

# Introducing User Centered Design to Mid-Career Professionals: Experiences to Build Upon

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**Abstract:** In this paper, we describe the experiences and lessons learned of mid-career professional engineers who are introduced to the product design process as part of a graduate course. Students had several years of work practice in technical fields, but few had experience with formulating requirements based on involvement with users. User centered methods were presented through a reflective framework to encourage teams to think critically about their interactions with users throughout the process. “Lessons learned” were gathered from individual students at the end of the class. Analysis of these lessons present implications for thinking about how user centered methods are applied by engineers in practice and how they may be taught in the classroom.

**Key words:** *design process, design pedagogy, reflective practice, user needs*

## 1. Introduction

User centered design is the practice of focusing on the needs of end-users to guide the design and development of products and services. User centered methods are widely practiced in a range of industries, particularly in those with a strong end-user focus such as consumer products. Well regarded and broadly adapted textbooks on product design and development for both undergraduate and graduate students discuss such approaches to planning design [2, 11, 20, 21]. These texts are typically aimed at students with a technical background but assume little practical experience in industry. This paper is a qualitative study that considers how user centered methods are accepted by students with substantial professional experience in engineering technical fields, but with little experience in the formulation stages of product design, including understanding user needs and setting product specifications. The research leads to a framework for future points of study.

We explore what such students learned from taking a product development class that emphasizes the voice of the customer [7]. Teams were asked to document and reflect upon their interactions with users throughout the design process. For each interaction, teams answered questions that addressed how they prepared for, interacted with, and responded to their encounters with users. The reflective framework of *prepare-interact-respond* is part of a larger framework that encourages open-mindedness towards determining a design.

### 1.1 Key questions

The goal of this qualitative study is to gain insight into these questions:

- How will mid-career professionals respond to situations in which they need to deal with users?  
We predict that these students will find it difficult to navigate through these beginning stages of design of needfinding and product specification because they are used to projects being well-defined from the moment they receive their tasks. Also, we predict that these students will find it difficult especially to deal with users directly because of their lack of experience.
- How will mid-career professionals respond to the short-term and long-term outcomes of the design process?  
We predict that these students will find it difficult to deal with outcomes of the process that are beyond the technical and well-defined. However, we predict that these students will appreciate the new experiences they gain from taking the class because of their time in industry.

## **2. Background**

### **2.1 Needfinding**

Needfinding and user-centered methods are commonly taught as a critical activity in the product development process [3, 10, 22]. “Needs” can be categorized at many levels including: observable, explicit, tacit, and latent [14]. Also, there are a variety of methods that can be employed to uncover needs depending on the situation. For instance, Sanders’ map of design research considers two questions when determining which methods to apply. First, is the method driven more by research or design? At one end, the designers collect information to analyze the problem they need to solve. At the other end, they design and create artifacts to discover the problem. Second, is the “user” seen more as a “reactive informer” or an “active co-Creator” [15]? A “reactive informer” responds to the prompting of the designer whereas the “active co-creator” is a partner with the designer to determine the problem.

### **2.2 Reflective practice**

How do designers go about acquiring information? On one hand, the information can be sought after as explicit knowledge. On the other hand, designers can observe the situation at a distance, trying to obtain an intuition for the circumstances and design space. We argue for the emphasis of a reflective practice about any interaction with relevant stakeholders throughout the process. This section describes the theory behind our approach.

Dewey first speaks of reflective thought as that which is “active, persistent and careful consideration of any belief” [4]. Schön builds upon this idea and brings to attention to the need for reflective practice in various fields of practice. This awareness and critical thinking of action and thought is made important through the continuum of understanding [16]. The continuum goes from data to information to knowledge and finally to wisdom. The first two areas (data, information) require less effort whereas the latter two areas (knowledge, wisdom) require more effort to obtain.

The issue of knowledge acquisition has been brought up in the field of knowledge-based systems and the anthropology of artificial intelligence. Forsythe contrasts the different paradigms and views between knowledge engineers and social scientists in how knowledge is extracted [5]. This analysis shows how the different paradigms fundamentally affect the approach of building up knowledge-based systems. Additionally, Reddy talks about two differing views of communication: the conduit metaphor and the toolmaker’s paradigm [12]. Similar to the understanding continuum, the conduit metaphor implies that no effort is required to

communicate a message whereas in the toolmaker's paradigm, a "radical subjectivity" exists wherein each party must make an active effort to make meaning out of communication.

Understanding these principles of communication are thus important in studying how designers approach users throughout the design process. Designers cannot simply view users as having clearly laid out functional requirements in their mind. While needs may sometimes be explicit, often the innovative opportunities require more effort, for example, through careful observations.

### **2.3 User centered design in the classroom**

Significant work has been done considering the lessons learned from students in product development classes. Hey et. al, considers seven years worth of data from UC Berkeley. After categorization of the lessons learned, it is found that some of the most important lessons are with respect to user needs [8]. Reasons why designers choose particular methods have been explored [6]. Qualitative analysis has been done on how companies might benefit from "temporarily sustaining ambiguity" [1]. Co-reflection with the user about the design process has been developed in order to give designers "a deeper understanding of the context, motivational aspects, associate behaviors and desired functionalities" [19]. Studies have promoted accepting a ambiguity while discovering opportunities for design and have created methods, such as contextmapping, to help gain empathy with users [13, 17, 18].

In this work we seek to understand what students with substantial engineering experience in industry learn from the design process, particularly related to user centered methods. This work takes a novel approach in focusing on mid-career professional students who have had many years of working as engineers, technical managers and scientists, but not necessarily in the design aspects of the process. Furthermore, a reflective framework is developed in order to give scaffolding, which encourages an open-mind throughout the process and asks designers to think critically about the methods they choose in the midst of a fast-paced process.

## **3. Methods**

### **3.1 Testbed**

This study was conducted in the context of Master's level product design and development class taught at a United States university. In one semester, teams of 5 to 7 students each engage with users to develop an unmet, compelling need, generate solutions to address that need, create and iterate through prototypes, and present a final alpha prototype accompanied with a brief business plan. There were 71 total students in the class with an average experience of 10 years in industries such as hardware and software engineering, defense contracting, military, and other commercial products. Teams are given a budget of \$800 and are guided through the design process through lectures on design methods, techniques, and case studies with consultation with faculty in engineering, industrial, and product design.

### **3.2 Student profiles**

Figure 1 shows the average number of years spent in his career self-reported by each student. Students were given a survey at the beginning of the course asking them to quantitatively report their prior experiences. On average, students have worked for 10 years and have spent 5 years on projects dealing with "user needs". The five categories on the right-hand side, *marketing*, *user needs*, *prototyping*, *business*, and *team projects*, represent

the number of years each student has worked on projects with those elements. These numbers, however, should be considered with caution. For example, within one standard deviation, students have had work experience from less than a year all the way to 10 years. Also, each student's perception of what it means to work in a project that considers user needs can be different.

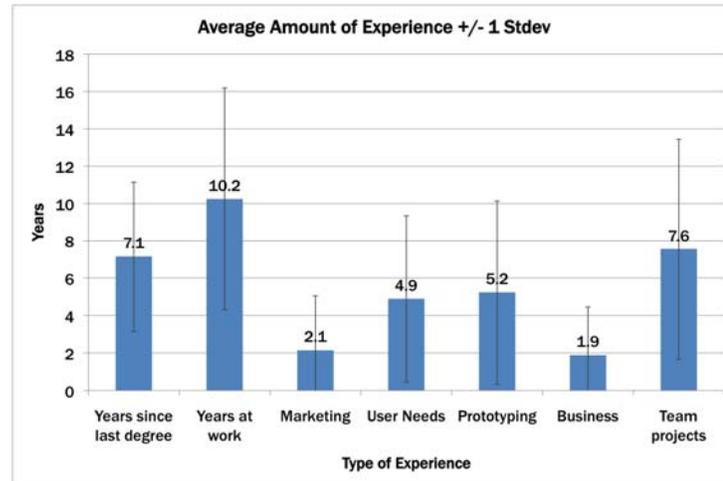


Figure 1: Average experience in various aspects of product development

Since the term “design” and “designer” means a multiplicity of things depending on the context, those terms, along with “students” and “teams of students” will be used interchangeably throughout this paper. Additionally, students in this study will be considered as design novices, meaning that they have limited experiences in dealing with users directly despite their many years working in industry.

### 3.3 Presentation of methods

There are 2 lectures within the first 3 weeks of the course that describe the motivations for user centered methods and how to employ them. The following methods are covered in class, while additional methods are mentioned and resources are given if students want to learn more: field studies, interviews, surveys, and bug lists. At each of the milestones, teams are asked to submit a report summarizing their activity for each period. Teams are asked to report any interaction with users via the user interaction forms mentioned in Section 3.4. The milestones were the following: *determine potential user groups, select user group, assess customer and user needs, propose 3 concept ideas, select concept, product contract, and implement concept and present business plan.*

### 3.4 User interaction forms

In order to encourage the reflective practice about interactions with people, a reflective framework was developed shown in Figure 2. The *prepare-interact-respond* framework was presented to ensure that designers thought critically about the methods they were about to employ. Detailed analysis of this data will appear soon in publication [9].

For each interaction with the user, teams are asked to complete a user interaction form. There are three phases through which teams of students must think. First, *prepare* makes sure teams know why they are about to interact with the given group of people. *Interact* asks the teams to document what happened in the interaction. *Respond* challenges the team to think about the next steps and what to do with the newly acquired information.

This component of the class was motivated by several things. First, the quality of interactions could inform the grading of teams. Second, this provided rich documentations for the team to be able to look back on their process and for the teaching staff to follow the story of each product. Most importantly, the form helped scaffold reflection as teams interacted with potential users throughout the process.

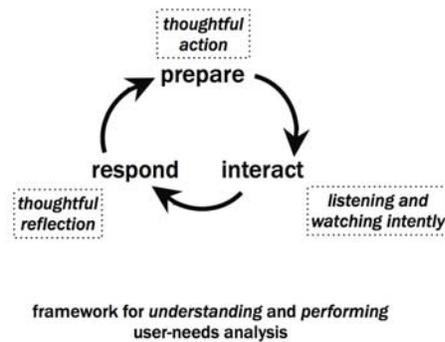


Figure 2: Reflective framework

### 3.5 Lessons learned

A final assignment is given to students at the end of the semester. Students are asked to list five or more “lessons learned” throughout the class. The “lesson learned” is a one sentence summary while an “explanation” expounds on the lesson that the student mentions. Students are reminded about different aspects of the design process: *user needs*, *market opportunities*, *business plan*, *prototyping*, and *teamwork*. For this analysis, a representative from each of the 18 teams was studied.

## 4. Results and discussions

The first subsection describes a pathway that has been developed while analyzing the data in this study. It helps frame one way to think about how an individual or team of designers should approach open-ended design problems. The subsequent subsections list examples of particular lessons learned from students organized in categories that we felt were pertinent to the reflective practice approach we are advocating. Each stage of the pathway towards design intuition is linked with each lesson.

### 4.1 Journey Towards Design Intuition

In Figure 4, we show stages through which a student or teams of student will go through as they go through the process. We call this the Journey Towards Design Intuition. This pathway is divided into four different stages, *situation*, *action*, *attitude*, and *outcome*. In the dotted boxes, there are quotations that represent an example of what a student may be thinking at a particular point in time. The pathway can be traversed at many levels of abstraction, for the whole project or at a particular aspect of the process. The user interaction forms mentioned in Section 3.4 are an embodiment of approximately the second and third phase, which includes *action* and *attitude*.

First, placed in the design situations, students are faced with *uncertainty* and *ambiguity*. A student thinks, “I don't know how to figure out what to design.” We acknowledge that there are cases in product design where the specifications may be clear what exactly to design. Often, however, this is not the case and designers must create something that is outside of the current pattern. Students need to be placed in to these unfamiliar situations in order to learn how to adapt. Second, this requires the actions of *engaging* and *exploring* the problem

space, whether talking to relevant stakeholders or benchmarking existing solutions. This necessitates an appropriate attitude that is *open-minded* and *listening*. A student thinks, “I’m willing to take the effort to figure this out.” Designers must realize it takes effort and energy to first formulate the problem.

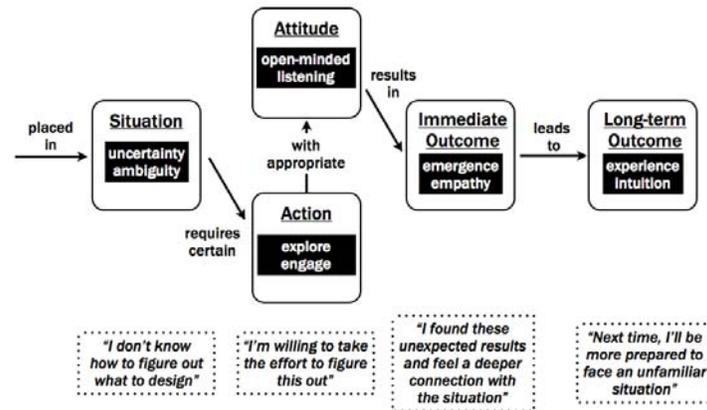


Figure 3. Journey Towards Design Intuition

Third, after this action is taken, the immediate outcome will be a deeper understanding of people (*empathy*) in the situation and unexpected, or *emergent* findings. A student thinks, “I found these unexpected results and feel a deeper connection with the situation.” Finally, in the long-term, the student will gain *experience* and develop his *intuition* further. A student thinks, “Next time, I’ll be more prepared to face an unfamiliar situation.” In going through the design process with the given actions and mindset, these novice designers can gain experience. For our studies, students have a unique access to live case studies where they can appreciate the diversity of design situations and the multiplicity of ways to approach design problems.

## 4.2 The big picture

### 4.2.1 Processes exist

*“...I realized that we would have done things better if we had right work processes in place at the very beginning – the process to interview potential customers and collect customer needs, the process to define product contract etc. These processes themselves are accumulated experience and knowledge that eventually to improve performances...”*

Students realized that methods existed for design and that adhering to the steps can anchor a process that is otherwise complicated. The anchoring allowed them to be placed back on track. This contributes to students learning about the **long-term outcomes** of the process.

### 4.2.2. Keep an open-mind and prepare to adapt

*“...By being unbiased and staying in the problem space for a significant length of time, we learned a lot about the product development process, which we might not have done if we focused on a specific product from the beginning...”*

However, they emphasized the importance of keeping open-minded. Phrases such as “don't marry your first idea” and “considering user needs without pre-determined solutions” were shared in talking about the importance of not being fixated to one idea. This contributes to students learning about the appropriate **attitudes** of the process.

#### **4.2.3 What does this mean?**

In structuring the design experience, there should be a balance between scaffolding and allowing freedom to decide according to judgment. Even if students did not find user interaction methods easy, they gained an appreciation for the value of these tools.

### **4.3 How to deal with users**

#### **4.3.1 Takes two to tango**

*“...I learned that user interactions were not so much an interview as a two-way conversation where the user could ask questions about potential product aspects and uses. Such questioning was sometimes more revealing than the users' answers to prepared questions...”*

Students realized that dealing with users is a non-trivial task. They realized the strengths and weaknesses of different methods. Once they chose interviews, for example, it wasn't a matter of simply following instructions. They learned that interviewing a user should be a conversation that flows naturally back and forth rather than a rigid question and answer session. This contributes to students learning about the **actions** required of the process.

#### **4.3.2 All the voices (of the customers) in my head**

*“...I think interpreting needs into requirements remains half art, half science. I thought that I could not go by what users tell me, and had to put myself in users shoes and make assumptions about what would work for them; of course, assumptions need to be confirmed and adjusted during field testing...”*

With the information they had, they realized that dealing with it took thoughtfulness too. They learned how to weigh different input from users and whether someone's opinion may be important to consider. This contributes to students learning about the **actions** required of the process.

#### **4.3.3 What does this mean?**

Students learn about the nuances of user centered methods. While nothing can replace learning through direct experiences, design educators should consider how these methods are presented. Are methods merely instructions to follow? Or are they conducted in the context of a situation, where one should be mindful and ready to adapt? In our reflective framework, we encourage critical thought about the process.

### **4.4. Benefits of a simulated environment**

#### **4.4.1 Breathing room for ideas to develop**

*“...A lot of the times on projects at work we are so tight on deadlines that we don't have the time to really let concepts develop...”*

Students appreciated the looser deadlines they had in the classroom compared to the product cycle they faced in industry. Additionally, each team of students was the highest level of management in their fictional company.

While the teaching faculty provided support and consultation, the students ultimately made the decisions on what they would create. The fewer constraints meant that students had more freedom for their ideas to develop. This contributes to students learning about the **short-term outcomes** of the process.

#### 4.4.2 Learning how other industries do it

*“...As much as I wanted there to be, as we talked to various people and heard from different lecturers, it became apparent that you cant just teach one style of PD but rather develop a broad base to draw from for a particular product...”*

Also, they realized that there are a multiplicity of ways to approach a design prompt depending on the industry and context in which it is situated. In their jobs, they were exposed to a limited amount of tasks and areas. This unique opportunity gave them a chance to see the importance of the role of design in the process in diverse settings. This contributes to students learning about the different **situations** in which the process may occur.

#### 4.4.3 What does this mean?

For students from whatever backgrounds, the classroom time can be valuable even though it is limited in how accurately it can simulate the real-world experience. Students are able to see other teams' work and appreciate the assortments of way to approach problems. Also, because they are in smaller groups compared to the size of a company, they are forced to deal with more aspects of the design process than what they are given in their job.

### 5. Conclusions

First, we discovered what mid-career professional students learned throughout the design process, which included a reflective framework to guide and scaffold the process for designers who have not much experience in the user needs aspect of the design process. Second, we developed a pathway to design intuition to describe the journey that a student could take as he matures.

#### 5.1 Original questions

To summarize the findings, the original questions have been modified to accommodate the journey to design intuition that was developed.

- *Situation* – How will mid-career professionals respond to situations in which there is **uncertainty** and **ambiguity**?

We found that students appreciated learning about different aspects of the design process with which they were not familiar and for which they were not responsible in projects in industry. They also enjoyed learning about the different contexts in which the design process can occur.

- *Action* – How will mid-career professionals act when they are required to **explore** and **engage** with the situation?

We found that students struggled with the challenges in dealing with users. They expressed the difficulties of engaging in a dynamic conversation with users and judiciously handling all the information and opinions they gathered from these interactions.

- *Immediate outcomes* – How will mid-career professionals respond to the short-term outcomes of the design process, in trying to gain **empathy** with users and discover **emergent** findings?

We found that students were surprised when they found that their conception of the task at hand was wrong after interacting with users. Also, students valued the classroom setting, where there was a little bit of breathing room for their ideas to incubate and develop, in contrast with the fast paced nature of industry.

- *Long-term outcomes* – How will mid-career professionals feel about the long-term outcomes they encounter in developing their **experience** and **intuition**?

We found that students were satisfied to discover through their experiences in the class that processes exist for the design process, even though the process is never straightforward.

### 5.3 Limitations

First, the lessons learned may be skewed towards concepts which students feel they *ought* to have learned. There is no way to test whether or not students have improved in these areas or quantitatively validate the methods presented in this study. Second, the nature of this study is a qualitative one, intended to gain an initial understanding of this population, rather than a large-scale comprehensive study. Third, the analysis does not link the lessons learned of specific students to their respective past experiences. The data, lessons and experiences, is considered as a whole. Thus, any conclusions drawn are generalizations.

### 6. Future work

In subsequent offerings of the class, similar analysis will be done to see if there are trends over the time of many years. Data from other programs and universities will be helpful, as there are different cultures of product design practices at different locations. Based on this analysis, new methods of guidance and intervention will be developed to help students in their design. Additionally, a perspective from actual workplace culture will be obtained. A controlled comparison will also be interesting to contrast these lessons learned with undergraduates in similar courses who have not had much working experience. A closer look at the intricacies of mid-career professionals and how they learn and practice design is needed.

### Acknowledgements

The work described in this paper was supported in part by the National Science Foundation under Award DMI-0547629. The opinions, findings, conclusions and recommendations expressed are those of the authors and do not necessarily reflect the views of the sponsors. This work was also supported in part by an A. Neil Pappalardo Fellowship.

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