson correlations between familiarity and affinity are calculated and shown in the table. The positive correlations and low p-values suggest that those who are familiar with a certain method are more likely to view it positively and thus use it in the design process. Therefore, it is important to teach students about user methods in their product design education. It is interesting to note that the correlation between familiarity and affinity for survey is relatively low compared to the correlation for other methods. One explanation is that surveys are often used in the workplace because they are easy and cost-effective way of obtaining information from users, although the methods is not well perceived due to the limited information that is received from its use.

Correlation between Previous Experience and Choice of User Methods

Table 3 shows the Pearson correlation between student's familiarity and affinity for previous methods and their use of the methods in their design process. Only four methods are listed in the table because these are the only methods that are relevant in this stage of the user-needs analysis process. A broad look at the correlation shows that there

is no clear relationship between students' use of user needs methods and their previous experience. However, the observed correlations can be explained and provides insight on the process designers use to select user needs identification methods.

Method	Frequency of use	Familiarity			Affinity		
		Correlation	t*	P-value	Correlation	t*	P value
Interviews	37	0.15	0.59	0.56	0.00	0.00	1.00
Surveys	10	0.28	1.19	0.25	0.28	1.16	0.26
Field Studies	14	0.14	0.55	0.59	0.02	0.09	0.93
Buglist	15	-0.47	-2.13	0.05	-0.19	-0.76	0.46

Table 3: use of methods vs. previous experience

- *Interview is the most commonly used method*

Interview is the most commonly used method because it is the most convenient to use for students in the class – many groups interviewed family, friends, and peers who were part of their identified user group. It requires little advanced planning, since each interviewer only needs to prepare a list of interview questions. It also requires little learning of the use of the method, since most students are already familiar with the method, and even those who have never used it before understand how it works. Thus interview is an obvious choice for students who want to easily obtain user-needs information.

- *Familiarity More Important than Affinity*

Overall, the use of methods is more closely correlated to students' familiarity with the methods than to students' affinity of the methods. That is, students are more likely to choose a method if they are familiar with it; students' affinity of a method does not seem

to matter as much (the magnitudes of the Pearson correlations ranged from 0.14 to 0.47 for familiarity as compared to 0 to 0.28 for affinity).

- *Positive correlation between previous experience and use of method*

In most cases, there is a positive correlation between previous knowledge – familiarity and affinity – of user methods and use of the methods in the design process. The exception of correlation numbers for buglists, which are negative, is discussed in the section below. However, since the p-values of the correlation coefficients are relatively high, there is little confidence in the significances of the correlations. Further studies are needed to more precisely determine the relationships previous experience and use of method. Other explanations for the choice of user methods are provided in the sections below as we look beyond the raw quantitative data.

Teaching influences students' user needs analysis

All the methods presented in this paper are taught in ESD.40 lectures. In addition, the reading material for the class contains more detailed descriptions of the methods. Thus all students are aware of the methods when they performed user-needs analysis. This then, could explain the weak correlation between students' previous knowledge of the methods and their use of the methods. That is, many students used methods that they were not aware of before entering the class.

The best example of this is the use of buglists. While buglists are the least known amongst the user needs methods at the beginning of the class, it is the second most popular method used among the groups in determining user needs, following the use of

interviews. It is interesting to note that buglists are generally used by the teams in conjunction with other user methods. For example, several teams used both interviews and buglists to identify user needs. This is because buglists, while useful in identifying a broad range of user needs, especially at the early stages of the user-needs analysis process, does not provide detailed information about each need. Thus another method is needed to obtain that information.

Further insight on the influences of teaching on students' design work is revealed through case studies.

Case Studies

The quantitative information obtained from surveys and reports does not tell us about why students choose to use particular methods. To better understand engineering designers' approach to user needs, it is critical to gain insight on their thought process. Thus we performed case studies of teams by further examining their reports and presentations. This provides us with more qualitative data that helps explain some of the quantitative data shown earlier. Here, we present the two most representative cases, in the categories of "ideal user needs analysis" and "poor user needs analysis".

- *Case Study Part I: "ideal" user needs analysis*

First, we look at a team that carefully analyzed user needs using the design approach that taught in the class. This team provides an excellent example of a systematic process that designer should use to best identify user needs.

After initially surveying three markets, this team decided to follow the market of tea drinkers. In doing so, the team incorporated “lessons learned from many studies” and concluded that it is best to gather tea drinkers’ user needs by observing the user group’s interactions with several products (i.e. field studies) and one on one interviews. The team took notes during observations and interviews based on the recommended customer data chart described in the course textbook, which recommends describing typical users, their likes and dislikes and if they make any suggested improvements to note them. After analyzing their observations, the team found that their notes revealed many latent needs or improvements to existing products.

The team then narrowed down their market to tea drinkers on-the-go, which they carefully defined as those who brew their tea at home or buy their tea at cafés. However the place where they consume their tea is different from where they obtain their tea. The team also characterizes the group: convenience, trendiness, and taste are some of the characteristics that this group of tea drinker is interested in. In the end, the team was able to design the Perfect Teacup, a traveling mug with a built-in infuser from their list of user needs and many product concepts.

The concept generation and selection process for the team is user-needs driven. That is, the team used a list of user needs to brainstorm products that satisfied those needs. The entire product design process, starting from market research, is extremely systematic and well-documented.

Many of the tasks that were performed well by this team were part of the requirements for the class. For instance, the team created an organized list of potential user needs as a part of the Customer User Needs Report submitted to the class. By closely

following the class's guidelines on user needs analysis in designing a product (such as systematically narrowing user needs to groups to markets), this team was able to choose appropriate methods for their analysis and obtain meaningful results. This illustrates the importance of having clear and detailed instructions in product design classes. Students left completely on their own are at the risk of missing the key points of the analysis, decreasing the educational value of the experience. Providing resources on the design process and requiring checkpoints (such as presentations and reports) that ask the appropriate questions to students are useful ways of providing guidance.

It is equally important to note that this team performed better than many other teams because their effort went beyond meeting the classroom requirements. For example, with their list of user needs, they creating a database (spreadsheet) that helps track the relationships from attribute to product function. When conducting interviews, the team made an effort to elucidate needs that can only be seen with longer interaction times. Thus this team, by being genuinely interested in understanding the users of its product and understanding the product design tools and methods, were able to successfully choose the most appropriate methods and use them to develop a user-needs oriented product.

- *Case Study Part II: poor user-needs analysis*

Next, we look at teams that did follow good design practices. These teams, for instances, did not conduct user needs research with the user in mind, or neglected to design products based on user needs.

In particular, we look at one team that went on to develop car seat covers. At the start of the design process, before any market and user research, the team has already identified its product of car seat covers. It is only after picking the general product that the team looked at possible customers, thus identifying the three user groups of gym users, contractors/mechanics, and families with children, each with a slightly different need for car seat covers. This is contrary to the user-oriented design process where designers create a product to satisfy user needs. By identifying a product before finding user needs, the team limits itself to a specific product category that can only satisfy a limited number of user needs. The needs satisfied by the product are not necessarily the most critical needs of the user group or best satisfied with the given product. For example, for the chosen user group of active professionals, their most critical need is not necessarily an easy-to-use car seat cover. Instead, they could want a disposable washcloth that they can use instead of a shower to clean themselves off before entering their car. However, the team, by focusing only on the need for car seat covers, never looked at user needs for other possible products.

In addition, the user needs identification process is mostly done using the team member's needs rather than a broader sample of users. Instead of designing user methods to identify user needs, the team has found some needs from within the team, and used further interviews with others in the user group primarily to reaffirm their predetermined needs. The team seems to have taken a convenient and time-saving route to identifying user needs, which is ineffective in gathering insightful user needs. Perhaps as part of the design project, they choose to interview users in order to satisfy the requirements of the class without a genuine interest in identifying user needs.

Regardless, by poorly choosing and designing the user needs analysis methods, the team did not obtain insightful user needs can be incorporated into a practical product. This case shows us the importance of improperly following the steps of and user-oriented design process. Thus in product design education, it is not only important to teach students about the design methods, but also encourage their proper user through meaningful design projects.

- *Summary of findings from case studies*

By examining the progress of individual teams in the design process, we find that there are large variations in the ways teams approached user-needs identification. There are several explanations for this. First, it is possible that some teams do not understand the user-needs analysis process, thus failing the follow the proper procedures. Secondly, some teams could simply disregard what they know is the proper procedures either because of time constraints or the lack of motivation to do so for a class project.

Thus we learn from these observations. First, it is critical engineers to the design process in their education. During the education, adequate time and resources should be allowed for meaningful user-needs analysis, and design projects should be as realistic as possible. This encourages students to select the appropriate user needs methods, leading to a more insightful user-needs analysis and product design.

Conclusion and Future Work

From this study of teams of engineering design students, it is seen that familiarity of user needs analysis methods is critical to their use in design. Data show that for

designers choosing user methods, their familiarity with a method is more important than their affinity of a method. It is also shown that familiarity is positively correlated with affinity. Thus designers are more likely to think favorably of a method when they know more about it. Furthermore, in addition to knowledge of design tools, students need proper guidance and resources in design projects to use the methods correctly and make their design experience meaningful and productive.

While this paper focuses on the user-needs analysis stage of the product design process, much of the research is applicable to other steps of the process, such as concept generation and selection, and user testing. In each of these stages, the designer needs to be aware of the available methods for the task, choose the most suitable ones for the market, design, or product at hand, and use the resulting information appropriately. Thus the teaching of the entire product design process is critical. While teaching is effective by familiarizing students with the tools and methods designers have, it is even more effective when it correctly guides the students through the process of identifying markets and user needs, generating and selecting concepts, and prototyping and testing products. In industry, designers should be given adequate time and resources to properly utilize user needs analysis methods as well as other tools in the design process.

One limitation of this study is the number of design teams sampled, especially through the qualitative stage of the study. Eighteen teams with a total of sixty-eight students are included in the surveys, but only a few teams are studied in detail in case studies. Qualitative measures of design processes are difficult. The next step would involve a larger scale study of teams' decision making and thought process. A more qualitative measure of these processes would enable the larger scale study.

In the future, it would be beneficial to perform a user-needs analysis post-survey, similar to the pre-survey given to the class, to determine how students' experience and affinity toward the methods have changed during the course of the semester. Does teaching the methods make the students think more positively of them? How does using the methods affect the likeliness of the students to use the methods again in the future? This survey would give us more definite answers to the effectiveness of the user-needs teaching and the product design project.

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