From Design Research to Theory: Evidence of a Maturing Field

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Abstract: As a discipline evolves, research practices mature and begin to define the field they support. The field of design is currently undergoing this type of evolution. Design researchers are undertaking new forms of research, articulating methods and processes, and in some cases, building new theories of and about design.

In this paper, we attempt to characterize the maturation of the field of design by understanding theoretical contributions of design research through interviews with design researchers. Our goal is to better understand *types of design research* in design researchers' native terms, to understand how design research supports problem framing and the selection of research methods, and to understand if and how the outcomes of design research activities lead to theory construction. Through synthesis and analysis of interviews, we characterize three types of design research: research on design, research for design, and research through design.

Our goal in creating these classifications of design research is to move the field forward, and better clarify the relationship between the different types of design research and the relationship between design research and design practice. A deeper understanding of existing and recognized types of design research and their application is an important step in the further refinement and development of design research and particularly design theory.

Key words: design research, design theory, research on design, research for design, research through design

1. Introduction

As a discipline evolves, research practices mature, and their results become unique to the specific field and are not found in any other field. The discipline of design is undergoing this type of evolution, as researchers and practitioners are defining typologies of design research and design practice, and in some cases, building new design theories and new theories of design. Many researchers in our community believe that we are on the verge of a revolution in design research that can offer new theoretical contributions to the rest of the world (Dorst, 2008).

While examples of these results both inside and outside of the community continue to grow in number, one problem the design community faces is how to develop design theory from design research (Friedman,

2003). This is currently a shortcoming of many potential design research contributions, as they fail to document and produce theory that researchers and designers can apply in future research and practice.

This paper is a step towards remedying this situation. Our goal is to identify specific types of design research in the native language of contemporary design researchers, and to understand if and how the results of this research can form the seeds of design theory. We present the results of a literature review and of interviews with design researchers that form the basis of our findings. We discuss three types of design research identified in our interviews and echoed by others in the community. The results of our interviews provide evidence for the existence of a slowly but recognizable growing body of design theory as a result of design research. Even though our interviews are primarily with design researchers in interaction design and human-computer interaction (HCI — an interdisciplinary research and practice community that include behavioral science, computer science, and design), we believe the results are of interest to a broader range of design fields. Our contribution to the design research community includes clarity on types of design research, and illustration and examples of design theory.

2. Method

The overall goal of our work was to understand if and how design researchers view different forms of design research. We also wanted to look for evidence of theoretical contributions developed from the results of design research efforts.

Literature review. We conducted a literature review focused on theory in scientific and non-scientific disciplines. We reviewed literature from design and other disciplines to find definitions and descriptions of theory both within and outside of the scientific disciplines. We also reviewed literature in design and human-computer interaction (HCI) that discusses forms of design research.

Interviews. We conducted semi-structured interviews with 12 leading design researchers currently working in the field of general design research, interaction design research, and HCI. We chose to focus on interaction design and HCI as an important subset of design research as these research contributions must connect with both a design research audience and a scientific research audience that splits between behavioral scientists and computer scientists. During the interviews, we asked the researchers to (i) articulate different forms of design research; (ii) discuss how different forms of design research can produce theory; and (iii) provide examples of that document the different research types and that illustrate how these research types lead to theory.

3. Findings:

3.1 Findings from Literature Review

There have been many models of design research. These include Nigel Cross' three design research classifications: design epistemology, design praxiology, and design phenomenology (Cross, 1999); Susan Roth's classifications: concrete and specific, conceptual, and theoretical and philosophical (Roth, 1999); Daniel Fallman's classifications of design-oriented research and research-oriented design (Fallman, 2003); and design practice, design exploration, and design theory (Fallman, 2008); Richard Buchanan's classification scheme: clinical, basic, and applied (Buchanan, 1996); and Zimmerman et al's model of research through design

(Zimmerman et al, 2007; Zimmerman et al, 2008). These models all provide valuable perspectives on the connections between design and design research; however they mostly neglect to explicitly address how design research connects to design theory.

Theory is a highly complex and diversely defined and used concept. Even though the purpose of this research is not to define theory as such, we want to establish a basic understanding of what we mean by theory and theoretical contribution in our study. On a general level, we see theory and theoretical contributions to be about intentional knowledge production. When it comes to (i) what *constitutes* a theory and (ii) what is required from a *process* that is supposed to lead to theory, there is no commonly accepted definition of descriptions. In our research we have tried to find out how design research is understood both when it comes to constitution and process.

In our literature review, we focused on definitions of theory within and outside of design. A theory in its most basic form can be thought of as a model that describes the structure, relationships, and influences between phenomena (Friedman, 2003). Theories serve to describe processes, actions, and dynamic situations, or act as taxonomies that illustrate related elements and structures without addressing the actions or influence of one upon another.

Researchers in scientific disciplines develop theory by making repeated observations over time, and producing a construct that can be used to orient to an idea at a high level, and understand the underlying complexity. Theories contribute to a part of research discourse where researchers propose new work to extend, refine, or refute the work of others. Theories also evolve when researchers may consolidate many small theories into a larger whole. Theories can be nascent, suggesting a research agenda for further refinement; intermediate, where constructs that are formed need to be tested; and mature, where a theory is very well established, suggesting that no new evidence is likely to alter the explanation (Edmundsen and MacManus, 2007).

Another definition of theory is the exploration of a subject matter through the development of propositions (Mautner, 1996). This approach is similar to the activity of sketching, where each sketch functions as a quick hunch or proposition about the problem at hand, and the preferred state. In fact, Weick defines theory as disciplined imagination that explores subject matter through artificial selection, where the researcher "defines, conducts, and interprets imaginary experiments" (Weick, p. 516). Weick's constructs also map naturally to the process of sketching and prototyping in design, where sketches evolve from a grounded understanding of the problematic situation and systematically explores many possible problem framings.

These perspectives cast the construction of theory as a creative process involving sketching, ideating many possibilities, and iterative refinement into a unifying whole that addresses how all the elements and properties of a theory relate. An interesting challenge exists for the design community in connecting the outcomes of design research activities (the creation of the *ultimate particular* [Nelson and Stolterman, 2003]) with the development of nascent theory. To understand this process, we sought clarification through our interviews, carefully examining the intentions and outcomes involved in each design problem.

3.2. Findings from Interviews

In our analysis of the interviews, some common themes emerged. We found a shared concern that a romantic view of design (genius designer who magically discovers good ideas) is perceived to be very common outside of the design community, and that this notion of design works against the idea that people trained in design can

make research and theoretical contributions. Additionally, participants had a number of views of design research, defining it as a research focus on the activity of design, theoretical outcomes and activities that produce theory.

Based on the interviews, we identified three interconnected intersections of design research and theory. The first is *Research on (or about) Design*: a *research focus* on the human activity of design, producing theory that describes the process of design. The second is *Research for Design*: a *theoretical outcome* of many different activities that provides designers with theories they can apply to improve their practice of design. The third is *Research through Design*: a *research approach* that employs the design process as a method of inquiry on the near future, and that can produces theories in the area of *research for design*. We found that even though design research and especially design theory are still quite elusive concepts, even among prominent design researchers, the idea that design research has these three foci is slowly developing into a more agreed upon and common understanding.

Throughout the findings section, we will refer to *minority views*. These views do not indicate a point of disagreement within the participants. Instead, they represent ideas or insights proposed by one or two participants that go well beyond the contributions of the other participants.

Research on (or about) Design

Research on design was the most widely recognized type of design theory among the participants. The goal of this kind of research is to develop a detailed and unified understanding of the human activity of design or of design related activities such as creativity. The most popular example of this kind of contribution mentioned by participants was Schön's work on reflective practice (Schön, 1983). In general, participants felt this type of research was more about understanding the human activity of design than in generating knowledge specifically intended to improve the practice of design.

One minority view to arise in this area was a suggestion for more research that addresses the role of the designer and of the other stakeholders in a design process. As an example, a participant mentioned that Löwgren and Stolterman's book, *Thoughtful Interaction Design* (Löwgren and Stolterman, 2005), could be renamed *Thoughtful Interaction Designer*, as it describes the characteristics of the designer during the activity of design.

Research for Design

Our use of the term research for design functions as a catchall for several different kinds of theory that all have been produced with the intention of being applied in the practice of design. The main forms to emerge from the interviews include: conceptual frameworks, guiding philosophies, design implications arising from the investigation of people and contexts, and design implications arising from the analysis of designed artifacts.

Several participants mentioned design theory in the form of conceptual frameworks that function to help designers reframe the problems they are addressing. Examples include the work on co-experience (Battarbee, 2004) which describes how the user experience with respect to mobile communication devices is co-constructed by the two people communicating; the product ecology (Forlizzi, 2008), a framework which helps designers view a product's impact on people's social relationships when using products; and rich interaction design (Djajadiningrat et al, 2004; Overbeeke and Wensveen, 2003), which details how designers can increase

the aesthetics of interactive artifacts by more fully considering the full range of human sensory inputs and the ability to express intention with the human body.

In many cases, these frameworks are presented with design methods that detail or at least provide an example of the application of the framework in practice. Two minority views emerged around the topic of methods. First, a few participants felt the research community focused too heavily on method as the research contribution as opposed to seeing it as support material for a conceptual framework. Second, one participant held an almost conflicting view, expressing a desire for more and better research on methods that connect conceptual frameworks to the process of design. This participant worried that the frameworks would be less valuable if other researchers and practitioners did not have clearer guidance on how to apply the framework. Finally, there was a minority view that quality of conceptual frameworks should be judged by their impact on the design community, on the number of people that take-up and advance an individual framework.

Several participants talked about theoretical contributions in this group as in the form of *guiding philosophies*. These are quite similar to conceptual frameworks. Guiding philosophies are intended to guide the practice of design by helping designers to reframe problems, broadening the scope of the design activity. However, guiding philosophies were generally seen as less mature, or as more of an attitude than a specified approach to design.

Participants shared several examples of this type of contribution. They mentioned the MIT Media Lab research on tangible interaction (Ishii and Ullmer, 1997), which focuses on moving controls for computational systems off of screens and back into the physical world. Participants also mentioned Sengers and Gaver's work on design for appropriation. The main proposal here is that there is a valuable and unexplored design space for products that do not have an intended use, but are designed in order for users to appropriate them and create uses for them (Sengers and Gaver, 2006).

In discussing both conceptual frameworks and guiding philosophies, participants stated that these theoretical contributions can also emerge from the practice of research *through* design.

Participants recognized research that focuses on target audiences and on different contexts of product use produces design theory in the form "design implications." These contributions generally focus on people, places, and social interactions, and they have the intention of producing insights that can guide the design of new products and services to affect these people and situate within and intentionally transform the investigated contexts.

Participants shared several examples of this kind of research. They mentioned the PARC research on how people use email as a personal information management tool (Whittaker et al, 2006). They also mentioned Everyday Creativity (Wakkary and Tanenbaum, 2009) and Artful Systems in the Home (Taylor and Swan, 2005) on the daily activities of families in their homes.

In addition to design implications arising from the investigation of people and contexts, participants mentioned design implications that arise from the analysis of artifacts as another type of theoretical outcome from design research. Many participants mentioned Tufte's investigation of graphic and information design examples as a well recognized example of this kind of research (Tufte, 1990).

One participant raised a minority view here, claiming the design research community needs a better and more formal approach for evaluating the quality of a designed artifact. They want to see more research that

allows the community to engage in critique of artifacts and consensus building on what makes for a "good design."

Research through Design

Research through design is *an approach to research* that leverages the design process of repeated problem reframing as a method of scholarly inquiry. The two most critical aspects of this approach are that it allows researchers to engage with wicked problems (Rittel and Webber, 1973) and it allows researchers to become active constructors of possible futures.

Participants described how this approach can produce different types of design theory. The work can result in the conceptual frameworks *for design* and evidence of the value of guiding philosophies *for design*. In addition, it can result in methods in support of conceptual frameworks and guiding philosophies. This research can also produce new problem framings that suggest preferred states for the world. Finally, this approach results in new product forms that broaden the space of design. For example, one participant mentioned in order to create online newspapers, designers had to engage in the process of making, to understand what this thing might be, and in this way the resulting artifact functions as a proposition or early theory contribution.

Participants mention many different examples of this kind of work. Three of the most popular examples to emerge were the research by Dunne and Raby (Dunne and Raby, 2001); the Equator project (http://www.equator.ac.uk/); and the investigation of rich interaction by Overbeeke and colleagues (Djajadiningrat et al, 2004; Overbeeke and Wensveen, 2003). Participants also mentioned the work from the MIT Media Lab as an example of research through design, but in this case the work is driven by the researcher becoming facile with technology as a method of exploration. One participant mentioned that this comfort with the technology allowed for what Schøn characterizes as a conversation with materials (Schön, 1983). Several mentioned Ishii's glass bottles as an example of research through design where new technology allowed for rethinking what interactive products might be (Ishii and Ullmer, 1997). Finally, one participant used Wright's development of Usonian homes as an example, describing how the building of the homes informed the design principles, and this example helps to illustrate that research through design is not at all a new approach to research; however, it is an approach that is still not well recognized or formalized by the design research community.

Participants mentioned many issues and challenges with this research approach. They mentioned that it is often difficult to recognize this kind of work as research because in looking at a single example, it is difficult to tell what the contribution is. In making this point, one participant referred back to Ishii's glass bottles, statting that in looking at this specific instance it is not clear what the research question is that drives this work nor the knowledge produced. However, participants felt that when this approach is used to repeatedly investigate an area, then the opportunity for theory as an outcome can happen. Participants stated that Overbeeke's work is an example where theory has emerged, but they also stated that most researchers taking this approach fail to investigate an issue long enough for real theory to emerge. One participant shared that the first question researchers must address when taking this approach is to determine if the problem they are addressing really is "wicked". Additionally, a participant shared that researchers taking this approach too often focus on making useful artifacts at the expense of make a more substantive contribution of knowledge.

A minority view did arise around the value of this research approach for other communities. One participant mentioned that this approach is valuable for many different kinds of research, allowing for more wild exploration. Another mentioned that this approach to research might one day be considered the design research community's most substantive contribution to the larger research community.

4. Discussion

From the interviews, it is clear that most design researchers think about and reflect on the nature of design theory and on design research as an approach to theory construction and refinement. Participants initially struggled to answer our questions on research types and theory production, which reveals a lack of formalization in characterizing this process; however, the strong consistency across participants also reveals that more formal patterns are beginning to emerge. For anyone doing design research, there is pressure to be able to argue for the approaches chosen, for the relevance and rigor of the outcome, and the potential theoretical contributions.

Looking at the classification of research on design, research for design and research through design, it is interesting how similar they are Albert Borgmann's (1999) three forms of *information* where one is information *about* the world (descriptions), the second is information *for* the world (prescriptions), and information *as* the world (virtuality). The main difference here is that research through design has a distinctly more future perspective.

Our participants had a great deal of consistency in their view of research on design. However, their views began to differ around research for design, particularly in terms of methods. In reflecting on this, we see two possible sources for conflict. First, the legacy of the design methods movement makes research focused on the production of methods somewhat suspect. Second, many design researchers working in HCI and in interaction design find they can only publish their methods as a research contribution when submitting to scientific venues.

The responses to research through design seemed most interesting. We were particularly taken with the proposal that research through design may be the greatest contribution of the design research community to other research communities. The unique value of this approach appears to be the focus on a future state and on a preferred state with respect to a wicked problem. This is unusual focus for research practices. In a sense, this approach allows researchers to become active constructors of possible and desirable futures.

Even though the interviews showed a diversity in how the researchers think and define design research, it is possible to see a growing convergence and acceptance of the fact that there are several forms of design research that each has its own methodological challenges but also theoretical potentiality when it comes to outcomes. We could also see that when asked about theoretical contributions and good exemplars of design research that common names and theories were mentioned by several researchers. We interpret this as a development where some design research contributions are getting the recognition of being theoretical contributions of lasting and common importance. We take these results as positive signs that design research is slowly maturing, and that good design research is being recognized and that the results are brought forward as candidates of theoretical development and evolution.

5. Conclusion

Design research is alive and well, and is recognized by the design community. Design research is beginning to produce theory that can be applied to many types of design, including products, services, systems, processes, media, and information. From our interviews, we found that often theoretical payoffs come after a project or design is finished, allowing for "reflection on a project with backward thinking." Our goal taking this initial step towards defining design research and design theory for the design community is to begin a discussion of what design theory is and the role it can play in design research. We will continue to refine and evaluate our ideas with others in the community. Our goal is to better support the integration of research practices and theoretical outcomes in all aspects of the field of design.

6. Acknowledgments

7. References

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