AC 2009-995: THE DESIGN LANDSCAPE: A PHENOMENOGRAPHIC STUDY OF DESIGN EXPERIENCES

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Abstract
Design is central to engineering education and practice. Thus, it is important to investigate aspects of design that can be applied to facilitate engineers in becoming better designers. Designers' experiences impact their views on design, which then impact the ways they approach a design task. Design approach then impacts new experiences, and the cycle continues. To investigate experiences and analyze the results in a way to understand key differences in a broad range of experiences, a particular research method was utilized, that of phenomenography. This paper explores and explains phenomenography as a research method through an example of phenomenography of design experiences. For this study, the outcomes included six qualitatively different ways that design has been experienced. Represented in a hierarchical form, from less comprehensive to more comprehensive, these categories of description included: Design is 1) evidence-based decision-making, 2) organized translation, 3) personal synthesis, 4) intentional progression, 5) directed creative exploration, and 6) freedom. An additional outcome of this study was four themes of expanding awareness, including the role of the problem, the role of ambiguity, the task endpoint, and the task outcome. This paper describes the path from the beginning to the end of a phenomenography, contextualized in a study on design experiences of professionals from diverse disciplines.

Introduction

What does it mean to design? There are theoretical answers to this question. For example, Visser[1] described design as consisting of the act of "specifying an artifact, given requirements that indicate — generally neither explicitly, nor completely — one or more functions to be fulfilled, and needs and goals to be satisfied by the artifact, under certain conditions (expressed by constraints)" (p. 116). While I could continue to present definitions of design, it is more interesting to point out that none of these definitions that could be presented come from professionals who design on a regular basis as a part of their careers. The lack of understanding design from this perspective prompted the research study presented in this paper. My search to find a research approach to address this question of how professional designers understood what it means to design lead to investigations on an approach called phenomenography. This approach yielded results that contributed to understanding the broad picture of what it means to design. The intention of this paper is to emphasize the design and outcomes of phenomenography as a research approach. Presenting the research design and summarizing the outcomes of a phenomenography of how design professionals experience design allow for an example of what a phenomenography looks like as it goes through the development stage and is analyzed for outcomes.

Research Approach

Phenomenography is grounded in the idea that what people remember and aspects on which they reflect about concrete experiences are related to the meanings they associate

with a particular aspect of the world, discerning critical components of an experience from non-critical components[2]. These memories and reflections can be defined as constituting a person's awareness. Each person's awareness is unique, and as different people express different critical components, there becomes a number of qualitatively different ways an aspect of the world is experienced. Thus, the primary goal of a phenomenography is to uncover these qualitatively different ways an aspect of the world is experienced. The way of experiencing an aspect of the world is situated in the relationship between subjects and that aspect of the world according to the way subjects see that relationship, which is different from an independent focus on either the aspect of the world or the subjects[3].

In this case, the reason to do a phenomenography was because the target was a big-picture view on how designers experienced design in their profession. In other words, what was their perceived relationship between them and design? How did they view it? How did they experience it? How did they approach it and carry out a design task? These questions could have been studied through intense observations or think-aloud protocols, but the aim and outcomes of the study would have changed. The intention was to get at how professionals associated meaning with design, and the best way to do that was to design a rigorous way to ask them personally. It was not a question that could just be asked with the expectation of a well-developed deep answer in response. To get at this would require a well-designed way to facilitate professionals in deeply reflecting on what it really meant to them to experience the act of designing, not just a surface-level response. Phenomenography was well suited to guide this pursuit.

Research questions in a phenomenography are targeted to understand the qualitative critical variations in how a particular aspect of the world has been experienced. This outcome could be described as a landscape of possible experiences. For this phenomenography, the following research question guided the study: What are the qualitatively different ways practicing designers from a variety of disciplines have experienced design? This question addressed the goal of understanding critical components and meanings professional designers associated with their design experiences and also indicated the diverse disciplines from which professionals would be recruited. Thus, the outcome of the phenomenography would be a landscape of how design has been experienced across disciplines and not restricted to a single field, which would reduce the opportunity to fully understand the variation.

Participants. Participant selection is guided by an attempt to gain the largest diversity in experiences possible within the aims of the study[4]. Phenomenographic studies do not aim to generalize, thus the sample is not statistically representative, but rather chosen to obtain diversity. The sample size of a phenomenographic study is traditionally small, in the range of fifteen to twenty participants[5].

In this study, twenty professional designers served as participants. Participant diversity was based on three criteria: gender, years of experience, and disciplinary association(s). After considering the scope of possible disciplines from which to recruit, which were justified by comparing disciplinary activities to Goel & Pirolli's features of a design

task[6], participants were selected based on researcher networks within those disciplines. Table 1 provides participant information.

Table 1. Study Participants

Pseudonym	Gender	Years of Experience	Domain(s) of Expertise (as stated by the participant)
Alan	Male	15-20	Architecture
Bill	Male	20+	Biomedical Engineering
Charlotte	Female	5-10	Chemical Engineering
Duncan	Male	20+	Chemistry
Evelyn	Female	10-15	Civil Engineering
Fritz	Male	5-10	Computer Science
Glenda	Female	20+	Dance Composition
Hannah	Female	20+	Fashion Design
Isaac	Male	5-10	Mechanical Engineering
Jack	Male	10-15	Painting and Writing
Ken	Male	20+	Physics
Leann	Female	5-10	Mechanical Engineering
Marcus	Male	20+	Experience Design and Computer Science
Netty	Female	10-15	Instructional Design
Omar	Male	10-15	Culinary Arts
Parker	Male	20+	Civil Engineering
Quentin	Male	5-10	Chemistry and Educational Research
Roberta	Female	15-20	Chemical Engineering
Svenson	Male	15-20	Chemical Engineering
Tyson	Male	20+	Analytical Chemistry

Data Collection. Data sources in phenomenographic studies are typically interviews[7]. While other qualitative methods may use multiple data sources for triangulation purposes[8], one source of data—interview transcripts—comprise a typical phenomenographic study[2, 4]. A phenomenographic interview is designed to utilize detailed discussions on concrete experiences to uncover understandings about the aspect of the world of interest[2, 4, 9]. The core of the interview and the sought data are not the specific details of the experiences, however, talking about these details facilitates contextualized and more meaningful reflections about the awareness held and values associated by the individual. In this study, interviews were used as the sole source of data.

The structure of the interview protocol is key in achieving the intended outcomes of a phenomenography. Questions should facilitate movement between discussions of concrete experiences and reflections on those experiences. The protocol is semi-structured, consisting of a general order of open-ended questions and supplemented with deeper probing ones asked to investigate responses more deeply[7]. The structured

questions provide a context for the participants to discuss deeper meanings and facilitate participants in verbalizing their awarenesses[10]. A structured protocol maintains some consistency in the interviews from participant to participant, a vital aspect to ensure the validity of the data[3].

Examples of questions used in this work to get at underlying intentions or purposes included reasons the participant had for their decisions, what they hoped to gain from a particular experience or decision, why aspects of the experience were or were not important to them, how one concept or meaning they discussed related with other concepts or meanings they discussed, and how one priority, reflection point, or experience compared to another. While general ways to follow-up with participants may be the most important part of the interview for achieving the outcomes of a phenomenography[2, 4, 9], often follow-up prompts cannot be pre-planned because they depend upon what the participant says during the interview.

The development of the interview protocol in this study was governed by the focus on design as the particular aspect of the world being investigated. The goal of the questions in the protocol was to prompt participants' discussions on their experiences, meanings, and awareness related to design. Interview questions began with background ones, which lead into questions about concrete experiences. Having participants provide concrete examples of their experiences with design achieved a number of goals; if the participants were asked right away what it meant to them to design, the answer may not have been at the core of what it really meant to them. Participants may have provided answers for which they thought the interviewer was looking, may have suggested a theoretical or by-the-book idea on design, or may not have been able to verbalize a response at all[4]. Discussing concrete experiences and illustrative examples of what they have done in practice provided a context for participants to consciously realize and verbalize meaning and awareness.

Pilot interviews are vital to the preparation of a phenomenographic study[3, 11]. Questions must be refined to facilitate participants' reflections while still being focused on the relationship between the participant and aspect of the world under investigation. Additionally, an interviewer must become comfortable with the protocol, efficient and effective at asking follow-up questions, and aware of how to facilitate participants' discussions of their personal meanings. The interviewer should not introduce a topic not already raised by the participant. Instead, the participant should be the first to bring up specific points, words, or phrases. This means the interviewer is not leading the participant to say things that may not be in his or her realm of awareness, but allowing the participant to take the lead in the flow of the discussion.

The interview protocol for this study was piloted with two graduate students, one who identified himself with the disciplines of art and writing, and the other who identified herself with chemical engineering. Both had several years of experience working in their disciplines before coming to graduate school. The art and writing student provided a test of the protocol in the context of disciplines with which I, as the researcher, did not associate myself, and the engineering student provided a test with a discipline to which I

did associate myself. These pilots helped transform the protocol into one with better flow and organization. The pilot tapes were reviewed with a researcher experienced in phenomenographic studies to help improve the protocol as well as my skills as a phenomenographic interviewer.

In the case of this study, the interview protocol did not change significantly from the initial versions to the final versions. Questions that seemed repetitive were combined or removed. For example, in the initial version, I asked participants the following series of questions:

- Based upon our discussion, we've been using (insert word) to describe designing in (your field).
- What is your definition of design?
- What does it mean to design something?
- What is your process of design?
- What does design actually mean to you? What role does design play in your life? What do you get out of designing?
- Do you think that your definition of design has changed over time?
    - If so, in what way?
    - If not, why do you think that is?
- Do you think that your design process has changed over time?
    - If so, in what way?
    - If not, why do you think that is?
- Do you think that what design means to you has changed over time?
    - If so, in what way?
    - If not, why do you think that is?

When I piloted these questions that asked about defining design, what it meant to design, and a personal process of design, I got the same or similar answers to each question. The participants responded as if I had asked the same question in three different ways. Thus, this was changed on the final protocol.

In addition to making changes based on repetitive questions, I altered ones that introduced an idea that the participant might not have into the interview. For example, it came to my attention that all participants did not view design as a process; this question was removed on the final protocol. I also added questions to the protocol that seemed to better facilitate participants' reflections on their experiences. For example, I added a question to the final protocol asking about recommendations the participants had for design education. This question seemed to help them talk about what aspects they felt were important to design because they believed the aspect was necessary to be addressed in the educational setting.

The interview protocol used for all of the participants had the same overall structure, but the need to ask for meaning, clarify experiences, and probe for further information caused additional follow-up questions to be posed in the context of the interview. The final version of the interview protocol is displayed in detail on the following pages. In general, the interview protocol started with structured questions about the individual's

background, moved into questions about concrete experiences, and ended with open-ended questions about meanings associated with the particular aspect of the world of which was the focus. Interjected in these structured questions were follow-up questions clarifying word choices, asking for reasons, meanings, and importance, and values. Follow-up questions were inserted within the structured framework during the actual interview so that I, as the interviewer, felt I had gained an understanding of what meaning the participant truly had about the aspect of the world in focus.

Opening Statements

- Thank you for taking the time to talk to me.
- I'm going to give you some background on how this will work.

Explain interview logistics

- Our conversation will be recorded and later transcribed. Everything you tell me will be confidential. And identifying information will be removed on the transcript and the audio will be kept in a secured location.
- Do you have any questions about the consent form?
- Can I get you to sign it if everything seems okay to you?

Structure and purpose of the interview

- The purpose of the interview is for me to come to understand experiences you've had in your field related to design and what is important to you about those design experiences. Your experiences will inform the goals of the study which are to understand design from multiple perspectives. This information will be used to inform future education experiences of designers.
- There are no right or wrong answers to any of the questions I ask you.
- I'll ask follow-up questions so that we can arrive at a deeper understanding of your experiences.
- I'm going to leave some open time after I ask a question. I won't jump in to clarify a question if there is a pause. I want to give you time to think. If you need clarification of a question, please ask me.
- Do you have any questions for me before we get started?

Field Background and Word Choices

- During our conversation, I'd like you to talk to me about your experiences designing in your field.
- Before we get started, can you tell me what it means to you when you use the word design?
- I use the word design, but there may be a word that you are more comfortable or familiar with when you describe your design experiences. Is there a particular word or phrase that you would use that describes what it means to design in your field?
- What do you consider the field of work that you design (insert their word of choice) in to be?
    - If the interviewee needs prompting:
        - What discipline do you associate with?
        - What do you call yourself? Why is that?

        - What do you call yourself that when you're describing what you do to other people, you are a (insert disciplinary title, i.e. mechanical engineer, business owner, choreographer, etc.)?
        - What field is your background in? What area have you been trained in?
- How long have you been involved with design (insert their word of choice) in (insert field)?
- Do you have any formal training involving design (insert their word of choice)? What did that involve?

Describing Experiences

- Can you tell me about an experience you have had designing (insert their word)?
- What did that experience involve?
    - Possible Prompts:
        - What was the goal?
        - What were you designing?
        - Who were you designing it for?
        - Where were you designing?
        - Who else was involved in the design experience?
        - What was your specific role in the experience? What were your responsibilities?
        - How did you approach the task from beginning to where it is now? Can you walk me through the way you went about doing it?
        - What did you do?
        - What led to that?
        - Why did you do that?
- Did your approach change over the course of the project?
    - If so, how and why?
- Did you learn anything about designing from your experience?

Comparing Experiences (If time permits and depth has not been reached)

- Can you describe another practical experience you have had designing in your field?
- How do you think this is different from the experience we talked about earlier?
- Did you approach this project in the same way as you approached the previous one we discussed?
- Are your strategies for approaching a design task similar across tasks or specific to the task? How so?

Further definitions

- We've been using (insert word) to describe designing in (insert field). Based on your experiences that we talked about today, what is design to you?
    - Has that changed over time?
    - Was there a particular time or experience that prompted that change?
- What role would you say design has in your life?
- Has what design means to you personally changed over time?
- Based on what we talked about today, are there ideas or recommendations you would have for design education?

Closing

- Do you have anything else you want to add about design?
- Do you have any questions for me?

Upon completion of the final version of the interview protocol, additional participants were recruited and interviewed. The recruitment of participants for interviews relied on my professional networks as well as the networks of my advisors and coworkers. The interviews were audiotaped and lasted between thirty minutes and an hour.

A phenomenographic interview should be rigorous because the interview traditionally provides the only source of data for an individual. The quality of data collected impacts the quality of the final research outcomes. Thus, a need exists to continue asking for more clarification until the interviewer feels that the underlying meaning of the phenomenon for the participant is obtained[10]. This may make the participant uncomfortable; providing some background to how the dialogue will go prior to the discussion may limit any discomfort. Other ways to ease discomfort and reassure participants in the course of an interview include telling the participant that others had similar difficulties, rewording the question, and coming back to the difficult question later. The question order can change as a function of natural flow and the atmosphere the interviewer is trying to create. The comfort level of participants is important and can impact the quality of data that is obtained. In general, an interviewer can stop eliciting more in an interview when it is understood how the interviewee experienced the phenomena, even though the interviewer may not yet be able to verbalize it[4]. "Stopping criteria" for interviews provided in the literature based on experiences of phenomenographers in their studies include a feeling that meaning had been expressed, repetition in comments, and difficulties getting any more information.

Data Analysis. Data analysis starts with the transcription of interviews. Debate also exists among phenomenographers as to whether the whole transcript should be viewed at one time or if selections from the transcripts will suffice[4]. Some researchers utilize segments from transcripts to facilitate category generation, which is called a 'pool of meanings' approach, while other researchers suggest that looking at segments may result in non-contextualized and incomplete meanings represented by the final categories. Care must be taken if using excerpts as a tool. It was my view that the meanings associated with a phenomenon should not be taken in pieces, because awareness is a summative and relational view of multiple aspects. Thus, transcripts were taken as a whole, and the context of smaller segments were kept in mind when utilizing excerpts as a tool to generate category ideas[7].

The researcher should maintain faithfulness to the transcripts during the data analysis process[7]. Interview transcripts provide evidence needed to make claims. Words should be taken literally within limits because the attempt is to understand underlying meanings. Reading before and after words, looking at transcripts as a whole, and documenting the process helps to discern the central meaning.

The data analysis in this study began by reading and re-reading transcripts as a whole group for familiarity and so they could be viewed collectively. To increase the

familiarity with each of the transcripts, I summarized big ideas that existed within the interviews. These summaries consisted of direct excerpts from the transcripts as well as the researcher's interpretation of key meanings based on the transcripts as wholes. I then attempted to use these summaries to generate some preliminary categories of description. This was difficult because the initial search for meanings separated each participant out as an individual, and the goal was to create categories that identified critical variations between groups of individuals.

Thus the next step in analysis was another read-through of all of the transcripts, followed by a sorting of the transcripts into piles based on similarities. The transcripts in each pile were read again, resulting in some resorting of piles. Once the piles seemed to represent distinct ideas from the other piles, I generated a description of how the experiences represented in the transcripts were a way of experiencing design. After a description was generated, I read the transcripts in that pile again as well as consulted with another researcher with experience in phenomenographic methods and the descriptions and transcripts were discussed. Rereading and discussing with other researchers often prompted another iteration of the piles and descriptions of the way design was experienced in that group of transcripts. Seven official iterations occurred in this study. In the early stages, there was frequently sorting and resorting, trying to determine cohesive groups. Once solid groupings were achieved, the first categories of description were written.

There is some disagreement in the community of phenomenographic researchers on the need for collaboration during analysis. Åkerlind[4] claimed this is very important, but in a separate paper discussed that if the analysis is being done individually, the researcher should take frequent breaks from the data and remain open-minded throughout the process[7]. The stance taken for this study was that collaboration was sought as much as possible but the critical-eye approach was also utilized.

During the analysis process, the researcher aims to construct a limited number of qualitatively different ways of experiencing an aspect of the world. This is an iterative process in which the researcher must take a critical eye to his or her work and seek feedback from other people. The categories and their descriptions, as well as the relationship between categories are the goal of the analysis process.

The first attempt made at writing the critical similarities in design experiences within each pile is show in Table 2.

Table 2. First Iteration of Categories of Description

Category	Design is…
1	Building on technical knowledge to achieve a pre-set goal: This way of experiencing design is about the level of technical detail required in a design and sticking very closely to a goal defined by a boss or client. (Ken, Leann, Parker, Svenson, Tyson)
2	Using feedback and resources to make something work for all parties affected within a context: This way of experiencing design deeply involved the role of people in influencing the experience of design as well as in the consideration of who would be impacted by the design. (Charlotte, Hannah, Isaac)
3	Data collection to choose a solution that works: This way of experiencing design is about the selection of a previous design pattern or template, choosing from a number of limited options, for a design solution that works best and validating that decision with evidence. (Duncan, Evelyn)
4	Synthesis to achieve a goal: This way of experiencing design is about taking "pieces" that already exist, choosing relevant ones, adapting some, building connections, etc. and synthesizing them into a whole. (Glenda, Netty, Omar, Quentin, Roberta)
5	Courage to explore and find something of value: This way of experiencing design seems to include the notion of setting yourself up for more, but it is also about having courage to let the design take you places that you may not have expected because you think there could be value is taking that unplanned path. (Bill, Marcus)
6	Setting yourself up for more (does this include learning?): This way of experiencing design means designers talk about the process as a building block for more. The "more" can be future designs, the creation of a template or pattern, personal growth, career growth, etc. (Alan, Fritz, Jack)

In this first attempt at descriptions, there was no specific attempt to find evidence for a hierarchy, so the descriptions were not presented in this round with respect to a well thought out hierarchy. After the descriptions were written, each of the transcripts in the pile were read again to see if they conveyed similar critical ways of what it meant to experience design and if the description was appropriate for that critical way. Initially when I grouped the transcripts that became category 1 (Design is building on technical knowledge to a achieve a pre-set goal), I believed that they held together because the designers included a lot of technical details in the way they talked about their concrete experiences. As I reread them and compared them to the other groupings, I realized that these details did not seem like the core of what it meant to them to experience design; they were just providing background information of their projects for context.

As I read the other transcripts and their descriptions, I became aware of variations in the ways design was discussed that I did not notice as clearly in my first sort. For example, in the first attempt at categories, I grouped Jack with Alan and Fritz because it seemed like Jack learned a lot from his experiences and that was important to his way of

experiencing design. As I read his transcript again, however, it seemed evident that while learning was important to his personal progression as a designer, what he emphasized more was the freedom he had to create his own boundaries and constraints. Questioning the emphases on which I formed piles and recognizing critical variations between transcripts in the same pile prompted the next iteration. The written descriptions of this iteration is shown in Table 3.

Table 3. Second Iteration of Categories of Description

Category	Design is…
1	Evidence-based decision-making to find something that works. The transcripts here focused on grounding design decisions in evidence. Design decisions started from several options that are traditional ways to tackle situations of that particular nature, choose an optimal starting point based on evidence, and adapt the design to the specific situation. (n=2: Evelyn, Duncan)
2	An organized approach to meeting stakeholder's needs. Some discussion of details, but more talk on social influences including the attainment of feedback from experts, conversations with vendors, consideration of the users, etc. (n=2: Isaac, Charlotte)
3	A detailed process to achieve client's pre-set goals (focus on details). Transcripts in this category focused on the stage by stage path of completing a design and how the details of those stages were significant to meeting the needs of the client or the boss. Detailed constrained exploration for a pre-set goal. (n=5: Tyson, Parker, Leann, Roberta, Svenson)
4	Synthesis to achieve a self-set goal. Design was about taking pieces of many things that exist in the world and adapting or building onto them, and making connections between them to synthesize a final design. (n=4: Netty, Hannah, Glenda, Omar)
5	Intentional progression (setting yourself up for more). Transcripts in this category indicated the importance of building something that could later be built upon or setting yourself up for something more personally. Progression could mean self-progression, community progression, or progression of the design concept. (n=4: Quentin, Fritz, Ken, and Alan).
6	Freedom. The transcript focused on the freedom aspect without emphasis on intentional progression, including freedom to grab what comes along, freedom within personal constraints, physical system, and community constraints. (n=1: Bill)
7	Freedom to pursue intentional progression that has value (for others vs. self). Transcripts in this category included those focused on the creation of something deemed valuable personally or for others that would serve as a building block or stepping stone for something else. The path to building this thing of value that could later be built upon was open-ended and provided them with freedom to explore whatever possibilities they could imagine. (n=2: Jack, Marcus)

When the transcripts in the same pile seemed to have different emphases, the transcripts were resorted to find better groupings. When the category descriptions did not seem to fully encapsulate the emphases of the transcripts in a pile, I would rewrite the description or resort the piles. For example, as I reread Duncan and Evelyn's experiences, it seemed that they were not talking about any working solution, but the best situation for the context. Thus the wording was changed to reflect how they discussed their experiences.

Other descriptions were changed by reviewing the transcripts as well. For example, the transcripts in the second pile seemed that they were not critically differentiated from the other piles by the desire to meet stakeholders' needs, as many other designers not in that pile had discussed this point. The critical variation was more about the organized approach to mapping out a plan to meet the problem that existed.

Quentin's transcript was moved to the third category in this iteration, which also prompted the category of description to be rewritten to include the emphasis on the role of the person who was designing. These changes and the other changes that were prompted by reviewing and reading transcripts with respect to their descriptions and the other groupings were included in the third iteration of categories of description and are shown in Table 4.

Table 4. Third Iteration of Categories of Description

Category	Design is…
1	A series of evidence-based decision-making. Design is about finding, creating, choosing between alternatives based on investigations and evidence about which would be the best design for the situation. (n=2: Duncan, Evelyn)
2	Organized translation from idea to something that works. Design is about a systematic or organized plan to go from the original idea to a working plan, product, process, etc. (n=4: Glenda, Parker, Leann, Charlotte)
3	Personal synthesis to achieve a goal. Design is taking pieces from previous experiences, similar tasks, others' contributions, and fitting them together to achieve the goal. (n= 4: Quentin, Omar, Roberta, Netty, Hannah)
4	Intentional progression. Design is about setting yourself or the project up for future development, to grow, to be built upon. (n=4: Alan, Fritz, Ken, Isaac)
5	Staged exploration to create an outcome with value. Design is exploring within stages so that each exploration within a stage prepares you for next stage until you get to a final useful product. (n=3: Bill, Tyson, Svenson)
6	Freedom. Design is freedom to create something that has never existed. While boundaries and constraints still exist, there are still an infinite number of possibilities for the final design. (n=2: Marcus, Jack)

While many iterations of the categories occurred as I sorted, read, and resorted, at seven points during the process, I documented what I thought held the piles together, with the seventh being the categories of description presented as outcomes. In the preliminary

phases, and when something caused me to resort, I moved transcripts from pile to pile frequently as I tried to understand what was being emphasized. These groupings were not documented because I was not yet at a point where I could describe what the new categories meant. As it seemed that there was a common link between the transcripts in a pile, I wrote a new description of the category.

As the categories seemed to be getting closer to a finalized version, i.e. the changes from iteration to iteration became smaller and smaller, descriptions of the relationships between the categories were written. Looking for relationships sparked additional iterations of the categories of description, leading to a more specific description of the ways design was experienced.

As the relationships between categories and the categories of description were refined, the researcher considered a possible existence of a hierarchy in the categories of description. It became evident that the categories of description represented a less comprehensive to a more comprehensive way of experiencing design. The transcripts and the categories provided evidence for this hierarchy and a representation was created and described based on these data.

Further analysis of the data considered the emergence of themes of expanding awareness as an outcome. To be considered a theme of expanding awareness, an idea had to be discussed in groups of transcripts, but in a different way as the grouping moved from the least comprehensive way of viewing design toward a more comprehensive way. Empirical and logical evidence supported the emergence of a theme.

Outcomes

The primary goal of using phenomenography as a research approach is to capture the variation that exists between differing understandings of the same aspect of the world[4]. While there will be variation among every individual, the key is to find the critical variations that show key differences. The meaning of one person's experience comes from its comparison to the ways the phenomenon is talked about by others. The results reflect the collection of meanings among the group of participants, not individual meanings. Thus while less detail is provided about individual experiences, the categories show the variation across a broad range of experiences.

The outcomes of a phenomenography include categories of description, sometimes represented in a hierarchical fashion, as well as descriptive relationships between the categories of description. An additional output sometimes includes the generation of themes of expanding awareness. Each of these outcomes are discussed in the following paragraphs.

The categories of description generated from a phenomenographic study are a smaller number of more holistic meanings[7]. They are representative of the way a group of people have experienced a phenomenon, not how an individual has experienced a phenomenon. These results are based off of the specific experiences the participants discuss in the interview. The analysis does not makes claims about who the participant is as a designer

in general, but more how the context of the design impacted the way the participant experienced that particular design task. Table 5 includes the categories of description that resulted from this study. A great deal of qualitative evidence supports the categories, however, these data are not presented as a part of this paper.

Table 5. Categories of Description

Category of Description (Design is…)	Summary
Category 1: Decision-making	Design is finding and creating alternatives, then choosing among them to make evidence-based decisions that lead to determining the best solution for a specific problem.
Category 2: Translation	Design is organized translation from an idea to a plan, product, or process that works in a given situation.
Category 3: Synthesis	Design is personal synthesis of aspects of previous experiences, similar tasks, technical knowledge, and/ or others' contributions to achieve a goal.
Category 4: Progression	Design is dynamic intentional progression toward something that can be developed and built upon in the future within a context larger than the immediate task.
Category 5: Exploration	Design is directed creative exploration to develop an outcome with value for others, guided and adapted by discoveries made during exploration.
Category 6: Freedom	Design is freedom to create any of an endless number of possible outcomes that have never existed with meaning for others and/or oneself within flexible and fluid boundaries.

The category relationships should be clear, logically related, and parsimonious[2]. The differences between the categories are also a component of the outcome space. Table 6 summarizes the relationships that existed between the categories.

Table 6. Category Relationships

Category 1 -> 2	The approach to design in discussed as a mapping of the approach as opposed to a series of decisions.
Category 2 -> 3	The role of the human in design is emphasized.
Category 3 -> 4	The context becomes much larger than the immediate design task.
Category 4 -> 5	The notion of exploration within constraints and the resulting discoveries is introduced.
Category 5 -> 6	Facilitated ambiguity and self-imposed constraints introduces the idea of freedom in design.

The categories of description themselves can form a hierarchy, but this is not always the case. If a hierarchy is discovered, it is not necessarily from worse to better, but more often from a less comprehensive to a more comprehensive awareness of the particular phenomenon under study[7, 12]. In this study, an analysis of the differences among the categories resulted in a hierarchy in the ways design had been experienced by the

designers in this study. The hierarchy resulting from this study does not represent better or worse ways of experiencing design, but less comprehensive to more comprehensive. A representation of the categories of description, the relationships, and the resulting hierarchy are shown in Figure 1.

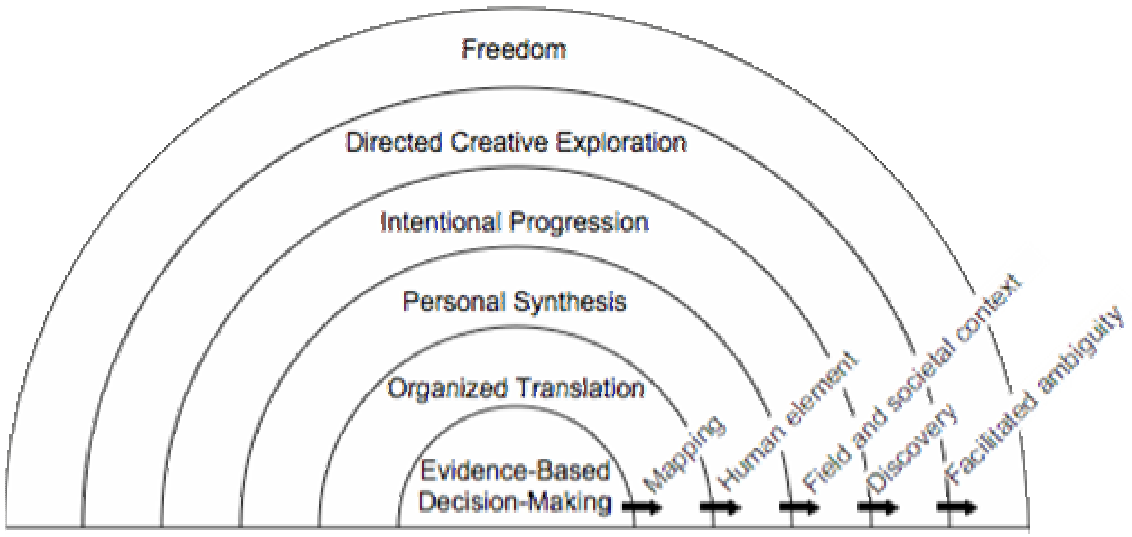

Figure 1. Categories of Description, Category Differences, and Resulting Hierarchy

General trends in the hierarchy include an expansion of context from the immediate problem to a wider consideration beyond the problem, a movement from a solution-focused design approach to one that is problem-focused, and a change of who defined the problem as well as evaluated the design, moving from others to oneself.

Themes of expanding awareness are different than themes that result from a thematic analysis. They are themes that appear in the categories of variation, but in different dimensions[10]. Much as the categories of variation represent less comprehensive to more comprehensive ways of experiencing an aspect of the world, the themes of expanding awareness represent less comprehensive to more comprehensive dimensions of themes.

Four themes of expanding awareness were found in analysis of the categories of description: the role of the problem, the role of ambiguity, the task endpoint, and the goal of the outcome. These themes were discussed in the experiences of all of the designers interviewed; however, designers whose experiences comprised different categories of description discussed these themes in different ways. The descriptions of the themes are general, based on the groupings of the experiences of the designers. Table 7 displays these four themes and how each aspect was viewed in the lens of each category of description.

Table 7. Themes of Expanding Awareness

Category	Role of problem	Role of ambiguity	Task endpoint	Goal of outcome
Category 1: Evidence-based decision-making	It is set by someone else; there is no flexibility	Gather data to eliminate ambiguity	When evidence supports decisions as the best	The best solution
Category 2: Organized translation	Problem is set by someone else or self, but the designer discovers and adds new problems to be solved along the way	Tolerant but seeks to overcome where possible	When the solution achieves the goal and is satisfactory for all parties involved	Something that works
Category 3: Personal synthesis		Tolerant	When the intention has been fulfilled	Achieve goal and expand repertoire
Category 4: Intentional progression	Problem is loosely set at "start" and developed by the designer and the stakeholders along the way	Just part of design	When it can be built upon	Something that can be built upon
Category 5: Directed creative exploration		An opportunity for new paths	When applications, new paths, and frameworks for guiding future work are evident	Something of value for others
Category 6: Freedom	Designer develops a problem to be solved	Cultivates it; transforms constraints to freedoms	Only when someone else takes it over; it always evolves when it is with the designer	Something with meaning for oneself or others

The differences between categories 1, 2, and 3 and categories 4 and 5 for the theme of expanding awareness, the role of the problem, could not be discerned from the data. The shift in view of the role of the problem from category 1 to category 6 became more expansive, thus the ways the role of the problem was discussed in the experiences that comprised categories 2 and 3 as well as in categories 4 and 5 are reported together. For the other themes of expanding awareness, the meanings in each category were different. The themes of expanding awareness relate to the categories of description; as the

categories of description become more comprehensive, so does an idea discussed in each of those categories of description. These ideas that exist in all categories of description, but become more comprehensive, are the themes of expanding awareness.

Conclusions

This paper summarized the research design and outcomes of a phenomenographic approach to understand the critical differences in the ways professionals experience design. These outcomes contributed to a fuller understanding of what it means to design because it introduced a new perspective, that of those who design regularly as a central part of their profession. Understanding this perspective of what it means to design has implications for both design practice and education. It brings awareness to the fact that everyone does not view design in the same way, and these differences in design lens are hypothesized to have a direct impact on how one approaches a design task. The ability to bring awareness of different design experiences and approaches to designers at all levels, novice to experts, also brings the potential to facilitate the development of better designers.

Phenomenography as a qualitative research approach is one that can bring new and necessary information to the engineering community. It is unique to other qualitative approaches, which may be challenging for those who have never participated in this type of approach; however, the unique aspects of phenomenography also mean that the outcomes contribute a unique perspective.

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