For User Study
The Implications of Design

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To Michael Redeker

C O N T E N T S

FOREWORD

I began my Ph.D. study in 1999 in Chicago, United States. After having changed schools three times, dragged myself across North America from west to east, and further across the Atlantic; I am now living in Braunschweig, Germany, trying to write a thing called Ph.D. dissertation on the topic of user study. What has happened? Reflecting on what has happened can help contextualize this dissertation richer than the Introduction allows. Behind or surrounding this dissertation are my experiences with doctoral design education, design conferences, design literature, design discussion lists on the Internet and people in design with whom I have come into contact between 1999 and 2005.

I started my Ph.D. study with the desire to seek a deeper understanding of design. Certainly I did not know what I was looking for except that I felt a serious lack. With the help of hindsight, I can say now that I wanted to understand design beyond the knowing-how-to-design. I wanted to understand the relations between design and other things. In other words, I sought relevance or meanings in design. Ironically, I got increasingly confused after a year of Ph.D. study let alone having a better grasp of its meanings. (So this is life). It was partly because there was no introduction to the theories or ideas of design in either Chicago or Raleigh at the time but also that 'design' meant different things to different people. I once asked a Ph.D. candidate about design theory. He said that he was only aware of one and that was User-Centered-Design. Design theory to him was an approach to designing. I was a teaching assistant for a 'design theory' class in Graphic Design, and the theories taught were communication theory, semiotics, perceptual psychology and some general issues about design practice. So for the curriculum developer design theory was theories that inform designing. And in literature, design theory might mean design method or theory about artifacts. In my doctoral experiences in the U.S., except for a seminar conducted by Nigel Cross, there was little exchange on ideas of

design - what design means in a bigger scheme of things. The neglect of design theory in the field of Design is generic. Theory is often suspect for its value to practice, and I assume this is a point not to overlook. And I have struggled with the question over the value of theorizing on design. If theory, by its nature, is generalized abstract descriptions, then what is its use when designing is specific and context bound.

When we ask about the value of theory to designing, we instantly enter a circular state. It is similar to ask how valuable computer technology or anything else is to us, there are of course certain functions that a particular object affords, but in the end its values depend on how we make use of the functions. There is no intrinsic value as such for all values are assigned. And how valuable theory is depends on how we use it. The value of theory to designing is created not given. In other words, to engage in examining how theory is valuable for designing is to engage in the (creative) use of it. Our task, therefore, is not to describe the value of theory as if it were something constant, fixed, and waiting for our discovery. Our task is to demonstrate how theory *can be made* valuable by/for designing. It is this belief that gives me strength for writing this dissertation in which I hope to use various discourses on designing to establish some principles for examining user study. But is this project qualified as a Ph.D. dissertation in Design?

The question of what constitutes a Ph.D. dissertation in Design entered my mind in the summer of 2000 after my attendance to the second Doctoral Education in Design conference held in La Clusaz, France. Apparently, there had been some international concerns about the development of doctoral education in design not long before I got involved as a student, a prototype in this education ‘experiment’. There were debates over something called ‘practice-based’ Ph.D., the notion of tacit knowledge in designing, the role of artifacts in research, the essential differences between a Master and a Ph.D., and the whole idea of ‘design knowledge’ and ‘design research’.

The last few issues were not only interesting to me as a student seeking relevance and understanding. They were also important discussions framing the context of my study. They were fundamental questions upon which my study would stand or fall as a Ph.D dissertation in Design.

Right at the beginning, I have learned that a Ph.D. dissertation is an original contribution to knowledge. No matter how clear and widely accepted criterion this is, it is easier to say than to understand its meanings and implications. And to no surprise, people interpret this slogan differently. Some give very technical interpretation and go by all the institutional requirements. And in my experiences, these some people are the majority. Fortunately, there are some, exceptionally few, will think more deeply and give some guidance beyond bureaucratic details.

I was most inspired by Clive Dilnot's article "The science of uncertainty: the potential contribution of design to knowledge" (1998). He suggests or provokes that knowledge arises from Ph.D. Design should contribute to knowledge in general, not only to design practice. It should fill the gap left open by the humanistic and scientific inquiry. Many implications can be drawn from his idea. But to me, the most salient is the role of 'making' in a design dissertation. 'Making' here refers to the construction of the 'real'. Dilnot points out that the sciences and the humanities are fundamentally and traditionally concerned with true 'notation' or description of what exists. While Design, as a field, is concerned with creating something that is yet to exist.

Certainly I can imagine protesting voices disagreeing with the sharp artificial line just drawn between Design and the other two disciplines. Ranulph Glanville (1999) has made it very clear that research in any field is a process of designing. And Wolfgang Jonas (1999) has advised that science is approaching design. Even in this dissertation I will argue the difference between science and design is the product, not the process. So by citing Dilnot, I do not intend to express the view that there is some

necessary distinctions lie among disciplinary practices. But rather, it is the spirit contained in his ideas that I want to point. It is to recognize Design as a potential intellectual discipline on par with, not subordinate under sciences or humanities. The suggestion that Design can be made a paradigm of inquiry is, to me, a very exciting idea.

Design as a paradigm of inquiry is yet to be articulated and established firmly. Alain Findeli (1998) has articulated a 'project-driven' approach to research in which designing or design thinking plays a central role. And it is much in line with the ideas of Dilnot (1998)" …what design, as a mode of transformative action, allows us to see is how we negotiate the limits of what we understand, at any moment, as the Actual. In design, in other words, we begin to see the processes whereby the limits of Actual are continually formed and re-formed". I interpret these suggestions to mean that in my dissertation, I may not examine theory as an object and argue why it might or might not be useful to design. But rather, I may engage directly in the use of it to construct principles that interfere with practice. Here the approach to inquiry is unscientific in a sense that I do not aim to objectively describe the co-relational or causal relationships between phenomena. Rather I am involved as a subjective actor in the (re)make of the relationship.

If the idea of 'making' is central in a Design dissertation, as making should be central in Masters and the undergraduate studies, how can we differentiate a Ph.D. dissertation from a Masters thesis from a Bachelor project report? Some people might think the difference lies in the volume of work or the complexity of the project. But I find the characterization Richard Buchanan has used more satisfying. During a discussion on the Ph.D.-Design list, Buchanan suggested 'reasoned principles', 'reasoned themes' and 'reasoned facts' to capture the essential distinctions. The idea of reason is a tricky one because it carries a historical baggage of meanings. As Toulmin (2001) pointed out, rationality and reasoning have been made to mean the

same since the 17th century in the pursuit of knowledge. The sharp distinction between 'pure reason' and 'practical reason', and between 'logic' and 'rhetoric', 'formal argument' and 'substantive argument' were created then. Exactly how Buchanan meant by 'reasoned' in that occasion was not entirely clear. However, being quite familiar with his work, I could not image Buchanan took a narrower view on the meaning of 'reasoning'. Having said that, I still hold the idea of 'reason' to characterize designing in pending for I believe that designing requires both reasoning, in its widest sense, and imagination. It is a contentious and important point and I should give a proper attention to it in the dissertation. That aside, the idea of 'principle, theme and fact' is a useful one to differentiate the levels of work. I take that principles are rules or theories or assumptions by which themes and facts can be organized. This dissertation is aimed to construct some theoretical scaffolds by which user study can be discoursed and examined.

Here a few words are needed to explain my careful use of language when I speak of principle as scaffolds. It should be noted that I deliberately choose 'scaffolds' rather than 'foundations' to signify the role of principle in the affair of designing. This deliberation is due to the discourse on foundation initiated by Wolfgang Jonas at the real-cum-virtual *the basic paradox* project (Jonas et al 2002). The key questions then are: is there a foundation of designing, and if there is, what is its nature?

To me, foundation is a poor metaphor for describing principle in use. Principle by necessity is general and theory-like. It is general so that it can be made used of in a variety of situations in practice. Its generality is both its power and limitation. However, designing is fundamentally context bound, thus specific. And its outcome is far away from principle in quality. In designing, principle is not applied but rather transformed. It is not that once principle is laid down then design can be built upon it. A better image to describe principle in use is that of how Chinese construction workers create bamboo scaffoldings as they construct buildings. The bamboo

scaffoldings are what the construction workers stand on, while they make the scaffoldings and construct the building. Once the building (design) is done, the building structure (design criteria) will not be seen and the temporary scaffoldings (principle) will come down. Principles are more like supportive scaffoldings rather than foundation for designing. Besides I prefer scaffolds to foundation because scaffolds has a sense of tempo. A principle is renewed or superceded when it can no longer support dealing with practical issues. Principle is modified by being used and tried in practice. If principle is subject to change in light of practice, then scaffolds gives a better image than foundation, at least to me. Besides, it also implies that principle *can* indeed be grown out of practical issues and that renders the pyramid of basic-applied-clinical research model a little bit shaky.

The quarrel on using the basic-applied-clinical research model to categorize types of research first caught my attention when Wolfgang Jonas openly disagreed with it during some discussion on the PHD-Design listserve. I have also entered into the debate myself at one point questioning whether this model is the most constructive way to categorize research given the stage at which design research was. I believe that if we think of design as a SUBJECT of inquiry, then the B-A-C model makes sense. If we conceive design as a PARADIGM of inquiry, then it does not. Here I quote my contribution in length.

If the purposes of design research include the advancement of our field and the changing of the world, then the conception of design research as a subject of inquiry is less powerful than that of a paradigm of inquiry. As a subject of inquiry, a design research program can be constructed UNDER either a scientific or a humanistic research paradigm. Here we use the scientific paradigm for illustration since it is from which the B-A-C model comes. Let us try to diagram how the B-A-C model fits into a design research program when the conception of design is seen as a subject of inquiry under the scientific research paradigm.

Figure 1. Design research under the scientific research paradigm

As figure 1 shows, design appears to be under the mercy of the scientific research paradigm. If we are generous, I can imagine that design practice can be on level 5 under the category of clinical study as a part of a research program. This is unproblematic if we are satisfied that design research will NOT be an equal partner to scientific research and humanistic research, and the field of design will NOT be an equal partner to the scientific and humanistic fields. But if we can agree that this is not all right because we hope that Design as a field can complement and supplement the sciences and the arts.

As many have pointed out that, one pressing problem facing us is to materialize scientific and humanistic knowledge in order to change the world we live in and that design can potentially fill this gap. Thus we might not only see design as a subject of inquiry, but also a paradigm of inquiry. It is through the latter conception that we have a chance to gain independence, to offer what we can do best and to achieve the status that we think we deserve.

If Design is seen as a paradigm of inquiry equal to scientific and humanistic paradigms, then a conceptual map of a design research program will/can not be the same as the above. We have much work to do to conceptualize design research under a design paradigm. But now I think this is where the contested concept of

'research through design' gains currency and the model of B-A-C loses its value since the basis of research is designing. The pyramid of basic – applied – clinical research program is turned upside down. The model does not make sense any more.

Besides, I think that the B-A-C model conveys an inaccurate picture of how research is practiced. The sharp lines are difficult to draw in reality and if this is the case, why hold onto a description that is not valid? A Ph.D. dissertation in Design although deals with subject matter on the level of principle, its context of inquiry is not necessarily bound by the traditional division of basic-applied-clinical research. And that leads me to accept that there is no particular need to view an inquiry on user study as basic, applied or clinical.

While struggling with all these issues surrounding the meanings of a Ph.D. dissertation in Design, I have, like many others, changed the topic, the focus and the method of my inquiry. The dissertation has gone from the study of HIV communication, to the method of user study and finally to the principles upon which user study for design can be examined. The pages that follow are a reflection of all that I have considered and the experiences that I have gained.

This dissertation could not have been realized without the labor of others who have come before me. I am grateful for my supervisor Prof. Dr. Holger van den Boom, a true scholar and a gentleman, who has taken me under his wings and given me the intellectual stimulants that I need and appreciate. Overdue thanks must be made to Prof. Dr. Wolfgang Jonas, who more than anyone I know, has taken very daring moves in design theory and research; and has involved me in some of these exciting events. And all my friends at PHD-DESIGN discussion list deserve a thank-you, for my intellectual life would have been so lonely without them.

ABSTRACT

The practice of user study is well presented at numerous conferences, documented in various literatures and discussed at different Internet discussion groups. At the moment, there seems to be plenty of experiences and knowledge about user study accumulated in design practice. The idea of user study is well received and affirmed across professional and educational institutions. It is generally accepted that user study is important for contemporary professional practice of Industrial Design.

However, our belief is mostly supported by informal observation, testimony and good will but lacks formal articulation. The profession of communication design lags behind other design fields in terms of practicing user study. Rigorous discourse on user study in Industrial Design lags behind that in Human Computer Interaction. Moreover, other fields have already recognized the need for more in-depth understanding on user study so research on user study has begun. These studies, however, are missing a perspective from design. The lack of formal articulation and design perspective has left the 'applicability gap' open between user study and design. Although we know that user study results are not necessarily useful for design practice, we have not dealt with this issue properly. This study is aimed to address this problem.

Research on user study has been empirical: observing how designers design. However, this type of research often lacks theoretical framework, and as a result, we are not certain if the research outcome is by chance or systemic. More importantly, this type of research slights historical and cultural contingency, and it begs the question whether it can serve as principle for future practice and research that for sure will change. User study is an invention to suit design practice. But design practice is also an invention. We do not have to describe and explain design practice as now but to interpret and articulate the potential/possibility of user study based on

an articulation of the nature of design – to create an idealized scenario. I seek to articulate the nature of design and draw implications for these two questions: “How does user study inform design?” and “What are the formal characteristics of user study outcome?” This theoretical inquiry provides a language by which the practice and research of user study can be reexamined and reorganized. The result will bring issues to the public domain for debate and improvement. It will increase the effectiveness of our communication to one another and will serve a (temporary) map for guiding research and design on user study.

In the first part of the investigation, we explore the nature of design and arrive at a workable definition that design is an inquiry oriented toward a specification that fits. In the second part, we derive meanings from this articulation to address the research questions, and it leads to some unexpected conclusions. For the research question, “How does user study inform design?”, based on the nature of design articulated, it is implied that current user study provides a context for design. For the question, “What are the formal characteristics of user study outcome?”, it is concluded that the context ought to be a specific reasonable narrative rather than a general casual explanation. More interestingly, the results of the inquiry make us realize that context creation does not necessarily precede the generation of possible specifications in the design process, thus it calls into question the fundamental assumption on which the research questions are based. It is revealed that not only user study informs design, but also in principle, design can drive user study. Not only is design-driven user study possible, but it is also preferable for design situations where the product to be made is highly undetermined. The conclusions project new perspectives on jumping the ‘applicability gap’, open up new line of inquiries for user study, and shed light on the potential coordination between design and research in general.

INTRODUCTION

1 A NEW FORM OF USER STUDY

Design research, if viewed as a collective and systematic activity, is rather young. The Design Research Society was established in 1966 and the founding of Environmental Design Research Association happened around the same time. The 'design method movement' that took place in the 60s was an attempt to make designing a rational/logical process. In hindsight, we know now that logical deductive methods are not well suited for dealing with 'wicked' or indeterminate problems that are characteristics of design problems. Nevertheless, the 'design method movement' could be seen as one of the earliest, if not the earliest, design research efforts. Forty years have passed, design research is active again. In recent years, the subject of research has attracted much attention within the field of Product/Communication Design. A special issue on research appeared in *Design Issues* in the summer of 1999. In 2000 there were the international conferences, *Design Plus Research* held in Milan and *Doctoral Education in Design* held in La Clusaz. They were followed by the *Common Ground* conference in London in 2002 and *Future Ground* conference in Melbourne in 2004. Besides these major events, there were various symposiums including *Designing Design Research*, *Research into Practice* and the *Basic Paradox,* to name just a few. Besides these conferences, the European Academy of Design was established in 1994 and research oriented journals such as the *Design Journal*, the *Design Research Journal*, and new Ph.D. programs in various corners of the world were launched in the past decade or so. Among these efforts, considerable amount of research is directed to advance professional design practice. And a 'new'

form of study to understand people's needs and wants is frequently claimed to be essential to contemporary professional design practice. It is also touted that the collaboration between social and behavioral scientists and designers is an ideal way to study people and tackle design problems (Braiterman1999, Squires et al 2002). The social scientists seek to understand and explain human behaviors. They have developed various approaches and methods from which designers adopt and adapt to understand users. The research tradition of the social sciences has been a model for user study in all areas of design. Social and behavioral scientists are seen as partners to conduct user study and provide designers with needed information. This information is supposed to assist designers in creating better products and services to suit the needs and wants of people. User information is supposed to help designers to create solutions. This form of user study has many different names, such as "human-centered innovation, user-centered design approach, user research, user-experience modeling, design ethnography, strategic design or thinking 'outside the box' (Squires et al. 2002).

1.1 Not so new

Despite the different names, the current form of user study is not so different in fundamental perspective or practice from that of the traditional one. The history of systematic user study in design could be said to have begun after World War I with ergonomists in Europe and human-factor specialists in North America starting to be involved in the design of work related artifacts and environment (Kroemer and Kroemer-Elbert 1994). Since then, information supplied by ergonomics or human factor analysis has always been a source of information about people for designers, at least in principle or in goal. In the 1950s, the idea of understanding people and design products to meet their needs was emphasized by Henry Dreyfuss (1955) in his own practice. And at Standard University, John Arnold developed and taught what we now call user centered or design ethnography in the 1950s (Feland 2004). And in the 1960s the field of Environment Behavior Studies was established with the

belief that information about how people interact with the physical environment may inform the practice of environmental or architectural design. Also in the seminal book *Design Methods*, first published in 1970, John Chris Jones (1992) included methods of user study, although he did not name them as such. The belief that knowledge about people informs design underlined user study in the past as it does now. Thus it is more apt to think of the 'new' form of user study as a relative to traditional user study, although it is at a more privileged position than that of the past. Keeping this in mind, we continue to tease out its characteristics.

1.2 Characteristics

User study has always been practiced to a certain degree at a certain level within Product/Communication Design. So what strikes as the most significant difference about contemporary user study is that it is conceptualized within the more commonly known model – User Centered Design (UCD). The term 'User Centered Design' is coined by Donald Norman and Stephen Draper in the 1980s and it has been seriously promoted in the field of Human Computer Interaction (HCI) and widely acknowledged in principle if not in practice. UCD emphasizes that the design of products should give priority to human needs, desires, abilities and constraints rather than to aesthetic[1] or technological values. UCD is also conceived as a multidisciplinary and collaborative effort. While the exact working relation and environment may vary, user study in UCD is characterized by collaboration between social or behavioral scientists and designers. Norman (1998) specifies the make-up of a UCD team in HCI to include field studies people, behavioral designers, model builders and rapid prototypers, user testers, graphical and industrial designers and technical writers. As cited by Gulliksen et al (1999), the International Organization of

[1] Norman's conceptualization of 'aesthetics' is narrower than others such as Gianfranco Zacci (1995) who defines aesthetics as 'integrated all of the requirements that balance the rational, sensory, and emotional expectations of the individual user and of society as a whole'.

Standardization ISO/DIS 13407 - Human Centered Design Process for Interactive Systems defines User Centered Design as such

1 an appropriate allocation of function between user and system

2 active involvement of users

3 iterations of design solutions and

4 multidisciplinary design teams

The significant development, if this can be called a development, is that UCD is perceived and used as conceptual model to guide user study. As a conceptual model, UCD stimulates discourse and organizes practice in a more systematic manner. And as a conceptual model UCD is not only confined to computer product development, it is also well received in the world of product development in general. It is recognized by the business world that consumer, customers, end users – centered design/innovation help maintain the competitive edge of companies[2]. Particularly, UCD is very much perceived and developed with the concerns for innovative product development in and for business. Term such as 'User-Centered Integrated New Product Development' (Cagan & Vogel 2002) attests to this situation. UCD is as much a design model as a business model.

Thus it can even be suggested that user study in design, now practiced under the banner of UCD, is primarily driven as/by business strategy because more than ever, understanding people and design for them are given top priority in the world of business and product development. So in comparison to user study practiced in the past, user study now is perceived as the center rather than as a peripheral to design practice and product development. Although user study is at every turn of the design process, it is now particularly placed at the 'fuzzy front end'. It is placed at the beginning of the design process to determine what to design and Koskinen et al

[2] Practitioners in design management might suggest that they have contributed much to this recognition.

(2003) call this the ‘concept search’ stage. According to the practitioners, user study for design is necessary because ‘market research’ does not provide 'design data' that drives innovation. Beyer & Holtzblatt (1998), the inventors of the design/user study approach 'contextual inquiry' in HCI, succinctly point out that

> "understanding a market is fundamentally different from understanding what to design into a system, and the data traditionally collected for marketing has limited usefulness for product design. Marketing needs to understand what people will buy and how people make buying decisions; designers need to understand what will help people do their work better while fitting into their lives and matching their culture. There is only a limited overlap between these questions" (Beyer & Holtzblatt 1998: p.30).

They argue that although ‘market research’ provides a starting point for design, such as who the end users are, user study to discover qualitative data is necessary in order to develop effective designs for people. In other words, although both ‘market research’ and user study are aimed to understand people, they have different goals and generate different kind of information. It is generally accepted that it is user study that can provide ‘design data’.

Having said all that, it is necessary to point out that the characteristics of contemporary user study in design are not only a reaction to the practice of (innovative) product development; there is at least one more factor. The activities within the academy of design, I believe, have contributed to its development. Since the 1980s, there have been more collective reflection and articulation on the nature and process of design and its outcome. The journals *Design Studies, Design Issues, Design History,* and *Design Management Journal* in some important way contribute to many issues that are related to how user study is practiced in design. While it will be beyond this Introduction to trace the contribution from the academy, it suffices to say that one can easily notice the presence of these reflections and critical discourses in the literature of UCD or product development. The presence is admittedly smaller in comparison to the business or practice driven one.

Another point worth making is that while UCD is aimed at creating products in the widest sense, to suit people needs, wants and desires, and to involve users and stakeholders in the design process; it is different from the Scandinavian tradition of Participatory Design. The Scandinavian Participatory Design can be traced back to the 1960s (Ehn 1989). And it has been concerned with benefiting the social, economic and political situations of end users (Carroll 1996) and these concerns are hardly present in the UCD approach to user study.

Finally, 'user' refers to people for whom a design is intended and the term has been a point for criticism. The term 'user' has been criticized for limiting designers' thinking of people whom should be viewed as individuals with many dimensions and dignity. Historically, the intellectual core of influential designers, from William Morris at the turn of 19th century, to L. Moholy-Nagy at the beginning to 20th century, to Victor Papanek at the end of 20th century was humanistic. The concept of 'design for human' is also central to current design thinking (Buchanan 2001b), (Jones 1991), (Krippendorff 1995), (Nelson and Stolterman 2000), and (Sless 1998). These design thinkers see the critical role designers are subject to take if design is to respect people and act responsibly. 'User' is a limiting and perhaps humiliating term. While recognizing its negative connotations, for communication convenience, the common term 'user' is used here.

1.3 Current practice

Currently within UCD driven design practice, user study is conducted by various groups of professionals. The human factors or ergonomics professionals focus on usability, mainly physical and cognitive usability although some (Segal et al. 1997, Jordan 2000, Burns et al 2000) have begun to emphasize on emotion and 'experience' as well. The social and behavioral scientists focus on people's psychological, social and cultural needs and wants (Koskinen et al. 2003). And the latter type of user study is presently received much attention within the field of

design, driven mainly by the change in the business world where multidisciplinary product development, leverage cultural knowledge and design have become important elements in business strategy (Squires et al. 2002 xiv). This type of user study is often referred to as 'design ethnography', 'new product ethnography' or 'user experience study'. The focus of study is to obtain knowledge about the culture of users to discover needs and desires especially the 'latent' ones.

Due to the emphasis on socio-cultural knowledge, and the collaboration with social scientists, 'design ethnography' is thus characterized by the adoption and adaptation of social scientific research traditions and methods especially those from Anthropology and Sociology. Although there are thematic differences in the approaches and methods for user study, overall they are based on the social scientific research model. Many innovative techniques and tools are modified from the social sciences to carry out user study. The Netherlands Design Institute (1999) has compiled a list of user study methods used in design practice and can be considered an exemplar of state of the arts. Some other approaches and methods have also been developed and used in education and in industry. The design educator Jorge Frascara and colleagues have introduced social scientific methods for communication design practice (Frascara 1997, Strickler 1999). Some design firms have developed their own user study methods, see Buchenau & Suri (2000). And within HCI, there are many more examples, see European Usability Support Centres (2002). Having appeared are new techniques and tools such as 'scenario development' (Cagan & Vogel 2002), 'rapid ethnography' (Norman 1998, Jordan 1996, Squires et al 2002.), 'private camera conversation' (Vries 1996), 'the generative design tools' (Sanders 2000), (Jordan and Chattratichart 2003), to name just a few. Besides collaborating with social scientists, some designers also conduct their own user study and design students are trained in various educational institutions to do so (Hanington 2003).

1.4 Summary

The latest development of user study in design is characterized by being conceptualized within the User Centered Design model. It is fundamentally not different from the traditional user study in terms of basic assumption or practice. However it is perceived and elevated to a very important status in the business world and is given top priority – the center. This partly explains its popularity and the attention it receives in Industrial Design at the moment. In terms of practice, it is put at the 'fuzzy front end' of the design process to determine what to design. It is focused not only on physical usability issues but also on emotional and cultural issues related to the needs and desires of people. It is emphasized that collaboration between social scientists, designers and users is essential to conducting user study. Finally the traditions of social scientific research, especially the qualitative data collection techniques and tools are adopted and adapted for design resulting in many new techniques and tools.

2 UNATTENDED PROBLEMS IN USER STUDY

2.1 Lag behind

Although user study in product design practice is conducted at various scales, communication/graphic designers in general have been slower in integrating it with practice. Studies have shown that many communication designers do not practice user study. The communication designer John Olson (1999) found that more than half of the communication designers in his survey did not base their design on any user information generated by user study. The majority of these designers based their work on personal experiences and intuitive understanding of their users. The communication designer Paul Nini (1996) also found that over 50% of the communication designers in his study did not involve users in the evaluation of prototypes or final products. He suspected that the percentage of designers engaging in some form of user study was actually less, given that there may have been respondent bias – that respondents who practiced user study were more likely to respond to his study than those who did not.

Besides, even though many design firms claim to conduct what they call user study, the type of study conducted, the type of methods used, the role of designers in the investigation process and the relevance of study are not clear. This opacity is due partly to the fact that most, if not all, user study done by design firms is proprietary and not open for investigation and discussion by others. When design firms publish their studies and design activities, they tend to be general and promotional in nature. The design annual, featuring images and aesthetic critique by peers, is the way in which most designers share the outcomes of their practice. In these publications, problem setting, people, and evaluation receive little or no comment. Substantive literature about communication design practice and research is rare. Having said that, there is a small body of publication on user study for communication design. That includes information design: warning labels, forms, maps, plans, graphs, wayfinding information, and graphic symbols (Zwaga et al. 1999) and in social

communication design (Frascara 1997) and work published in the *Information Design Journal, Visible Language, Design Issues* and on the web-site of the Communication Design Research Institute of Australia. This work is systematic, its documentation of research and design processes explicit, and most importantly, it focuses often on the users. However, this type of work and its publication are the exception rather than the norm and the proportion is small comparing to the scale of practice. It is therefore concluded that as a whole, the profession of communication design lags behind other areas of design in practicing user study. Hence, I will refer to the field of Product Design and Human-Computer Interaction for discussion.

2.2 Lack in-depth discussion

The practice of UCD driven user study is well presented at numerous conferences, documented in various literatures and discussed at different internet discussion groups. Experiences in practicing user study are often shared among practitioners, designers and educators (Scrivener 2000, Cagan & Vogel 2002, Press & Cooper 2003). Case histories are often given to demonstrate the desirable results that this new form of user study brings (see Braiterman 1999, Bucheau et al 2000, Bruseberg et al 2001, Squires et al 2002, Koskinen et al 2003). Valuable recommendations coming from practical experiences are often heard, as in Gullinksen's (1999) report on the practice of UCD in HCI. So at the moment, there seems to be plenty of experiences and knowledge about user study accumulated in design practice. The idea of user study is well received and affirmed across professional and educational institutions.

Although the idea and practice of user study is well received in Product Design, there are some unresolved problems. First of all, while the narratives of user study in design practice are presented frequently, there is a lack of in-depth articulation and discussion. Study has shown that user study is well known but not well understood (Rothstein et al 2004). At the crudest level, the practice of user study is often

discussed without the articulation of how and why it works and sometimes with a highly promotional character. At a deeper level, it is presented without critical reflection on the articulation and with many assumptions unacknowledged and unarticulated. Our understanding of the relation between user study and design remains largely on the level of informal observation and relies mostly on testimony and good faith. And certainly, this is a fairly normal and acceptable situation for any 'new' form of practice. Besides, testimony and good faith by themselves are necessary and quite sufficient in the beginning of any development. However, for a longer-term development, critical reflection on this practice to detect certain hidden habits and beliefs is imperative. Especially as educational institutions begin to systematically teach user study in response to the changing practice, critical reflection and articulation on user study in design is a responsibility if not a necessity.

Generally speaking, in-depth discourse on user study in Product Design lags behind that of HCI. In HCI the practice and discourse of User Centered Design is more widespread. Literatures on the practice of user study are more abundant. Case histories of practice are presented with more detailed description and analyses. Certain emerging patterns of good practice are identified and are supported more by arguments than assertions. Having said that, even though these narratives all make intuitive sense, many still lack the level of articulation that can robustly drive intellectual development and support practical implications. However, this situation is beginning to change, and there are emerging some more rigorous discussion, and as a matter of fact, research on user study has already begun.

2.3 Missing a design point of view

Questions surrounding the practice of user study have already been raised in various fields. In HCI, a field that is very close to Communication Design in many respects, there have been studies to evaluate the effectiveness of User Centered Design. Mao et al (1996) concluded that there was a lack of measurement of UCD effectiveness

and any common evaluation criteria across the industry of HCI. Vredenburg & Butler (1996) found that many methods were not effective or practical. And in the field of Educational Technology, user study was also found not meeting up to expectation. Sugar (1998) has conducted an empirical study on students in Educational Technology, and he found that user observation has little effect on the students' design outcomes. The point for calling attention to these studies is not to suggest user study is useless, but rather to mark the fact that user study should not be taken for granted nor on face value. That is to say, much needs to be uncovered about user study to increase our understanding on how to conduct it optimally. Research on user study is necessary.

Besides HCI and Education Technology, there is research on user study in other fields. It includes that of Computer Science (Andre 2000, Jokela 2002, Gullikson 1996); Management (Freeman 2000); Engineering (Lif 1998), and Information Science (van Lill 1999). All these studies are bound within disciplinary discourse and practices. Although they are illuminating they do not necessarily examine user study from the point of view of designing. Most of the articulation or research on user study tends to focus on the value of how certain methods or procedures capture or collect information. But how the information actually assists designing is often assumed without deeper reflection and examination. This assumption of user study benefiting designing is captured in what John F. Sherry (2002) has expressed. When relating how 'design ethnography' contributes to product development, Sherry claimed "Ethnography lays bare the cultural erotics that consumers employ to animate the world of goods, and renders those principles accessible to creatives (designers, advertisers, and other visionaries) whose job is to translate them into artifacts and relationship". This is a believable statement for acting on knowledge is certainly beneficial to design. No one can deny the potential benefits of (any) knowledge. While it is very likely to be true that user study informs making design decisions, but in what way it does is a question that is seldom addressed and remains open.

2.4 'Applicability gap'

The lack of questioning on how user study actually informs design practice appears even more problematic when some designers have found that study on people do not necessarily generate results that are applicable to designing. These observations have been made about information design and ergonomics research (Zwaga et al. 1999), architectural design and environmental behavior studies (Mitchell 1993), building design and scientific knowledge (Bayazit 1993), as well as product design and various user models provided by ergonomists, marketing professionals and behaviorial scientists (Hasdogan 1996). Besides, even for those designers who collaborate closely with social scientists on design projects also experience frustration about user study results do not point to any practical implication that is obvious to them (Wasson 2002). This problem of mismatch between design and user study or research in general is referred to as the 'applicability gap' (Mitchell 1993) or the problem of 'information thrown over the wall'. This problem is known among designers for quite some time.

One common response to the problem of 'applicability gap' is to increase communication or to break down disciplinary boundaries. Another common response is to involve all parties in the whole design or product development process and with different groups leading different phrases. These are sensitive responses and are often accompanied with advice that are based on accumulated experiences. However, except for a few doctoral dissertations, to my knowledge, little has been done to look carefully and systematically into this problem and to articulate it in more depth.

In his doctoral dissertation, Melican (2000) described how product designers made use of user information handed to them by social and behavioral scientists. According to Melican, it was the first empirical study that addressed how designers

use information about people obtained through current user study. Using protocol analysis, Melican studied the cognitive activities of twelve designers. When these designers were solving a particular problem, Melican observed them by comparing how they used 'raw data' versus 'abstract data' and 'conceptual data' versus 'procedural data'. In his study 'raw data' represented the actual statements that users made, and 'abstract data' were the general psychographic profiles and behavioral segmentations that user studies summarized. 'Conceptual data' were descriptions of attitudes, perceptions and behaviors of users and 'procedural data' were visual narratives of the behaviors in question. He concluded that

> "More abstracted user study data have been found to be less likely to provide design teams in this study with material for the development of problem-solving themes; they are also less likely to be sources of organizing structures that teams use to frame the design problem, generate solution concept, and, in many cases, communicate those concepts. Raw data have been found to be most often and most productively applied in the development of user stories, and user stories are often representatives of larger problem-solving themes concerning users' issues and/or responses to them. Clearer distinctions are found in design teams applications of conceptual versus procedural user study data. Evocation of conceptual-oriented data tend to involve definition of design problem through proposal and elaboration of design issues. Procedural-oriented user study data, on the other hand, are most often applied to the validation of general solution directions and more defined solution concepts" (P. 146).

Melican's research is significant in questioning and deepening our understanding about the 'applicability gap' between user study and design. It increases our awareness on the need for a more critical approach to the evaluation of user study and it provides the needed information to supplement informal observation. However, Melican's study stops at explaining why designers have preferences for particular *form* of information. This lack of articulation prevents us from knowing whether this preference is by chance or systemic. We have not sufficient information to draw

conclusions. We are not certain whether this preference can be used as a guide for making important decisions in regards to user study.

These insufficiencies are not only found in Melican's research but also in Hasdongan's research on how designers use different 'user models' in the household product design process. Hasdongan (1996) also found out that designers in her study preferred using a particular user model, namely 'scenario-based models' to other user models such as 'empirical models'. Hasdongan was more balanced in her interpretation of the observation. On the one hand, she admitted that the designers had had little experience of using these other models; on the other hand, she mentioned that these less preferred models are ones that are not addressed to design practitioners. She attempted to explain that it might be due to the fact that designers think holistically, and the 'scenario-based' model has a holistic nature and mentioned the need for a more formalized approach to user study. However, like Melican, she stopped at exploring the deeper meanings of designers' choices. Our understanding on the issue requires further examination.

2.5 Summary

It is generally accepted that user study is important for contemporary professional practice of Industrial Design. However, our belief is mostly supported by informal observation, testimony and good will but lacks formal articulation. The profession of Communication Design in general lags behind other design fields in terms of practicing user study. Rigorous discourse on user study in Product Design lags behind that in Human Computer Interaction. Moreover, other fields have already recognized the need for more in-depth understanding on user study so research on user study has begun. These studies however are missing a perspective from design. The lack of formal articulation and design perspective has left the 'applicability gap' open between user study and design. Although we know that user

study results are not necessarily useful to design, we have not dealt with this issue properly. This study is aimed to address this problem.

3 WAY TO INQUIRY

3.1 Problematic approach to examine user study

If we are to understand user study, then we must first understand the design process. The reason is that if user study is to produce useful and usable information for design, then it should match the needs of designing. Based on the understanding of these needs, we can specify the form of information to be produced by user study to match these needs. The goal/function of user study will to a large extent dictate its own characteristics. (This is not a paradox nor a tautology).

This was the same reasoning that Melican (2000) employed for initiating his research into how designers made use of information generated by user study. And he had chosen to understand the cognitive aspect of designing by observing how designers design. As discussed earlier, he found that the designers in his study had a tendency to use certain forms of data while designing. The designers preferred to use 'raw data' for framing design problems and construct solutions, 'conceptual-oriented data' for defining design problem through proposal and elaboration of design issues and 'procedural-oriented data' for validating solutions. And based on his research results, he suggested that it would be better if designers could directly conduct user study rather than rely on social scientists. But he also recognized that his suggestion would not be practical, so in the end he advised to improve communication between designers and social scientists.

If the goal of observing how designers think/work is to draw implications for the characteristics of user study outcome, then there is a problem in the way the conclusions are arrived in Melican's study. On the one hand, the problem partly lies in a lack of articulation for why the designers in the study have preference for certain form of information. Due to this lack, we are not certain if the preference is by chance or systemic. Therefore, before we can use the results from Melican's research to draw implication for user study, there is a need to give more meanings to this data. In

other words, an explanation for the research results is required. On the other hand, the problem with the conclusion lies partly in the fact that designing is a cultivated ability. How designers use information is acquired through learning and learning is factored by the individual, the natural and the cultural, according to contextual developmental theories. How we think, act, design etc, etc are a result of the interaction among the individual, the natural endowment and the cultural environment. Melican's final analysis slights the cultural experiences that the research subjects have, namely their design education and design practice.

Since how one designs is as much naturally as culturally formed, observations of how designers use information only tell us the results of this culturally mediated ability. The 12 designers came from the same school, so their tendency to use certain form of data may have been a result of their education rather than due to the nature of designing. Thus what has been observed is not necessarily a situation to be accepted or worse taken as ideal and that user study has to be modeled according to this observation. The point here is not only that there may be a bias in the research results, but also more importantly there is a neglect of the historical and cultural dimension of design practice and the attempt to model user study without paying attention to the contingency of what is observed. For example, in Melican's research, we cannot determine if the designers could be trained to use abstract data to design. In sum, Melican assumed and aimed to discover some universal cognitive process that underlies designing, and he did in a way that slights the contextual and the cultural. Underlying this fallacy is the neglect for the fact that how we use information depends on the goal, on our habit, and on how we learn to use information, and all these are human factors that are not universal and can be changed.

And this deficiency is not only found in Melican's study but much research that seeks to improve designing based primarily on the observation of how designers design

without a more rigorous articulation on the nature of design. For example, Bruseberg & McDonagh-Philip (2000) tried to develop a training package and guide of the use of the research method 'focus groups' during the design process/practice for undergraduates and practicing designers. They based the design of the training package solely on interview results of five designers. Or in the case of Lewis & Bonollo (2002) who intended to understand the design skills and professional behaviors valued by practitioners and managers in order to develop educational courses. Both of these studies are valuable in that they provide empirical data about contemporary design practice. But to base the education of future designers entirely on understanding of design practice seems problematic. Whatever is practiced today may not be the case tomorrow. It begs the question whether what design practice is today could be served as the best model for educating future designers.

The point to be made here is not that understanding present design practice is unimportant. Observation of designers or design practice is important. Not only does it increase our understanding of current design practice, but it also is potentially very important material from which the nature of design can be induced. However, in order for the observation and understanding of individual cases of design to go beyond the state of unstructured data, an additional abstraction is required. Or better said, the observations and information need to be interpreted and organized, that is theorizing. Without articulating the general characteristics of design, research on design methods, processes or practices may be poorly guided.

Take an example of the different but related concepts weapon and gun. My dictionary says that a weapon is defined as an object that is used to kill or hurt people in a fight or a war. A gun is a weapon that consists of a long metal tube and a compartment in which bullets are placed. To describe a gun as a long metal tube and a compartment in which bullets are placed is a fair description of what it is. But that description does not say anything essential about the concept of weapon. To say that

a long metal tube and a compartment in which bullets are placed is a weapon is not wrong. But to say that a weapon is a long metal tube and a compartment in which bullets are placed is a conclusion badly drawn.

The conceptual relationship between the nature of design and a certain design practice is similar yet different to that of weapon and gun. However, the point of this illustration is that when a certain design practice is observed (like how a gun is described), we might well be describing the characteristics about this certain design practice rather than the essential characteristics of design. It is useful, for our discussion here, to keep in mind the difference between 'design' and 'design practice'. 'Design' (like weapon) is an abstract overarching universal category. 'Design practice' refers to a form of practice under the category of 'design', (like gun under the category of weapon). In this sense, design though must happen through methods, produce particular designs and take place in specific context (like weapon exists only in real object). Design as a concept refers to a phenomenon independent of particular methods, objects of design, and the context (like the concept of weapon). Design may not be equated with design practice although design is imbedded in design practice. The form design practice takes is always changing although design stays the same. Knowing about design practice is not the same as knowing about design and vice versa. Design is an abstraction standing for the essential and generic features of all design practices, in the past, present and future. Without identifying these features, efforts put into improvement exercise on practice and education is limited and might be poorly directed and therefore be futile.

3.2 Theoretical Inquiry

At present, we have informal and formal observations of designer having preference to certain form of information but we are uncertain about their meanings. We have not sufficiently described nor explained the how and why this is the case. Are these preferences a reflection of the nature of design or is it a reflection of the designers'

cultural experiences, namely their education, their practice, and/or the social circumstances of design? Or is it a reflection of the preferences of individual designers? Or, as I imagine, it is a reflection of a combination of all these factors. In facing this uncertainty, we may choose to inquire into these issues and begin to theorize with the hope that the inquiry will shed light on practice of user study. But before taking this step, let us pause and ask whether we need to give a full account of the phenomenon so observed before we can address the question of interest.

In general, we are interested in knowing the formal characteristics of information designers need for designing with a deeper level of articulation and trustworthiness. If we can point out these characteristics, then we can determine what needs to be produced by user study to match these characteristics. However, this question seems not requiring a full explanation for the observation of how designers work cognitively or socially today. Rather what is required is an understanding on the general nature of design and a projection of the idealized characteristics of user study outcome based on this understanding. There are reasons for this claim.

First of all, user study is an invention and is made to serve some functions in design practice. It is supposed to provide designers needed information and it is supposed to fit with the design process. However, the methods used or procedures taken in design practice are also inventions. Design practice is subject to change. Citing Tim Brown of the renowned design firm IDEO, Jeremy Myerson (2001:p.148) observes that "industrial design has gone through a constant process of reinvention… (by) Loewy and his contemporaries on the East Coast in 1940s, by British and German consultants in 1960s, and by the main Silicon Valley players in the 1980s and 1990s". And Buchanan (1995b) also captures these changes similarly. Buchanan suggests that some designers have shifted their work from the creation of images or physical products to 'strategic planning' where they contribute to the early phrase of product development. He further suggests beyond 'strategic planning' there is/can be

a 'fourth order of design' or 'systemic integration'. Systemic integration is which designers would be acting on 'discovering core ideas, values and thought which organize a culture or a system and propel it forward in a new search for expression in appropriate activities and products, often through a pluralism of individual initiatives that lead to creative debate'. While Brown and Buchanan make observations with the change in subject matters in design practice, John Broadbent (2002), following Jones, traces the changes made in design methods and he calls this an evolutionary pattern. According to Broadbent, the five generations of design methods are ‘craft’, ‘design by drawing’, ‘hard systems methods’, ‘soft systems methods’, and ‘evolutionary systems thinking’. Whether we agree with Brown, Buchanan and Broadbent or not on their descriptions, there is hardly any doubt that design practice will continue to be adjusted to adapt itself to the changing environment in which it is a part. We change design practice. Therefore, if we are interested in developing a particular user study to match a particular way of practicing design in a particular context, then observing designers or design practice and interpreting its meanings are rather sufficient and appropriate. However, the fact that design practice is always changing puts limit on the usefulness of observation and analysis of present design practice. The problem lies in the fact that however design is practiced today may not be the case tomorrow. If the goal is to seek understanding that has a wider relevancy for general principles rather than for specific cases, then to observe, analyze and explain present or a certain design practice is not suitable.

User study is made to fit what we want it to achieve within the constraints we find ourselves. The criteria for user study do not need to be constructed on what design practice is now but what is to be reinvented. The focus of attention needs not be on describing and explaining design practice as now but interpreting and articulating the potential/possibility of user study based on an articulation of the nature of design - an idealized scenario. Knowing the nature of design will allow us to draw implications for the *necessary* criteria for user study. And with these criteria, it will also systematically

direct us to investigate and design user study. Therefore, a more direct way to address the research question is to articulate the characteristics of user study based on our understanding on the nature of designing. In sum, to address the research questions we may not need to fully account for how design is practiced today. An alternative and more direct route is to establish criteria for user study based on an articulation on the nature of design.

3.3 Summary

Research on user study in the field of Industrial Design has been empirical: observing how designers design. However, this type of research lacks theoretical framework, and as a result, we are not certain if the research outcome is by chance or systemic. More importantly, this type of research slights historical and cultural contingency, and it begs the question whether it can serve as principle for future practice and research that for sure will change. User study is an invention to suit design practice. But design practice is also an invention. We do not have to describe and explain design practice as now but to interpret and articulate the potential/possibility of user study based on an articulation of the nature of design – to create an idealized scenario.

4 RESEARCH QUESTIONS

In general, we seek to draw implications from the nature of design for user study. In particular, as mentioned earlier, it is accepted that user study informs design, but in what way it does lacks articulation from a design perspective, so we seek to find out

4.1 How does user study inform design?

In the field of design we believe in the values of user study. We seem to be quite convinced about the different types of information about people, such as socio-cultural. psychological-emotional, physiological-biological etc, that are required for design practice. And we also know much about which type of methods are suitable for collecting which type of information. Opening any contemporary product development and design book will attest to this knowledge (Baxter 1995, Bruce and Cooper 2000, Cagan and Vogel. 2002, Ulrich and Eppinger 2004). However, what is less explicit or less known is the quality of the information generated by user study. In other words, we agree that understanding people is important, and there is no doubt about the value of user study for design. We know which domain of information is relevant to design, so we know about the content of information user study should generate. And we also know which method to use for collecting specific information. However, what we know less about is the form of information user study should produce so that it will be usable for designing. We do not know the general form of the information produced by user study. We seek to find out

4.2 What are the formal characteristics of user study outcome?

The research questions contain the words ‘does’ and ’are’. One might interpret these questions as seeking empirical answers and might expect a description of user study as practiced or how things are at the present, etc. This, however, is not the aim of this study. Rather I seek to define user study based on the nature of design, in other words, I seek rational conclusions from reflections and arguments. In the first part of the investigation, we explore the nature of design. In the second part, we derive meanings from this articulation to address the research questions.

5 CONTRIBUTIONS

This study is aimed to provide theoretical support to the understanding of user study. Given that theory is generally suspect within Design due to the practical nature of our field, here I must make clear my view on the value of theory for design in general before I elaborate on the contribution of this piece of work. When we ask about the value of theory to design practice, we instantly enter a circular state. It is similar to ask how valuable computer technology or anything else is to us, there are of course certain functions that a particular object affords, but in the end its values depend on how we make use of the functions. I see that theory of design is similar to any information in that its value is in the (creative) use of it. The value of this inquiry is to be created through transforming the results to use. This type of practical value cannot be found here. However, this inquiry provides potential values.

If this theoretical investigation is to carry any use for design practice, it does not only describe and explain for the sake of knowledge building, but also it ought to interpret the facts in such a way that it bears consequences for design practice. The implications need to be drawn as creative suggestions for addressing problems that are identified in user study. I am approaching the research questions like I would for any design problem. For this investigation, I will stop at drawing implications for user study and will leave prototyping and testing, production and evaluation for future studies. The results are a set of vocabulary by which the practice and research of user study can be discoursed, (re)examined and (re)organized.

5.1 Practice and research

Within Design, we often say that user study informs design, but in what way it does lacks formal articulation. We also seem to know about what sort of content that user study must produce, but we do not know the form in which it should be presented so that it will be usable to designers. These problems are part of the ‘applicability gap’ between design and user study. Without giving attention to these questions, the

knowledge produced by user study may not be optimally utilized by designers. The efforts and resources put into conducting user study may not bring out the best results. The knowledge advanced in this study is expected to help us determine how to design, conduct and evaluate user study. Knowing how to approach user study systematically is critical as we often hear contradictory recommendations on how to conduct user study. For example there are different opinions on the use of 'focus groups' in design. Norman (1998:p.192) finds that 'focus group' is not useful but Bruseberg et al (2001) recommend it. Or there are different opinions on who should interpret user data, Griffin et al. (1993) suggest that the design team should while some believe that outside experts should. It is likely that different situations call for different actions and the point is not who is right and who is wrong. These examples show that at the moment there is inadequate language and lacks a more systematic way to engage researchers and practitioners in more in-depth discussion and reflection on the practice of user study. The results of the study will bring issues to the public domain for debate and improvement. It will increase the effectiveness of our communication to one another. In short, it will bring the discourse on user study onto a higher level.

Besides being beneficial to practice, the results of the study will also help research on user study. Although we have accumulated experiences in user study through practice, these experiences have not been organized and research on user study is fragmented. At the moment we have little theoretical understanding on the nature of user study for design. And this study will contribute to this and the results of the study can be used as a (temporary) map for guiding research on user study.

5.2 Intellectual autonomy

Finally, user study is examined from a design point of view here – based on the various theorizing of designing, it also contributes to the intellectual autonomy of the field of Industrial Design. If we agree with others such as Donald Norman who

suggests that design is a multidiscipline team effort and each discipline brings its expertise to the table of collaboration; then industrial designers must also contribute our share. When speaking about design education in university, Buchanan (2001c) stresses the importance of the field of design to define its independent status as a discipline and field of inquiry. This task is urgent due to the fact that other disciplines have recognized the significance of design thinking and are interested in claiming it as their intellectual property. However, as Buchanan points out, to develop design as an independent discipline is not to discourage or stifle diverse ways to understand design. 'Rather it is to encourage such explorations, but with a deeper understanding of the core of design thinking that relates many intellectual and practical factors that cannot be reduced to other disciplines'. A disciplinary viewpoint is necessary to develop and advance the practice of design collaboratively.

While some may still see the primary contribution of designers as related to ergonomics and aesthetics (Ulrich & Eppinger 2004), the fact is that the contributions designers actually and potentially bring are still open to debate, investigation, and invention. For example, in the Design Management circle, some argue that designers are actually ‘knowledge brokers’ who synthesize different and at times contradictory information and turn the information into a product (Bertola & Teixeirz 2003). For Bertola & Teixeriz, a designer’s role in product development is more about knowledge management than ergonomics or aesthetics. What is significant about this example is that the role of designers is not fixed and can be changed. And the change to a large extent is dependent on the perception or vision that is projected on design. A view or a vision of design goes a long way to identify the types of contribution designers can bring to an interdisciplinary design team. Even though the field of Industrial Design will always benefit from seeing design from multiple points of view, ideas on design cannot come solely from other disciplines.

It is imperative and beneficial for the field of Industrial Design to seek to have a vision of design that, not as the only privileged one, but that can be called our own. My study happens at a historical moment where unprecedented interest is placed on research within the design community. And also the growing numbers of Ph.D. programs in design around the world has fanned the discussion. Generally speaking, there are only two established ways to conduct research, scientific or humanistic. As Clive Dilnot (1998) suggests, design research should aim to contribute to knowledge in general. Design research should aim to develop and understand designerly way of inquiry and design knowledge. It is important to point out that when I suggest a designerly way of inquiry, I am less concerned with the methods but rather the point of view that sets the path of inquiry, the way we approach. To have a point of view does not mean that we ignore others' views but that we are in a reflected and clearer position to evaluate other points of view. A stated point of view also allows others to see us more clearly and thus assists communication. Our own point of view is important to disciplinary autonomy. Autonomy here does not mean that we do not depend on others, rather it means that we are interdependent. Autonomy is an important attribute if we want to be an equal partner in any form of collaboration. Therefore, to examine user study from a point of view of designing is to add to our intellectual repertoire so to further contribute to a collaborative effort that characterizes the current practice of designing.

Having said all that, this study has small significance to those who are engaged in user study and practice design successfully. Practitioners must have developed their own ways, tacitly if not explicitly, to conduct user study and derive meanings from and make use of user study results. Their experiences are likely to continue to guide their practice, so at its best, this study might express what they have experienced or found to be true. However, this study is likely to be more useful for those who have a need or interest to demonstrate the reasons behind their actions or to communicate and share them either to teach students or explain actions to others, such as the

public, government, academy and industrial institutions. Those who are interested in conducting or creating user study in a more systematic way and those who would like to continue to develop design practice and user study in a more informed way will find theoretical support here. It is also of value for those who are simply interested in being reflective and articulate. In sum, this study contributes to the development of user study for the field of Design.

PART I THE NATURE OF DESIGN

Here we explore the nature of design. We begin by defining 'nature' and pointing out that there are many definitions and multiple discourses on design. To take advantage of the diversity, I propose to integrate these different insights. I also argue that a definition of design should not only be a consistent/valid description of design, but also it should distinguish design from science. With this in mind, we trace the debate on the relation between design and science, and notice that the debate has been long running, difficult and has not yet come to any agreed conclusion. I identify that the difficulty lies in the business of comparison and resolve to overcome it. To distinguish design from science, we need to ascertain that design, like science, is a form of inquiry. After arguing that design is indeed a form of inquiry, we arrive at a conclusion that there is no fundamental difference in process or structure of inquiry between design and science. They are different mainly in objectives and have different orientations. Science is an inquiry oriented toward a generalization that describes. Design is an inquiry oriented toward a specification that fits.

6 MULTIPLE NATURES

Before we begin to examine the nature of design, it is necessary to clarify what is meant by 'nature'. The meanings assigned will be the anchor or frame of reference for our subsequent discussion. According to John Dewey,

> '(t)hat which is included or excluded is of necessity of a *kind or species*. For singular objects, *a* man, *a* rock, *a* particular community, come into being and pass out of being. They are particular (partial), not complete. The species or kind of which the singular is a part is eternal. Humanity is a species, and as a substantial species it does not originate nor pass away with the birth or death of Socrates, Alcibiades, Xenophon, etc. The substantial species is necessarily present in every particular or part, making it to be *what* it is, whether man, horse, oak tree or rock. That which belongs inherently and necessarily to a species is its nature or essence. *Definition* is the form which essence takes *qua* known. Far from being verbal or even a convenient process or product of 'thought,' definition is cognitive grasp of that which defines (marks out) ontological substance. It marks it off from everything else and grasps its eternal self-same character' (Dewey 1991: 91).

If we go by Dewey's definition of definition, then 'nature' is understood to be the eternal, inherent and necessary characteristics that mark something off from everything else. Describing the nature of design is defining design.

6.1 Many definitions

To define design is not so straightforward a task. I have not seriously reflected on design for very long, just a few years; and what I have learned can be summarized as the followings: anyone can define design all he or she wants and desires, and there are many different definitions of design. Here are some examples (arranged by year):

- 'Everyone designs who devises courses of action aimed at changing existing situations into preferred ones' (Simon 1969:p.111).

- '… our new definition of designing as *the initiation of change in man made things*' (Jones 1992:p.6 italics in original).

• “Design is the human power of conceiving, planning and making products that serve human beings in the accomplishment of any individual or collective purpose”. (Buchanan 2001c).
• ‘Design is the ability to imagine, that-which-does-not-yet-exist, to make it concrete or concretized form as a new, purposeful addition to the real world’. (Nelson 2002)

• ‘Design is a noun referring to a specification for making a particular artefact or for undertaking a particular activity. ‘Designing - non routine human internal activity leading to the production of a design. (Love 2002)

• Design is a network of chunks of ideas and activity patterns in the interface region between the contextual and the artefactual”. Jonas (2004:p.222)

The definitions quoted above are by no means representative let alone comprehensive of the many definitions that are proposed. Terrence Love (1998) has compiled a 30,000-word annotated bibliography on the definitions of ‘design’ made between 1962 and 1995 in the field of Engineering Design alone. As it appears, definitions of design are as many and various as those who make them up. Each person views the essence of design differently, or better said, each person talks about design from different points of view and assigns significance to different aspects of design based on the chosen view. (This is the nature of definition?) By quoting these definitions; therefore, I do not mean to pigeon-hole these authors, but rather to illustrate the diversity (in expression) that exists and to point out that there is not a single agreed upon common definition of design.

Having said that there is no agreement on a definition of design, it is not my intention to imply that it is a problem to be rectified. To the contrary, I believe that it is both unavoidable and necessary to have pluralist viewpoints on design. As Jonas (2002) suggests, ‘theoretical approaches in design are rooted in personal preferences, biographies, academic backgrounds etc and are evolving in communicative processes of negotiating positions’. Jona’s view resonates with what is proposed by Vygotsky in his contextualist view of human cognitive development or by Bateson in

his ecological view on human learning. Both Vygotsky and Bateson see that people cannot escape the influence of the environments in which they are a part, and learning and knowing are circumscribed by the interactions between the individuals and their environments. Definitions are results of individuals working from some certain perspective embedded in individual experiences, including knowledge of other design definitions. As long as each person has different living/learning backgrounds and individual minds, diversity in opinion is unavoidable. Besides, for research, definition is supposed to direct inquiry. Given collective research into the nature of design is at a relatively early stage, not having a common definition is expected and perhaps even desired. If 'design' is too narrowly defined, then it might prohibit the potential growth of the field. If too widely defined, then it might account for everything and thus nothing. Consequently, it may also jeopardize the identity of being a designer and being a design field. Not having a common definition is leaving open investigation into the nature of design. Having pluralist viewpoints on the nature of design not only encourages discourse and enriches inquiry; it also prevents us from inadequately perceiving design and from setting research on the wrong course.

6.2 Pluralist Discourses

The diversity in the definitions of design is not only a reflection of individual preferences but also a reflection of the state of research into design. Discourse on design is as various, as diverse and as individual, and this situation has been observed and explicated by Buchanan. Buchanan (2001a) constructs a four-section scheme to explain the various ways of theorizing about designing. According to Buchanan, there are four generative principles on which design theorizing stand and they are 'Experience and environment', 'Agent', 'Underlying forces' and Transcendent Ideas'. The first two are toward phenomenal processes and the last two are toward ontic conditions. He also suggests that these principles seldom appear in pure form of expression in design theories, but rather in 'ratio'. Although Buchanan describes or constructs the principles underlying design theorizing, he

does not give any example of current design discourse, therefore it is necessary to perform the task here.

Before we do that, it is useful to note that there are also different opinions on 'design theory'. What is considered a design theory is a question that will find different answers depending on the perspective taken. One merely needs to quickly scan through the discussions on the PHD-Design discussion listserv to detect this situation. For some, design theory is the principles for designing certain things; for some, it is the philosophy underlying the field of design; for some, it is substantive knowledge that enables designing, and for this inquiry it is theory of the nature of design. And once again, I do not see the diverse views as a problem as long as there is an awareness on the situation of plurality.

Similar to theorizing about design, there are various ways one can take to organize or tell a story of current design discourse. In other words, there are different approaches as how one might conduct meta-discourse. For example, one migh take Buchanan's scheme mentioned above to map design theories, or the 'meta structure' proposed by Terrence Love (2000) to organize design theories according to degree of abstraction. Or one might use the 'evolutionary model' by Findeli & Bousbaci (2005). If one follows the American literary scholar Stanley Fish (1989), one can suggest that there is no meta-discourse as such because there is not a bird-eye view of observation. Like definitions and theories, meta-discourse is various and based on rational as well as personal reasons. My telling of others' telling of stories does not and cannot presume a higher position, but merely a different one.

With these caveats, I will present a picture of current discourse based on my own view that is inevitably circumscribed by my own experiences. To give the meta-discourse some background, it is necessary to briefly mention my educational background in design. The reason for giving this background is to acknowledge the

meta-discourse is but a particular rather than a universal view. I am involved in a community known as Design Research. This design research community can be understood as comprising the Design Research Society and the European Academy of Design. Research and discourse spinning out of these two organizations through their instutionalised journals, publications, conferences, symposiums and through their affiliated members have been my main source of reference. My association with this particular design research community necessarily circumscribes my presentation on the current discourse on the nature of design. My view is therefore a view among many possible views. Nevertheless, it is my belief that the research presented below is a serious attempt to understand the nature of design as I know it.

I name the different paths of inquiry into the nature of designing as such: the Cognitive Problem Solving, the Knowledge Processing, the Communication Interaction, and the Philosophic Intellectual. As the names suggest, the differentiating factor among these different strands of inquires is their particular view on designing. By naming I project my own view on what these articulations are about or the perspectives they represent. And by unfortunate necessity, I exaggerate differences and blur similarities. Therefore, there might be discomfort or disagreement with these names or with my interpretation of these approaches. Nonetheless, I believe that the followings serve to provide an impression on the scene of design discourse at the present, as I see it from my own vantage point.

Cognitive Problem Solving is one that has generated the most research and been around the longest. Based mainly on cognitive sciences for theories building and research methods, efforts are made to describe the cognitive processes of designing – how designers solve problems. Informed primarily by the work of Herbert Simon (1969) and Donald Schön (1983), the goal is to develop a theory of designing that is domain independent and to develop design methods and recently design education based on this understanding. The work is published often in the Journal ‘Design

Studies' and is presented in a series of conferences titled 'Research in Design Thinking'.

Knowledge Processing comes from the business management perspective and draws upon theories of practice and organizational learning. These researchers see designing as processing information or knowledge within product innovation and development. It describes and articulates the significant but often overlooked role design plays in bridging different interests and knowledge among various disciplinary groups in product development and innovation. Research efforts and outputs are less concerted and less voluminous than those of the Cognitive Problem Solving. It is not sure how this line of research will develop or how much it will grow. Nevertheless, research activities are present. (See Reinmoeller 2000, Cooper et al, 2002 and Bertola, P. and J. C. Teixeirz. 2003).

Communication Interaction is based mainly on theories of soft systems, complexity and social evolution. This group views designing as a social system. Due to its systemic view, this group emphasizes the dynamic interaction between environments of designing. It shifts the view of design from creating products to the handling of communication or interaction between products and environments. The latest and strongest expression of this work can be found at the EAD06 conference 'Design system Evolution' (Jonas et al. 2005). It can be said that both 'Knowledge Processing" and "Communication Interaction" take a social or sociological viewpoint to investigate the nature of design.

Philosophic Intellectual sees designing as an intellectual activity or ability and design is considered as practical reasoning, practical philosophy or practical wisdom. Taking the route of philosophical inquiry, researchers highlight the intellectual rather than the technical dimension of designing. See for example Buchanan (1995a), Sless (2002a,b) and (Nelson & Stolterman 2003).

6.3 Summary

To describe the nature of design is to define design. Within the field of Design Research, there are countless definitions of design. Besides, there are a number of perspectives on design that I name as Cognitive Problem Solving, Knowledge Processing, Communication Interaction, and Philosophic Intellectual. The brief sketch is by no means exhaustive; but represents some noticeable patterns. It is intended to give a general impression on design theorizing today in a community known as Design Research. They are the resources from which I sketch out the nature of design.

7 APPROACH TO DEFINE DESIGN

7.1 Integrative approach

When there are different views and pathways to understand design, then how might the nature of design be described? I can think of two ways. One way is to ignore the reality of diverse views and choose a model that one finds the most arresting to describe the nature of design. This choice is most often taken in design research. The advantage of choosing a particular approach to follow is the depth one gains in a particular perspective or line of thinking. The disadvantage is that research becomes easily fragmented and disconnected. Besides, it does not take advantage of the insights advanced by other discourses. Another alternative is to juxtapose various research streams and to bring the different perspectives into a meaningful relation. It is an integrative or synthetic approach. The advantage of this approach is to see design from multiple perspectives and to form a more holistic understanding of design. The disadvantage though is that it will require a much longer time frame for investigation if the level of analysis is to be comparable to the first approach. To compensate for the time factor, one must then sacrifice depth for breadth. I decide to take the integrative approach for this investigation. The choice is in part motivated by Bateson's discussion on 'binocular vision'. Bateson (1980) suggested that two descriptions are more than the sum of the parts. It is a kind of 'multiplication'. The insight gained from integrating diverse views will generate a different 'logical type' of understanding. Another advantage for taking the integrative approach is that it is an approach that is seldom taken, research based on this approach is needed for a matter of balance.

7.2 Criteria

I have decided to integrate various research efforts to depict the nature of design – to draw out its essential characteristics. What kind of outcome should be expected from such a construction? In other words, which criteria should be used to judge the quality of this construction? There are quite a number of established criteria by which

a given theory/model can be evaluated, but generally the criteria fall into two broad categories. Some criteria evaluate theory as a research product and other criteria judge theory as a research tool. As a research product, a theory is a type of knowledge. Generally, a scientific theory is to describe the (causal) relationships between mechanisms/elements to unify phenomena. The common evaluation criteria are internal validity, external validity, reliability, fasifiability, explanatory power, parsimony, and elegance. As a research tool, a theory is like a map or a guide. A theory directs observation and experimentation, and organizes facts. The common evaluation criteria are how well it directs research and opens up new line of research and informs practice.

The decision on which evaluation criteria to use although is based on reason and tradition, it is also related to value and preference. For instance, Friedman (2002) drawing on Whetten, suggests to use the following criteria to build design theory: comprehensiveness, parismony, explanatory power, and substantiation of empirical data. This is a reasonable suggestion but it mainly evaluates theory as a research product. Not only that, it is different from the criteria used, for example, by Savery (1989: p.481) when he discusses the significance of John Dewey's philosophy. Savery suggests four criteria, namely 'originality', 'consistency', 'comprehensiveness' and 'fruitfulness'. Savery further elaborates,

> "Of these tests, the first and the fourth are fundamental. If a philosophy is not consistent as a whole the parts may be important and the philosophy may be somewhat transformed by successors so that consistency is secured, and a doctrine of narrow range may still have great value; but without originality a philosophy is only a transmitter of more ancient wisdom, and without influence its value is entirely self-contained. In a word, an important philosophy is novel in itself and in its effects'.

The point of contrasting Friedman's criteria with Savery's is not to show that there are differences in evaluating scientific theory and philosophic theory. But rather it is

to show that criteria are debatable. While there are common and well established criteria, they are not universally or equally valued among different people.

Furthermore, different types of 'theory' call for different evaluation criteria as well. When establishing a framework for the design process by using scenario as a guiding idea, Jonas (2001) claims that the framework (scenario) is a design:

> 'So the criteria for the appropriateness of the construction have no correlation to some reality 'out there', but comprehensiveness, coherence of the different chunks of knowledge, and beauty of the design, as well as adaptability and flexibility'.

Jonas' criteria are fundamentally functional evaluation criteria and stand differently from those to evaluate scientific theory, as mentioned above. However what needs to be focused here is not the specific criteria he uses, but the fundamental assumption that leads to them. For Jonas, the framework is not to do with 'truth'. In other words, the framework is not aimed to describe or explain some certain reality; but rather to assist practice and disciplinary development. The framework is, if you like, a normative theory or if you do not like, it is not a (proper) theory at all. At any rate, the criteria to evaluate this type of model are expectedly different from those used to evaluate descriptive or explanatory theory.

Given that which criteria to use is a matter of judgement related to personal preference and the task at hand, I choose two main criteria for our investigation and provide some justifications for my decision. First of all, I suggest that a description of the nature of design should be consistent. Consistency is commonly understood as internal validity and external validity. This inquiry should aim to describe the nature of design based on common and scientific observations and logical arguments. This criterion ensures some level of rigor and increases our confidence in its validity. Secondly, as the different definitions of design show, there are probably different consistent ways to describe design. If this inquiry will be a contribution to our

collective understanding on the nature of design, it needs to be more than another perspective. Therefore, as a second criterion, I propose that the definition of design must assist our current inquiry by distinguishing design from science. One may raise an eyebrow here and frown on the utilitarian characteristic of this second criterion. I will try to address this concern.

As mentioned earlier, a theory is customarily judged either as a research product – knowledge, or a research tool – a map. As a research tool, a theory has utilitarian value although not everyone pays equal attention to this fact. A theory directs the way we perceive and observe, in this case, design. It allows observations and ideas to be organized in a meaningful and systemic way. A theory serves to enable thinking and acting productively and intentionally. Thus, though a theory is descriptive in character, it is also in a sense projective. If we accept that both description and projection are legitimate functions and values of a theory, then we can suggest that a definition of design is not only a description of design as it is. It is also a projection of design *as* what we want it to be to serve our purpose. In a similar line of thinking, Sidney Newton (2004) explains the values of describing 'design as disclosure'. In his words,

> ‘What is interesting is then what such a metaphor reveals, what considerations it reveals, what connections it sustains, and how these service our understanding of the design problem. The conception of designing as disclosure presented here is but one episode in the conversation on how we conceive of design: how we design 'design'. As with any design project, its utility should be evaluated against the quality and direction that the conversation then takes’.

Therefore, I suggest that a definition is not only to describe design for its own sake, but also it is made intentionally in a particular way so to serve our purpose. And in this inquiry it is to enable the drawing of implications for user study in design. I will readily admit that the second criterion is a reflection of my preference. But I will also stress that lying behind my preference is a fundamental design attitude: to construct

so to fit a context. Towards meeting the second criterion, I suggest that the definition should focus on marking design off from science. This is not the necessary or the only choice to depict design; however, in the spirits of Herbert Simon, it is a satisfising one.

7.3 Mark design from science

As stated earlier, to describe the nature of design is to describe the eternal, inherent and necessary characteristics that mark something off from everything else. It not only describes characteristics of design but characteristics that separate design from others. To understand what design is, it is necessary to know what design is not. We must choose something to mark design off from. And I have chosen to mark design off from science for multiple reasons.

First of all, marking design off from science is relevant to our research questions. The current practice of user study in design is modeled from the social and behavioral sciences. However, as discussed in the Introduction, 'applicability gap' is known to exist between scientific knowledge and design. We have not sufficiently articulated and understood the basis of the adaptation and adoption of scientific model for user study. Identifying the similarities and differences between design and science will shed light on this problem. We will be able to determine which part of the scientific research tradition needs to be retained, strengthened and which part needs to be discarded and replaced.

Secondly and equally important, marking design from science will build on previous works and takes them a step forward. The research question is partly based on the understanding of design that has been advanced by comparing and contrasting design with science. According to Cross (1993), the launch of the field of design methodology can be considered to begin with the 'Conference of Design Methods' held in London in September 1962. It was believed that the traditional 'intuitive'

design methods were no longer adequate to deal with complex problems emerging at the time. The goal was to develop new design methods by applying 'scientific' methods to deal with novel and pressing problem. Even though the efforts to apply scientific model are believed to fail, the attempt has left a trail of debates on design and science. And it is through these debates that our understanding of design and design practice progressed (slowly). This inquiry will continue with this tradition and attempt to add to it in a productive manner.

Thirdly, distinguishing design from science will suit our current interest. The debate between design and science, as foreseen by Cross, has come back full cycle. Cross (2001), cited by Broadbent (2002), suggests that there is a 40-year cycle of interest in this relationship, beginning with the Modernists in the 1920s and appearing in the 'design method movements' in the 1960s, and now. One can merely look at publications in international design conferences or journals in the past five years to detect this return. This reoccurrence is, I believe, partly due to our continuous exploration into the nature of design, but It is also partly a result of the current discourse. For example, at the 'Designing Design Research' conferences (Robertson 2004), there is a struggle over which tradition of inquiry to follow, the scientific tradition or the design tradition. Science still dominates as a privileged way of inquiry and its tradition of research practice and discourse overshadows knowingly or unknowingly how we perceive design and design research. John Feland (2003) gives a personal account of the struggle of engineering design to gain status in the academy and how design discourse is measured and restrained by the scientists who hold the power. As far as I can see, discourse on design research in general is very much circumscribed by the scientific norms and traditions also. The discussion on how to categorize research is a prime example. The notion of design by/through research has received very strong resistance from people who hold onto the more traditional model of basic-applied-clinical research established in the sciences. This

debate will go on and struggles will continue, in the mean time, the current inquiry will contribute to this discussion.

7.4 Summary

To take advantage of the diverse perspectives on design, I propose to integrate them to define design. The definition is not only a consistent/valid description of design, but also it is constructed to help our present inquiry. Toward meeting the second criterion, I suggest that the description should focus on marking design from science because it suits the research questions, builds on previous debates and contributes to current discussions.

8 COMPARE DESIGN WITH SCIENCE

As mentioned earlier, the debate on the differences between design and science has a history within Design Research. The discussion has appeared in various forms in conference proceedings and journals over the years and continues till today. However as far as I know, the last concerted discussion was at the conference 'Design Methodology and Relationships with Science' held in Delft in 1993, organized by the National Science Foundation.

8.1 Difficult debates

Cross (1993) summarizes the discussion on design and science between 1960s and 1993 as this: 'From the earliest days, design methodologists have sought to make distinctions between design and science…[however it is later on criticized that the distinctions were based] on outmoded concepts of scientific method and epistemology'. By the 1980s, it was generally felt that, 'perhaps it was time to move on from making simplistic comparisons and distinctions between science and design, and that perhaps there was not so much for design to learn from science after all, and that perhaps science rather had something to learn from design'. And the general view is that 'the simple dichotomies expressed in the 1960s are being replaced by a more complex recognition of the web of interdependences between knowledge, action and reflection'.

While Cross outlines how the understanding on the relation between science and design has changed, Buchanan (1993) explicates the fundamental assumptions which underline different views on science and design. According to Buchanan, there have been four views on the relation, namely 'design is reduced to science', 'design is different in kind from science', 'science is reduced to design' and 'design and science are inseparable union of theory and practice'.

View 1 Design is reduced to science.
• 'First, design may be regarded as **an intuitive, instinctive activity for meeting human needs** that stands, itself, in need of the application of scientific laws and scientific knowledge to improve its efficiency and effectiveness. The goal is to discover a science of design, recognizing that some part of design may forever remain beyond scientific analysis because of aesthetic factors and the irrational, ever-changing tastes and preferences of human beings'

View 2 Design is different in kind from science.
• 'Second, design may be regarded as an **intellectual discipline of forethought and planning** that is different from science but draws on knowledge gained by the sciences to achieve ends of utility, pleasure, and justice in the everyday world. The goal is not to reduce design to science, as in the first case, but to discover a discipline of design thinking that may use scientific knowledge for practical purposes while also resolving the artistic and moral dimensions of a specific practical problem'

View 3 Science is reduced to Design
• 'Third, design may be regarded as **the art of operations and performance, the art of the practical and the possible, the art of making things work** to achieve any purpose, serve any interest, satisfy and desire. Within such an art, knowledge is power and power comes from a clearer understanding of operations and from a clearer understanding of what is to be operated upon. The effort is to make design scientific is, from this perspective, an effort to extend the sense in which science is an art of controlled operations; the description of design methods in this context is scientific operationalism. In other words, design is best understood in its most general form as the description or characterization of processes and operations of thought and decision-making such as one finds in the traditional sciences. The extension of scientific description to what are popularly known as the design professions is not a reduction of design to science; it is, in reality a validation of science as design, a recovery of a domain of design thinking that has heretofore eluded proper operational understanding. In a sense, design reasoning is the only valid form of reasoning, and the task is to clarify the operation of design reasoning for those professional designers who work at the boundary zones of special applications. Graphic design, industrial design, engineering design, architectural design and urban planning merely represent some of the special limitations in the scope of real problems that may be addressed by science'

View 4 Design and science are inseparable union of theory and practice
• Fourth, design may be regarded as the **dialectical interplay of science and art in action**. Design is the meeting ground of science, politics, and art.

> It is a place where doctrines clash, where alternative hypotheses about human nature and 'the good' compete in shaping the made-world and the understood-world. All knowledge is relevant to the designer and, in turn, the scientist must be cognizant of the possible uses of scientific knowledge in the practical world. In short, design is a technology – a science of art – that maybe used wisely or foolishly in the evolution and development of culture through a series of approximations towards an ideal state or condition. To bring science to design is to force the recognition of diverse values and beliefs in the scientific enterprise; to bring design to science is to force a recognition that knowledge is required from effective design thinking.

What we can learn from the past debates is that the relation between science and design is understood to be very complex and thus it has not been easy to distinguish design from science. Despite or perhaps due to a history of debates, there are diverse opinions on the differences and similarities between the two. As I observe, Cross' and Buchanan's descriptions of the matter still hold true today, we have not reached a common agreement on the matter. Given that comparing science and design has been so difficult and has troubled the design community for such a long period of time, what should we do at this point of our inquiry? We can either turn back, abandon the attempt to mark design off from science, or we can brace ourselves and punch deeper into the endless debates. Neither of the alternatives seems very promising. But fortunately there is a third option that I can think of. We can stand back and reflect on what makes the comparison so difficult; with that, we can at least avoid committing the same mistakes and find a way out of this difficult situation.

Upon reflecting on the debates between design and science, I reckon some of the difficulties lie less in the actual relation between design and science, but more in how we do comparison. I will use two cases to illustrate my point. We will first look at the line of research that I name Cognitive Problem Solving (CPS). CPS focuses on developing a theory of 'design cognition' that marks design from other activities, such as scientific research. Then we will look at Glanville's claim that science is a subset

of design. I will demonstrate where they fail in comparing design and science to lead to clear results. Learning from the experiences, we will not take the same path.

8.2 Failure to distinguish design from science

The Cognitive Problem Solving (CPS) has generated the most research and been around the longest. Research from CPS is well represented and published in the journal Design Studies and the proceedings of a series of workshop titled 'Research in Design Thinking'. Borrowing primarily from Cognitive Science for theory making and research methods, efforts are made to describe the cognitive processes of designing. In the words of Eastman et al. (2001) the central question is to find out how to 'develop experimental or experiential constructs and organize data collection methods that will reveal how designers solve design problems.' The goal of research is to develop a theory of design that is domain independent. It seeks to describe and explain designing across all various design fields such as engineering, architecture, industrial design, and software design etc. The practical aim is to develop design methods, tools and recently design education based on this research.

According to Dorst (1995), there are two main paradigms underlining the CPS research programs, represented by the works of Herbert Simon and Donald Schön. Simon favored the view of design as a 'rational problem solving process' while Schön saw design as a 'reflective conversation with the situation'. In a sense, most of CPS research is focused on the 'executive skills' rather than on the 'practical knowledge' of designer as expressed by Archer (1979). Bruce Archer was one of the first to name design the third discipline and suggested that there is a 'designerly' way of knowing. Archer suggested that a discipline has its own knowledge and specific skills. According to him, design is distinct from the sciences and the humanities for its 'practical knowledge' and 'executive skills':

> 'Where Science is the collected body of theoretical knowledge based upon observation, measurement, hypothesis and test, and the Humanities is the

> collected body of interpretive knowledge based upon contemplation, criticism, evaluation and discourse, the third area is the collected body of practical knowledge based upon sensibility, invention, validation and implementation'
>
> 'The repository of knowledge in Science is not only the literature of science but also the analytical skills and the intellectual integrity of which the scientist is the guardian. The repository of knowledge in the Humanities is not simply the literature of the humanities but also the discursive skills and the spiritual values of which the scholar is the guardian. In Design, the repository of knowledge is not only the material culture and the contents of the museums but also the executive skills of the doer and the maker'.

I believe that Archer's characterization of 'designerly way of knowing' is a fair observation and proposal. However, CPS so far has not yet articulated sufficiently and convincingly what this proposal might engender. Despite having generated relatively a large amount of research output over the years, the CPS line of research has yet to distinguish satisfactorily designing from other problem solving activity, such as scientific research. Others have pointed out the deficiencies of CPS research.

Most of these studies used protocol analysis (PA) as a research method and Pereira (2000) points out its limitations. He suggests that "PA is impractical for covering the complete design process, it oversights the presence of cognitive processes not dependent on language and inference, and it has not been able to apply its findings in design practice". Besides the limitations of using PA as a research method to inquire about designing, there are more conceptual problems with this line of research.

Zimring & Craig (2001) argue that the most often used concepts to describe designing have failed to distinguish designing from other types of problem solving activity and at the same time describe the common characteristics across the various

design fields. These concepts are ‘abductive reasoning’ ‘ill-defined problem solving skill’, ‘wicked problem solving skill’ and ‘design as construction’.

• Design as abductive reasoning. Abduction is a concept invented by the American philosopher Charles Pierce to explain the logic underlining hypothesis generation in science. Pierce highlighted that the deductive and inductive reasoning would not produce any new idea/knowledge and 'abduction’ is the only type of reasoning that results in new ideas (Davis 1972). Abductive reasoning was introduced by March (1976) to design discourse.

• Design as ill-defined problem solving. Referring to Reitman (1965) and Newell & Simon (1972), Zimring & Craig suggest that the concept of ‘ill-defined problem’ means problem that are open to redefinition either in ‘start state’, ‘operation’ or ‘goal’.

• Design as wicked problem solving. As pointed out by Buchanan (1995b), the term ‘wicked problem’ was coined by the philosopher Karl Popper and was used by Rittel and Weber (1973) in design discourse. Rittel and Weber saw that wicked problem is not only ill-defined but is also embedded in social relation. Values play a strong role in deciding the direction of defining a problem and producing a solution. Which means a solution is not necessarily and universally good for all stakeholders. And a solution to a wicked problem likely causes other problems.

• Design as construction. Referring to the work of Donald Schon (1983, 1988) who suggested that designers construct a problem/solution on the fly when ‘stuck’ in a given design situation. This construction is what Schön called a new ‘frame’ and the process ‘frame experiment’.

Zimring and Craig argue that these concepts are characteristics of designing but they are also characteristics of other problem solving activities. By these concepts,

designing might not be distinguished from other types of problem solving. Therefore, they suggest to treat designing as a type of problem solving, and to put design research centrally in cognitive scientific research and to focus on types of reasoning such as ‘analogy, coherence seeking, mental simulations, dynamic modeling, argumentation, decision making etc’.

I agree with Zimring and Craig that these concepts generated by the CPS research do not mark design off from science or other problem solving activities. However, I differ from Zimring and Craig to say that the distinctions between design and science may not be made on the level of cognitive processes at all. There are reasons for this claim. First of all, there is a problem in the unit of analysis in this line of research. In most studies designers, engineers, architects, scientists or artists and or students of these different fields are observed and their cognitive processes compared. But designers, engineers, architects, scientists and artists are social addresses not cognitive addresses. There is little reason to believe that cognitive functioning or processes are different among these different social groups. By the same token, design and science are social practices, there is little reason to believe that practicing design and science are different cognitively on a fundamental level. Even if differences are found, these differences are likely to be a result of socio-cultural or individual influences rather than natural factor inherent in the cognitive act of doing design or doing science. Thus the variations tend to be different in degree rather than in kind. And by these differences, it seems difficult if not impossible to differentiate design from science on a fundamental level. The thrust of the point made here however is not that there is a problem in the unit of analysis, it is just a symptom not the cause of failure to differentiate design from science. The problem lies, I believe and will demonstrate, in the business of comparison, and we must turn to examine it in some details.

8.3 The game of comparison

In order to understand the difficulty of comparison, I suggest that we begin by comparing something familiar and known to us[1]. Let us take the example of comparing rice with potatoes. So what is the difference between rice and potatoes? To this question, many different responses are possible, such as rice is white but potatoes are yellow, rice grows in high temperature but potatoes in cool temperature, rice is popular in China but potatoes in Germany. And we can go on and on about the differences. It is an undirected way of asking question and producing a lot of various (right) answers. Comparison can be quite arbitrarily and endlessly conducted. To give some direction for comparison, we need some structure. We may suggest that both rice and potatoes are food. Within this frame, we might say that rice is grain and potatoes are vegetable.

There are some important lessons to be learned from this example of comparing rice with potatoes. First of all, every time when we compare, we also classify. We determine implicitly or explicitly that there is a specific unit for comparison. When someone answers that rice is white and potatoes are yellow, this person is also saying that rice and potatoes are the same in some way: both have colors. Color in this case is the unit for comparison although it is not explicitly stated. Consequently and secondly, the implicitly or explicitly stated unit of comparison directs or even determines the results. Thirdly, although unit of comparison can be many things, they are not equal in terms of their relation to the compared objects. There is a subtle but significant difference in comparing rice and potatoes in terms of color and in terms of food. We can help ourselves by looking figures 2, 3 and 4.

Figure 2 Compare rice with potatoes under food

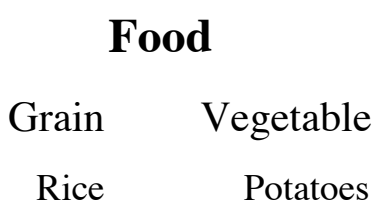


Figure 3 Compare rice with potatoes under color

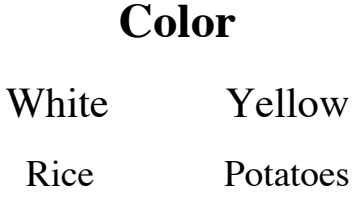
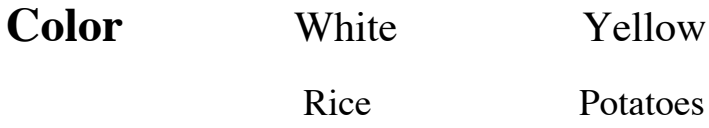


Figure 4 Compare rice with potatoes by color



[1] This is a method that Aristotle recommended when approach inquiry. We should always begin with something simple and obvious so that we won't be distracted by difficulties in accepting it as such (McInerny 2002).

Figure 2 shows a logical hierarchical classification structure as rice is a type of grain and potato is a type of vegetable and both grain and vegetable are types of food, and rice and potato are types of food. However figure 3 shows an illogical classification structure because although white is a color and yellow is a color, and rice is white and potato is yellow, rice and potato are not colors. To depict the relationship among rice, potatoes, color, white and yellow more accurately, the diagram has to look like the one in figure 4. Figure 4 shows a more reasonable structure. It can be said that color is outside of the relationship between rice and potatoes. On the contrary, food is inside the relationship of rice and potatoes, as illustrated in figure 2. Food, not color, is the class to which rice and potatoes belong.

The critical point to be made here is that although we can compare rice and potatoes using different qualities as units of comparison, not all quality-classification-unit are equal in regard to structuring formal relationships. To structure formal relationships, we need to follow what Aquinas called 'order of determination'. Aquinas, following Aristotle, suggested in inquiry into nature of things, we must determine 'what considerations must come first and are presupposed to those that come later' (McInerny 2002). To determine the relationship between rice and potatoes, we must determine their general nature before we go onto compare their more specific aspects. And in this case, the general nature of rice and potato is food not color, thus food as a unit of comparison is more 'order' than color. What we have learned from comparing rice with potatoes can help us understand the problem in CPS. And let us return to tease out why CPS fails to distinguish design from science.

8.4 The case of CPS

Why does CPS fail to draw a distinguishing mark between design and science? Basically, the problem is the unit of comparison or messing with the order of determination. In CPS design and science are compared in terms of cognitive

process. And this is like comparing rice and potatoes in terms of color. Cognitive process is definitely involved in doing design and science in the same sense that rice and potatoes have colors. However, design and science are not cognitive process in the same sense that rice and potatoes are not color. Cognitive process is 'outside' the relationship between design and science in the same sense that color is 'outside' of the relation between rice and potatoes. The assumption underlies CPS is that designing is seen as a cognitive process. Design process can certainly be seen as cognition, but design process is not cognition although designing involves or requires cognitive functioning. This is a difference between 'is' and 'has'. Cognitive process is an 'accident' to designing as color is an 'accident' to rice. In other words, cognitive process, like color, is only an attribute. Cognitive process is not an overarching category that can structure the relation between design and science logically. Cognitive process is quite an arbitrary unit for comparison.

8.5 The case of Glanville

Difficulty in distinguishing design from science is not only found in CPS, but also in the claim that science is a subset of design made by Glanville (1999). Glanville insists that his investigation into design is the process not the product of design. He sees the product of design as incidental, and he does not think it necessary to have a product or a goal in mind when thinking and talking about design. For Glanville, design is a particular type of thinking. '"Design is the more general, and that what scientists do necessarily involves design. Glanville argues that facts are produced not found, and research is designed. He concludes that scientific research is a restrictive type of design, a 'subset of design'.

Glanville's view of scientific research as a 'subset of design' is a departure from the attempts to seek the equivalence of science in design. It actually turns the view on its head and allows a different perspective to emerge. What is significant in his view is that design as a concept goes beyond its more traditional meanings. Under this

particular view of Glanville, the comparison and contrast between science and design take on a different dimension. Design is no longer meant just a profession or a field such as architecture, engineering, product design etc. Design is viewed as a general phenomenon inherent to human making of the world. Or as what Buchanan (1993) calls it - the 'art of operations and performance'.

However, as Glanville (2004) himself admits that some aspects of science are not included in design. And this contradiction seems to undermine the conclusion that science is a 'subset of design'. Besides, Glanville does not mark the distinctions between design and science and that leaves his conclusion open for doubts. Why is Glanville's account of design and science contradictory and fails to mark design from science?

The problem is also to do with category or unit of comparison. Glanville talks about 'design' and 'science' on two different levels or in two categories but mixes them when he draws conclusion on their relation. Glanville uses the words 'design' and 'science' to refer to two forms of social practices and two types of thinking, namely 'circularity' and 'linear', see figures 5. (The figures helps me, I hope it helps you too).

Figure 5 Compare design with science under social practice and thinking type

Social Practice		**Thinking Type**	
Design	Science	Design	Science

However, when he suggests that facts are constructed in science and concludes that science is a subset of design, he is mixing the two references. In his conclusion, 'science' is referred to a social practice when 'design' is referred to a thinking type. So when he concludes that science is a subset of design, he is not saying that the

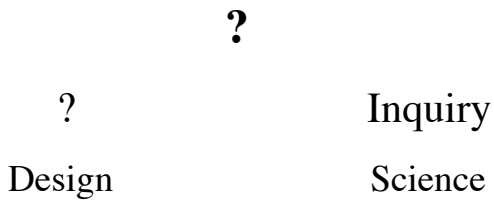
social practice of science is a subset of social practice called design, nor is he saying that the thinking type science (linear) is a subset of thinking type design (circularity). What he is actually saying is that (the social practice) science is a subset of (the thinking type) design. But here he is still not quite right because 'social practice' and 'thinking type' are different categories. A social practice is not a subset of a thinking type, just as rice and potato are not a subset of color.

Based on the premises that design and science are two forms of social practices and two types of thinking, Glanville might have concluded that the social practice of science to construct facts requires a type of thinking called design or circularity. This is the same to say that cognitive processes are required in doing science and design. In other words, (the thinking type) design is a necessity but not a generality to (the social practice) science.

What we can gather from this discussion is that comparing design and science is the same kind of problem as comparing rice and potatoes. However, it is even more difficult because the relation between design and science is not established. Ironically if we want to mark design off science, we must begin not with what is the difference, but what is the same. And what is the same has to be a more general order that encompasses design and science. It is known or agreed that science is a form of inquiry or a way of knowing. So the logical question that follows is whether design is also a form of inquiry. If the answer is yes, then we can go on to compare them under this general category. If the answer is no, then we will have to establish another category that overarches them, (see figure 6). As a matter of fact, this question is the same that CPS research tries to tackle. However, the logical misstep they take is to equate 'way of knowing' with 'cognitive process'. So instead of exploring the attributes that characterize 'way of knowing', and use them to compare design and science; CPS quite single-mindedly fixates on cognitive process and

confuses the issue. In order not to make the same mistake, we must therefore affirm that design is a form of inquiry.

Figure 6 Is design a form of inquiry?



8.6 Summary

The effort to mark design from science has a history. The debates have been difficult and cognitive and other research on designing so far has not been able to distinguish design from science. I have identified that the difficulty lies in the practice of comparison. Comparison can be arbitrary, confusing, and at times misguided. In order to overcome these problems, we must identify a unit of comparison. But this unit is not some secondary attribute that design and science have, but rather it is the class or category to which both of them belong. Since science is known as a form of inquiry, it is necessary to confirm whether design is also a form of inquiry before comparison is done.

9 A SKETCH OF DESIGN

Even though there are different ways to investigate and articulate the nature of design, as I see it, there is little conflict among these different articulations. The articulations are made up of different languages and project different thoughts, some narrower and some wider, some deeper and some shallower; they are or can be complementary rather than contradictory. Besides, there are also some shared beliefs and non-controversial characteristics that seem to convince people in Design Research. Here I will attempt to interweave them to form a picture of design.

9.1 What of design?

Following the much cited Herbert Simon, we perceive that the subject matter of design is the artificial world. It is a world that is human made, as opposed to the natural world that is given. The world of design, seeing from this view, is therefore huge. It is much more than cars, mobile phones and material products in general. It includes immaterial products such as languages and laws. It also suggests that design has existed through human history since the moment the stone axe was made and the first word uttered. It also implies that not only professional designers are involved in designing. Design as a professional practice or even as a field as we know it today is but only a (small) manifestation of a cultural phenomenon that has existed and evolved through time.

Although the view of design as a general cultural phenomenon is accepted within the field of Design Research, this view exists in ironic tension for it challenges the very identity of the design profession and design as a specialized field of study. On the one hand, it is within academic and professional design discourse that the perspective of design as a general human activity develops. It is through the reflection on and research into the (professional) practice of design, that we continue to explore design as a general phenomenon. On the other hand, the more design is understood as a general phenomenon, the stranger it is to see design as a

specialized profession or even a discipline. Tony Fry (2004) argues against Design Studies as a discipline and has made it his mission to bring other disciplines into the discourse on design. It seems that, at certain moments, seeing design as a general phenomenon should inevitably and eventually leads to the destruction of design as a particular profession or a particular discipline. As a matter of fact, John Chris Jones proposes the disappearance of the design profession and Russell (2005) suggests that design should be celebrated as creative living.

The prospect of these perspectives renders all the efforts, including this current investigation, to identify the nature of design and to draw implications for professional design practice, matters of triviality. Should we therefore abandon the project and go sun bathing? This is certainly an option but I tend to lean toward Sless' proposal. Sless (2002b) talks about design being an intellectual project of our time and urges designers and design educators to mount a 'revolution' on a scale comparable to that of Copernica. It is to place design thinking in the center of human affairs and it is a major paradigm shift on no small scale. The revolution is yet to come. At the moment, the tension in the field of design feels more like growing pains, as a teenager attempts to understand and develop her own changing identity and to accept the challenge of a potential responsibility. The field and the profession of design have a responsibility and an opportunity to play a role in offering exemplars and arguments for revolutionizing the intellectual landscape and way of life. Understanding the nature of design and offering insight to advance the design field should in turn contribute to the bigger project. It is with this hope that I continue with our investigation following works established in the field of Design Research.

9.2 What is design?

After accepting that the subject matter of design is essentially the artificial world, then follows is the question - what is design? Asking this question does not mean I expect a universal answer but one that satisfies our purpose here. Sless offers a

straightforward and simple suggestion. 'Designing is our most developed form of practical adaptation to our environment. It is the means by which we, as biological entities, change to meet the demands of our environment, and make changes to environment to adapt it to our needs' (Sless 2002b). People design to effect a change of existing situation by the making/introducing a product (in the widest sense). The existing situation - natural, artificial or social - is causing problems or as Nelson and Stolterman (2003) point out, people just have a desire to change it. As the much cited phrase says: 'Everyone designs who devises courses of action aimed at changing existing situations into preferred ones' (Simon 1991:p.111). Design implies human agents, their intentions and goals and their dealing with the environment by design to achieve their goals. As Buchanan suggests (2001c) '(D)esign is the human power of conceiving, planning and making products that serve human beings in the accomplishment of any individual or collective purpose'. This suggestion implicitly places design between us and the environment and it is related to but different from how Jonas sees design. Jonas views the design field as a discipline of 'interface'. Jonas connects with Alexander, Bonseipe, Simon and Buchanan to come to his conclusion. Alexander suggests that design is a fit between form and context. Bonsiepe sees design as negotiating 'man-artifact-intended action'. Simon proposes design as playing central role in 'artifact-design-context'. Buchanan sees design as acting between what is and what should/could be. In the end, Jonas proposes that '(D)esign is a network of chunks of ideas and activity patterns in the interface region between the contextual and the artefactual' (Jonas 2004:p.222).

Jonas although does not give central emphasis on human agency or intention (I can understand why. See the brief discussion on 'intention' in Chapter 12.1); however, I believe his idea can be integrated with others. The integration is best visually illustrated as a cross as there are two levels of analysis involved.

Figure 7 A design cross

Artifact

Human (intention) **Design** Environment

Context

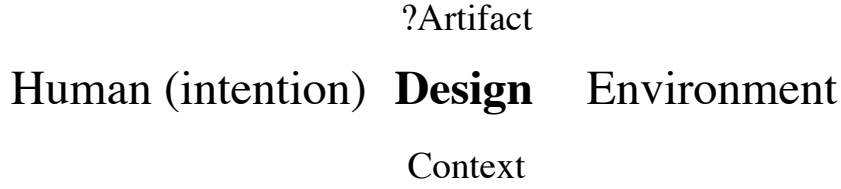
On the horizontal dimension, design is depicted as an interface between humans (their intention implied) and the demands and constraints of the living environment. This represents a 'zoom out' view of design and it describes design on a more general level. Vertically, design is depicted as an interface between the artefactual and the contextual. This represents a 'zoom in' view of design and describes design on a more specific – technical level. If you will, the 'zoom out' view is on the macro level of analysis, and the 'zoom in' view is on the micro level. Both views are useful and when placed together present a more dynamic view of design. To describe it verbally, the design cross tells us that design is an interface between the artefactual and the contextual that is an activity humans engage to change the environment to fit their intention. Although the design cross has its virtues, it ultimately does not depict the dynamics of the situation fully. The major problem of the depiction is that human, design, artefact and context are parts of the environment. They are not so neatly separated as distinct entities and must be understood as conceptual abstraction to serve our discussion here.

The design cross so far locates design in the relations of artifact, context, human (intention) and environment. However, there is still a very essential characteristic that ought to be added to refine this picture. Central to the discourse on the nature of

design is the recognition that the artifact to be created through design is uncertain, or indetermined. Nelson (2002) places special emphasis on the uncertain aspect of designing in his definition of design: “Design is the ability to imagine, that-which-does-not-yet-exist, to make it concrete or concretized form as a new, purposeful addition to the real world’. At the beginning of each design project, the existing situation, the desire or intention to change may be recognized and the goal of design may even be known. However, no one knows what the final product, the subject matter or the outcome of design will be beforehand. The artifact to be made is always indetermined. Buchanan (1995b) calls this a 'quasi matter, an indeterminate subject waiting to be made determinate'. Nelson and Stolterman (2000) make the same point in a different way when they describe design as ‘service’. ‘Service is not about helping people create what they already know they want. The success of the design process can be best determined when those being serviced experience the surprise of self recognition between what emerges from a design process and their original expression of that which they dimly perceived as desirable in the beginning (their desiderata)’. Uncertainty is always a condition of designing.

This important characteristic needs to be added to the design cross: The question mark ‘?’ represents the characteristic of being uncertain or indetermined. To describe it verbally, design is an interface between the indetermined artefactual and the contextual that is an activity humans engage to change the environment to fit their intention.

Figure 8 A revised design cross



Due to the condition of uncertainty, designer must conceive what the product to be. As Buchanan (1995b) says, designing 'has no special subject matter of its own apart from what a designer conceives it to be … in the process of application, the designer must discover or invent a particular subject out of the problems'. And here is where the major agreement ends and more theorizing begins. The cause and the process of coming up with a design solution are central points for design discourse and design research. Different perspectives are taken to understand this phenomenon. I will attempt to take from the various discourses to describe the process of designing.

Given whatever will be designed is uncertain, designers or design team will always rely on the vague goal of the design project to set the problem within which the search or construction of design solution begins. However, this problem is temporary and must be changed. As Jones claims, '(f)unctions, statements of requirements are essential but temporary. Without them, we can't begin, but unless we can change them, we can't finish, can't discover' (1989:p.224). In short, once the design project begins, designers aim to (re)construct the problem.

Problem definition is necessary for developing solution; however, the relation between problem defining and problem solving is more reciprocal. As pointed out by Jones, when designing what is perceived as a problem or a critical situation that affects achieving the goal is highly unstable. The definition of a problem can change in light of new information or understanding especially that is produced through testing of design solution. The emerging design solution modifies the boundary of search and redefines the problem and usually does that toward a greater clarity or a deeper understanding. As Jones suggests (1989:p.224), 'designing is a highly informative process (essentially one of unlearning what we thought was the case, but is no longer true when we have changed the situation by making something new which interacts with what was there before)'.

Even though we tend to (or need to) think of problem-solution as two separate domains, they are intimately related. The problem is the solution and the solution is the problem. Jonas (1999) states that "the apparently fixed 'real' problem thereby becomes *a designed project.* There are then no solutions, the solution is the problem". Designing is to define a problem so to develop a solution that in turn redefines the problem. When problem is seen as a 'design project' – a construction, the process of coming up with a problem is the same as the process of coming up with a solution. Schön (1988) calls this whole process a 'conversation' and a 'frame experiment'. Roozenburg & Eekels (1995) name it the 'basic design cycle'. Glanville would suggest this is the circularity nature of design. And this process carries on iteratively until a problem/solution is determined to be satisfactory. As Sless contends, 'knowledge and understanding are nothing but our own making, and the point for designers is to identify at the moment of closure, some structure for making design decisions'[2]. In other words, there can never be *enough* information to be gathered *before* designing. In much the same vein, Herbert Simon suggested that designers seek a 'satisfising' solution, not a final one. In sum, there is a common notion that design is an emerging process through iterative testing of ideas. Design problem and solution are interdependent. Problem is never stable and will change as designers construct it. Designing is a way of finding out or constructing problem-solution, and that designing happens simultaneously with understanding.

The process of coming up with a problem-solution requires exercising, depends on who thinks about what. One of the oldest articulations attributes it to 'creativity' and 'intuition'. But there are other concepts to describe this, including 'abductive reasoning' (March drawing on Peirce 1976), 'ill-defined problem solving' (Simon 1973), 'wicked problem solving' (Rittel 1973), 'construction' (Schön 1988),

[2] Email correspondence sent through the Internet discussion list – PHD-DESIGN (http://www.jiscmail.ac.uk/lists/phd-design/) on August 3, 2001.

'conceptual repositioning - placement' (Buchanan 1995b), 'letness' (Sless 2002a), 'innoductive reasoning' (Roozenburg & Eekels 1995), imagination-judgement (Nelson & Stolterman 2003), ‘disclosure’ (Newton 2004) or chemicals.

9.3 Is design a form of inquiry?

Without agreeing on the cause and process of constructing a design problem and a design solution, we can still agree to the fact that if any ‘product’ to be designed is indetermined at the beginning then the process of designing requires understanding or inventing a problem. Our current belief seems to indicate that designing is a way to understand and define a problem. So contrary to common saying, designing is as much problem defining as problem solving. Problem solving is problem defining and vice versa. In brief, designing can be viewed as a process of periodically shifting and negotiating between goal, problem and solution and bringing the indetermined to the state of determinacy. And this view of design goes very well with John Dewey’s philosophy of inquiry.

Dewey’s epistemology is naturalistic although it is more commonly known as pragmatist or instrumentalist. For Dewey “(I)nquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole (1991: p.108). It is an adaptive human response to the environment (broadly construed) that pose ‘problems’ and ‘problems’ are understood as uncertain or indetermined ‘situations’. Dewey thus emphasizes that problems are not inherently cognitive, but rather practical and existential. However, Dewey does not believe that knowing is a servant to acting – doing or making, but rather acting is always involved in knowing. Inquiry is an active ‘transaction’ between human and the environment and knowledge – warranted assertion - is the product and instrument for this interaction. Dewey distinguishes three aspects of inquiry. All inquiry contains recognition of a problem, process of understanding the problem where hypotheses

are entertained, and development of solutions to be tested. He believes that this model of inquiry is the only proper way to describe inquiry and explains the diverse forms of inquiry from the common daily life to the scientific. The latter is more sophisticated for its control of data in defining problem and its refinement of hypotheses.

This ultra brief outline of Dewey's philosophy of knowing allows us to see the similarity between Dewey's philosophy and the definition of design as *an interface between the indetermined artefactual and the contextual that is an activity humans engage to change the environment to fit their intention*. Both inquiry and designing are interfaces/interactions between human and the environment. Both are confronted with an indetermined situation and involve a desire to change it. We are also able to see that the process of design, as described above, is contained in the three aspects of inquiry described by Dewey. We might also consult many models of design process (Presley 2000, Morelli 2003, Pahl, and Beitz. 1984, March 1984, French 1985, Cross 1994). Despite using different languages, the stages within the design process are very similar and the information that is generated at each stage is also similar to that has been described. Designing, appears to be a form of inquiry.

9.4 Design: research or inquiry?

Some might at this point feel uncomfortable with the conclusion made. If designing is a form of inquiry, some might question if I see design as research? Yammiyavar (2000) suggests that design is a form of research and his view is met with some resistance (this is a mild word) for some definitely refuse to accept that design is research. The debate on whether design is research and in what way design is research will continue. Given it is such a sensitive issue, it is necessary to make explicit my position on the matter to minimize misunderstanding. I submit to Yammiyarvar's main argument that designing involves understanding, identifying and

resolving a problem. In short, as it has been argued above, designing is a form of inquiry. However, I hesitate to call design, research.

Unlike many people who have been involved in the design and research debate, I have come not to think of design and research as referencing to the concept 'knowing'. For practical reason, in the context of the debate, I think of design and research as particular types of institutionalized practices made up of certain activities. (See the difference I make between 'design' and 'design practice' in Chapter 3). On a practice level, clearly many design practices are not research. Saying that does not mean design practice and research do not change. Nor do I intend to slight the argument that design practice can be a form of research. However, it does mean that research when understood as an institutionalized practice can not be confused with research as an abstract concept referring to a process of knowing. The two references will lead to different kind of debates and results.

If we think of research and data collection as particular social practices, then we are unlikely to be confused about their differences. We know, I am sure, the difference in activities engaged by a researcher and a university student who conducts interviews for a summer job. But if we refer research and data collection to knowledge production in a more abstract sense, the reference will lead to similar debates to those on research and design. It will be an abstract discussion. Saying that does not imply that discussing design and research as knowledge production is unproductive. It only suggests that it is not very instructive to understand practical differences. Although design practice can definitely be seen as a form of inquiry, and has the potential to be a form of research, it is not research in the sense as how we understand research is practiced socially and defined institutionally.

My view is yet different from those who tend to take the middle road to claim that design is research but is a lower level of research, understood as clinical research. As shown by sociological studies of science, the hierarchical structure of basic research, applied research and clinical research is a hypothetical structure that presupposes the relation and the flow of knowledge between general knowledge and practice. It has been shown that this model does not represent reality. The most pertinent example is the independent development of knowledge in technology and science (Staudenmaier 1985). To relegate design to clinical research that implies a dependence on applied and basic research is to keep the illusive hierarchical structure between research and design. I would rather see design as design, serving its social function as research is.

9.5 Summary

I have integrated some definitions and ideas on the nature of design and suggest that design is an interface between the indetermined artefactual and the contextual that is an activity humans engage to change the environment to fit their intention. Without agreeing exactly what the cause of design is, we might agree that design is a process of defining problem, generating and testing of hypotheses and coming up with a solution. As I see it, designing fits into Dewey's general theory of inquiry and it allows me to conclude that design is indeed a form of inquiry.

10 DESIGN AND SCIENCE DIFFER IN OBJECTIVE

Dewey's general theory of knowing permits us to see designing as a form of inquiry. Logically, if both design and science are forms of inquiry, then there is little reason to believe that in terms of cognitive processes or structure of inquiry, there is any difference in kind. The differences are likely thematic, not essential. The methods and processes employed in design and science are similar. As such, we are left to conclude that the difference between the two lies somewhere else.

If there is no fundamental difference in structure of inquiry, what else is there to be different between design and science? Roozenburg and Eekels (1995:p.6) suggest that science and design differ in their aims. 'Scientific research aims at solutions for theoretical problems… Scientific research has to result in reliable statements shaped as laws and theories, that provide better explanations and predictions of such 'problematic' phenomenon'. Roozenburg and Eekels further suggest that 'Design process leads to material systems that have certain desired characteristics and, because of these characteristics, are able to solve practical problems'. And they conclude that due to the aims, science and design are practices that aim for opposite directions. From a particular perspective, Roozenburg and Eekels are correct about the aim of science and design; however, their characterization is somewhat misleading.

10.1 Subject matter and object(ive)

When the word 'design' is used as a noun, often people use it to describe an artifact. This is the case, when people comment that a certain chair is a nice design. This usage of the word 'design' is common and fairly understandable because a design is embedded in the chair and is manifested through the chair. And for most people the only contact with a design is through the interaction with products such as the chair. So it is easy to confuse the subject and object of design.

Dewey made a distinction between ‘subject matter’ and ‘objective’ that I find useful for our current discussion. ‘Subject matter’ is used to refer to the content of inquiry, and ‘object’ or ‘objective’ is used to refer to the aim of inquiry. From this perspective, laws, theories, material systems and chairs are, more accurately speaking, subjects. Material systems can be a subject (content) for both science and design. The object (aim) of science and design is something different.

Cross (1982) puts forth a characterization of the object of science and design that I find useful and would like to expand upon. He proposes that the object of science is a description and design, a prescription (or some prefer to call it a proposal). These characterizations, I believe, are useful for they are comparable on the level of abstraction, and they are not confused with particular subject matters. However, I suggest an amendment to Cross’ characterization. While scientific inquiry is aimed to produce a description, a description is not its most distinctive characteristic. For the power or use of scientific theory is not because it is a description, but rather because it is a *general* description. Therefore, I suggest that the object of science is a generalization that describes. By the same token, prescription is only the function, not the nature of the object of design.

10.2 The object of design

When a client goes to a designer and says ‘design me a table’, what is this demand aimed for? What is the characteristic of the final outcome? Let’s say that at the end the designer delivers a wooden 3m long, 2m wide and 1 m high rectangular yellow table that satisfies the client. From a demand for a table to this *certain* table, this process is going from an undetermined form of table to a (more) determined form of table. From an undesignated table to a designated table.

> “A thing is said to be designated (designatum, signatum) when it can be shown or pointed to with the finger. This is true of individual things but not of the abstract nature or essence. The latter can be defined; the former cannot be defined, but it can only be pointed to. In this sense, ‘designated’ is

> equivalent to the demonstrative article 'this'. A derived meaning of the word is 'determined' or 'limited'. The undesignated is the 'undetermined, confused, undifferentiated'
> (Aquinas 1984 p.37).

When the client demands for a table, he is demanding for *a specific* table, not any table. To be clear, table is the subject matter of design in this case, and *a specific form* (of table) is the aim of design. The object of design is a specific form, a specification, in the widest sense of the word. This example of designing a table should not be taken too literally. As we know, clients often come with the wrong answer, the client might not need a table, but a completely different design. A designer's task is often to change the initial request totally. However, the basic of the argument is still stable. Even if the content of design is changed completely, the object of design is the same: it needs to be a specific form.

Some might suggest that science also create specifications besides generalized theories. Some might also object that Industrial Design is no longer concerned with the production of specification. The tasks of designers are shifting and in professional practice designers are more and more involved in research and produce understanding and knowledge. The boundary of the field is shifting and the roles of designers continue to change. Finally, some might suggest that the distinction made between design and science is not new insight. I will try to address these objections in turn.

10.3 Science approaching design becoming research

I agree that some scientific inquiry deals with specification but that does not disqualify the difference made. Indeed many scientists specify something with the aim to effect a change of a situation. The best known examples are action research in social science and bioengineering in medical science. As Jonas observes, science is approaching design (practice) when scientists engage in making rather than

describing and explaining phenomena. John Broadbent (2003) also mentions that science and engineering are becoming more design like. These fields are more and more involved in making of artifacts either physical, biological or chemical. They also end up dealing with chaos and complexity and need to move from the approach of reductionism to holism as it is demanded from any design activity. The changing role of science as a social institutions is best exemplified in the study by Nowotny et al (2001) who describe the objectives of sciences are 'invaded' by the social, political and economical objectives. The 'mode 2' knowledge production is characterized by being 'contextualized'. However, the fact that science is becoming more design like does not disqualify the distinction that has been made earlier. To be clear about the distinction between science and design will contribute to inform how this transition from science to design might be dealt with. And it also makes the understanding of the distinction ever more important and urgent.

To the objection that design is no longer dealing with specification, I suggest that the design process is expanded beyond but does not exclude specification. Jonas (2001) sketches an extended concept of the design process including 'analysis', 'projection' and 'synthesis'. The last stage 'synthesis' is where specification is produced. Although design process includes scientific research like activity, they are but to inform the production of a specification. This is an important point and has great relevance for user study, as it will be argued later. Studying people to construct a general scientific theory is different from that to produce a specification. Therefore, although the design activity is changing as it always has, the final object of design is still a specification. As a matter of fact, without a specification, the design process is not completed.

To the objection that the conclusion is not new insight, I will say that while the conclusion might not be the most surprising, the details are subtly different and bear influence on the direction of this study. I have concluded that both science and

design are inquiries. Therefore, there are no fundamental but only thematic differences in structure of process; and that their essential difference lies in the object each pursues. The object of science is a generalization and the object of design is specification. The conclusions might appear the same as those previously proposed by Jonas and others. Jonas (2000) suggests, 'Although design uses elements from the pure, the aim is however different to that of the sciences, namely the creation of new examplary artefacts, and not the development of new, improved generalized components of knowledge'. I maintain that although Jonas, like Roozenburg et al, also sees that design and science differ in their aims, not in their processes, his reference to the aims is different from mine. I repeat that 'new examplary artfacts' are subject not object of design. I would also add that this difference although appear minor is fundamental in drawing implications from our current study. I will later show how the concepts generalization and specification can help draw implications for user study. The conclusion is a synthesis of many different points and an additional insight to our understanding of design in relation to science.

10.4 Summary

Given that design is a form of inquiry, there is no fundamental difference in process and structure between design and science. The essential difference rather lies in their respective objectives. I emphasize that subjects of science and design are various and can be the same, but the objects of science and design are different. Traditionally, scientific research is concerned with producing a general description. But the object of design is a fitting specification. It can then be said that the nature of design and science is the same, but the function or product of design and science is different.

PART II IMPLICATIONS FOR USER STUDY

Here I derive meanings for user study from the conclusion that design is an inquiry toward a specification. To the question – 'How does user study inform design?', it is implied that current user study provides a context for design. 'What are the formal characteristics of user study outcome?' It is concluded that this context ought to be a specific reasonable narrative rather than a general abstract causal explanation. More interestingly, it is realized that context creation does not necessarily precede the generation of possible specifications in the design process. Thus it calls into question the fundamental assumption on which the research questions are based. It is revealed that not only user study informs design, but also in principle, design can drive user study. Not only is design-driven user study possible, but it is also preferable for design situations where context is highly undetermined. With this understanding, we might suggest that although the applicability gap between user study and design can never be closed, jumping over the gap is made more confident if we introduce the concepts of generalization and specification. The gap is seen as a problem of aligning the level of specificity between user narrative and the goal of the design project.

11 USER STUDY CREATES A CONTEXT

The present study arises from a number of observations. It is generally accepted that user study is important for contemporary professional practice of Industrial Design. However, this belief is mostly supported by informal observation, testimony and good will but lacks formal articulation. Systematic discourse on user study in Industrial Design lags behind that in Human Computer Interaction. Moreover, other fields have already recognized the need for more in-depth understanding on user study, so research on user study has begun. These studies however are missing a perspective from design. This lack of design perspective has left the 'applicability gap' between user study and design open. Although we know that user study results are not necessarily useful to design, we have not dealt with this issue properly. Although we know that designers have preference for certain form of information, we do not know if this preference is systemic or accidental. This study is aimed to examine the nature of design so that implications can be drawn for addressing the following questions:

- How does user study inform design?
- What are the formal characteristics of user study outcome?

It is widely accepted that user study is to provide information about the end users for design. The purpose of user study is to ensure that design outcome suits the users on different dimensions, such as functional, emotional, cultural, social etc. User study is said to inform or inspire designing. Although it is widely accepted as such, as mentioned in the Introduction, what is less articulated is exactly how user study informs design, what is that user study produces that informs design? I will argue that current user study creates a (user) context for design. Besides, this context is (or ought to be) a specific reasonable narrative rather than a general casual explanation. I will further argue that this context does not guarantee designs and the whole idea of user-centered design can be reversed, and design-driven user study is equally important.

As argued in Part I, there is no fundamental difference between design and scientific research in terms of structure of inquiry or cognitive process. Therefore, by using the following characteristics to describe design process, I am not implying that these characteristics apply only to designing. Rather it should be understood that these characteristics although not unique to designing, nonetheless, depict designing, as we understand it. To repeat, as a form of inquiry, the design process moves from an undetermined situation (a problem) to a determined situation (a solution) or from a general form to a specific form. During the design process, three major activities are carried out, namely, creating a context, generating possible specifications and making judgements on the fitness. Putting these three activities in the language of inquiry, the context basically is the design problem, the possible specifications are hypotheses and the judgement is testing of hypotheses. While these three activities are intimately related, for conceptual grasp, it is necessary to see them as related and yet independent activities.

Whatever the methods and approaches, current user study seeks to describe the needs or wants of people in various dimensions/categories such as ergonomics, emotion, cognition, cultural etc. This information is commonly called 'user requirements' or 'user needs'. Whatever the content, all this information is fundamentally factual understanding and descriptions of the users. This information, when properly created, provides criteria that the final design (specification) must address. In our language, most if not all of existing user study approaches and methods are geared toward creating a context about users. Current user study produces a context to which the evaluation of how fit various specifications can be done meaningfully and reasonably. This declaration is probably not very exciting, and it might even seem merely word play. However, with this language which is lacking in our discourse on user study, further implications can be elaborated more coherently. If user study creates a context for design, then user study is also oriented toward a specification.

11.1 Orient toward specification

When a client asks for a table, this initial request is the context or beginning of a design inquiry toward a specific design. But this context is very general with little information for arriving at a design. Under this general context, many possible tables can be imagined. Figure 9 shows that under the general category of table, at least four different types of table can be thought of, namely dining, desk, coffee and bedside. The types are arbitrary and yet meaningful. For the dining table, different qualities such as material, shape, size, color etc, can be introduced. The more categories are introduced, the more information, the more specific, the more determined. A dining table is more specific than a table. A wooden dinning table is more specific than a dining table. And a wooden rectangular table is even more specific and so on. In order to be more and more specific, more and more categories need to be introduced. The more categories are introduced, the more possible forms of tables. We see that before the category shape is introduced, there are four forms of table and once 'shape' is added, there are 16 forms of table. In the world of table as shown below, there are many possibilities of its form. The possibilities are as finite as imagination. The more specific, the more possible tables there are to choose from. By implication, toward determining a certain table, many possible forms of table need to be determined against.

Figure 9 A family of tables

Table

Dining Desk Coffee Bed-side…etc

Material: Metal Wood Plastic Glass…etc

Shape: Rectangular Square Round Oval….etc

Length: 1m 2m 3m 5m …. etc

Color: Natural Black White…etc

Since many possible tables can be imagined, how might the client and the designer choose one from the other? To solve this problem, the context must also increase in specificity. A more specific context, for example, a table for children increases information (and hence understanding) in evaluation criteria. Tables that are not suitable for the context of children dining are decided against. An even more specific context, a table for children dinning outdoor, will further increase information in evaluation criteria, and thereby making judgment on the various possible tables more determined. Tables that are unsuitable for the context of children outdoor use can also be eliminated away. The more specific a context, the more determined evaluation criteria, the more determined about the fitness of possible specifications, the more useful for judging designs. If user study is to provide a context for design, then it ought to be oriented toward a specific context.

Seeking a specific context is reflected particularly well in sampling methods. Unlike most social scientific research, current user study particularly employs purposeful sampling and the method of ‘lead user’. User study does not seek to understand the general population, but about a particular group of people. In user study for design, it is very common that research subjects are chosen because they are believed to be the 'target customer' or 'market segment' for a particular product or service. For example, Squires (2002) records choosing young adults working in an office environment as research subject for developing a personal care product because this cohort is considered to be the targeted users. And the study of 'lead user' is believed to be useful for design. Drawing on the work by Hippel, Ulrich and Eppinger (2004:p.58) explain that ‘lead users’ are people who experience needs months or years ahead of the majority of the user group. To involve the 'lead users' is important because they tend to be able to make explicit their needs while these needs are not obvious to others. Secondly, lead users often develop ideas or practical way to deal with their needs. Therefore, their insight will prompt new product ideas. In user study, therefore, there is less concern for generalization in terms of user information

collected. It is less an issue if certain characteristics discovered about a particular target group might not be applicable or the same to another group of people. It is, to the contrary, believed that different groups of people require their own user study. In scientific study of people, there might well be attempt to integrate a variety of user data so to build a comprehensive theory about human nature. But it is seldom known to be a practice in user study. For designing, it is not about finding out the general needs and wants of a general population, it is always specific needs and wants of a specific group of people that interests designers. This conclusion is consistent with research findings that designers have found general information such as the average ergonomic data not useful. It might also explain why the designers in Melican's study find abstract data less useful. The practice of purposive sampling and the use of 'lead user' can be seen as a reflection of fulfilling the needs of designing rather than those of developing a theory to explain behaviors across a general population.

11.2 Bring something concrete

A specification, unlike a generalization, is able to create something concrete. A recipe is a specification. Following a recipe, we are able to make fried-rice, something concrete. Something concrete can be understood as occupying space and time or perceivable and sensible. Another conceptualization is that it is something experientially meaningful. In contrast to abstraction that tends to be purely cognitive, concrete things have immediate relevance or meanings to which one can more readily relate. A cup is concrete, we understand its 'meanings' – what it is. The understanding is embedded in our experience. It is precognitive, existential, experiential and qualitative. It is therefore also embedded in culture or everyday life. Something concrete are objects or phenomena to which we can attribute experiential meanings.

If user study is to produce results relevant to design, then it ought to focus on the concrete nature of specifications. In other words, it ought to take into account experiential meanings. This is the subject matter of user study. This suggestion should not come across as too surprising. It is consistent with the many interests and research in ‘product semantics’, ‘product language’, ‘emotion and design ’, ‘experience design’ ‘phenomenology of designed artifacts’ and ‘design as culture’. All these are to do with experiential meanings in the widest sense and are different ways to address the same broad issue. This also partly explains the relatively recent embrace of ethnographic research to understanding users or the general focus on qualitative data about users. In brief and in general, user study is to observe how users give meanings to designs. As meanings are result of interpretation, user study is to interpret how users interpret designs. This kind of second order interpretation is evident in practice.

11.3 The case of Ulrich & Eppinger

Ulrich and Eppinger (2004: chapter 4) suggest that understanding the needs of user/customer is integral to any product development. Ulrich & Eppinger suggest that the final product of use study is ‘statements of customers needs’ not product specifications. They equate the term 'customer needs' to 'customer attributes' and 'customer requirements'. And they use 'needs' to mean both desires and needs. Despite the particular terminology, their view on user study is also similar to others, such as the commonly known approach ‘Quality Function Deployment’. QFD was first developed at Mitsubishi’s Kobe shipyards in 1972 and later on exported to the U.S. in 1986 (Griffin et al. 1993). Professionals in the field seem to agree on the importance of user study to product development. They also have a set of methods to conduct various types of user studies and have recommendations on when and how to use these methods. They also give examples of how the information generated by user study can inform design. However, what is distinctive about Ulrich and Eppinger's description of user study is that they provide rather detailed examples

on how data are interpreted for designing. These detailed examples are useful for our discussion here. In some other cases, the step of interpretation is not given much attention. It is often assumed that information of people is automatically useful for designing, and the process of interpretation is sometimes all together omitted. And this omission can be seen as a sign of not attending to the applicability gap. Ulrich and Eppinger recommend a five-step procedure to conduct user study:

- Step 1: Gather raw data from customers
- Step 2: Interpret raw data in terms of customer needs
- Step 3: Organize the needs into a hierarchy
- Step 4: Establish the relative importance of the needs
- Step 5: Reflect on the results and the process

They recommend that after collecting data from the users, raw data is translated to statements of needs. After these two steps, the statements of needs are organized into a hierarchy of two or three levels, followed by prioritizing these needs in view of technical difficulties and costs. And the last step is to reflect on the results and process. The example they use is the development of an electronic screwdriver. According to Ulrich and Eppinger, user study is to result in a list of needs, organized by general to specific and each need is given priority of importance. This list guides concept generation, concept selection, benchmarking and the establishment of product specifications.

A portion of the list is provided as follows: (*** means critically important, SD means electronic screwdriver, latent need is denoted by !) (2004: p.64)

The SD provides plenty of power to drive screws.
* The SD maintains power for several hours of heavy use.
** The SD can drive screws into hardwood.
The SD drives sheet metal screws into metal ductwork.
*** The SD drives screws faster than by hand.

The SD makes it easy to start a screw

* The SD retains the screw before it is driven.

*! The SD can be used to create a pilot hole.

The SD works with a variety of screws

** The SD can turn Phillips, Torx, socket, and hex head screws.

** The SD can turn many sizes of screws.

Ulrich and Eppinger list 15 general statements and under them there are a total of 51 specific and concrete statements of needs. (The general statements are marked in bold types, and the specific concrete statements are in regular types). The statement of needs describes the specific context of driving screw to which the to be designed electronic screwdriver must fit.

11.4 Reasonable narratives

As stated by Ulrich and Eppinger, the statement of needs or user context is highly selective because it is constructed by the development team. The development team interprets the raw data given by the users and turns it to statement of needs. The general statement of needs is especially created and chosen by the development team to be important demand/need/desire of screw driving. Creating a user context may appear to be a formalized and straightforward practice, but time and again Ulrich and Eppinger mention that this is not an exact science and must rely on the experiences and intuition of the development team to carry out properly. As Sugar's study shows, for novice design students who are less experience in making sense of what they observe, user study has little effect on the quality of designs (1998). Ulrich and Eppinger actually recommend to having different people to interpret, to organize and to compare users' statements as part of the design process.

This practice is illuminating. The interpretation of raw data in user study is different from that in social scientific research. In spite of various paradigms to interpret

qualitative or quantitative research data, the tradition of the social sciences is aimed to construct theoretical knowledge from data to explain and predict human behaviors. A scientific theory is aimed to encompass as many phenomena as possible. In social scientific research, data is often if not always interpreted to seek causal explanation or to build a causal structure. Cause is understood as efficient cause. A cause is something both necessary and sufficient in the circumstances of the production of its effect. But since most effects in social life are results of multiple causation. So in social sciences, cause is understood to be an *inus* condition (an *insufficient* but *non-redundant* part of an *unnecessary* but *sufficient* condition). A causal structure is fundamentally a logical and abstract structure. We can say that raw data is abstracted to describe the 'essence' not the 'accident' of phenomenon. Theoretical explanation is de-contextualized knowledge.

But a specification is always about the 'accident'. In contrast to the social sciences, user study does not seek to develop causal explanation or develop a causal structure, but rather to provide a context for design. As indicated by Ulrich & Eppinger, user study practitioners interpret – create meanings – from their observation of users observing themselves. Meaning is to do with reference, purpose, intention and something (semi)conscious of humans. In short, it is to do with reasons, not efficient cause that is concerned with laws of effects. Raw data in the case described above is interpreted for its relevancy (meaning) to the design of screwdriver. User study practitioners create more or different meanings to the meanings (raw data) given by the users, based on, as Ulrich & Eppinger say, their intuition and experiences. There is no logical correspondence between raw data and statement of needs. The interpretation of the raw data is highly selective, multiple and is not measured by validity or reliability, but reasonableness. Although it is also common for scientists to interpret raw data differently, and according to some sociologists of science, scientific discourse is as rhetorical as logical; the recognition, acceptance and appreciation of subjective opinions and the role of rhetoric are much

more prominent in design practice. This, however, might seem to be non-rigorous or trivial, but as Toulmin argues, reason should be seen as valuable as rationality.

The American Philosopher Toulmin (2001) calls to 'return to reason'. His main thesis, following the pragmatist tradition, is to show the problem of equating rationality to reasoning in the pursuit of knowledge since the mid-17th century. He provides a historical perspective on the ongoing (academic) discussion on the problem with favoring theory over practice, logic over rhetoric, pure reason over practical reason and formal argument over substantive argument. The key conclusion relevant to this discussion is that '(F)rom early on, the word 'philosophy' referred to the systematic and methodical treatment of any subject. The spectrum reached from geometry and astronomy at one pole to autobiography and historical narrative at the other. In all these human activities "reasons" play a central part'. It is therefore a historical accident if we believe that reason is secondary to rationality. 'Substantive arguments are historically situated and rely on the evidence of experience' the best they can claim to do is to put a conclusion 'beyond a reasonable doubt' and establish the 'strongest possible presumption on its behalf'. (Toulmin 2001:p.19)

Toulmin's insight, I think, is related to all judgement in general and relevant to understand design judgement. User study practitioners make judgements on user data experientially rather than logically. Interpretation stops when the development team believes that the information at hand is sufficient to make design decisions. It is very similar to how scientists interpret raw data to explain, except that user study practitioners do not interpret to produce a causal explanation about human needs, but rather they tell reasonable (believable) and at times compelling stories of human needs in a particular situation. In other words, user study is not aimed to create abstract concepts or propositions but rather personal and cultural meanings. It is rhetorical not logical. The context is which and in which a specific design is to be found meaningful. Meaningful is something that is appropriate, makes sense and

reasonable. User study produces a narrative that becomes the justification for design decisions. It is not about efficient cause, but the reasons for design. In this sense, this narrative is a form of explanation.

Different disciplines require different form or type of explanation. What is considered a good explanation varies. Rogers (1983) discusses the differences in scientific, historic and technological explanation.

> "In its effort to explain phenomena, a scientific investigation can wander at will as unforeseen results suggest new paths to follow. Moreover, such investigation never ends because they always throw up further questions. The essence of technological investigations is that they are directed towards serving the process of designing and manufacturing or constructing particular things whose purpose has been clearly defined. … it may end when it has lead to an adequate solution of a technical problem…Because of its limited purpose, a technological explanation will certainly involve a level of approximation that is unacceptable in science" (p.32)

1. "Scientific explanations involve the establishment of general laws covering what were hitherto unconnected empirical events, and they enable predictions of future events to be made… As science develops it explains low-level generalisations by deducing them from more general hypotheses which cover a wider range of experience… The things with which the higher-level hypotheses are concerned often ceases to be directly observable and become theoretical concepts which are meaningless out of the context of the deductive system in which they arise" (p.40).

2. Historical explanations "must have a teleological element even when expressed in causal language. The explanation of a person's actions will involve at least two things: (a) reference to a purpose or intention, and (b) reference to previous events which gave rise to that purpose or intention. It is this group of previous events giving rise to the intention which is loosely called the cause of the person's action. Relying on 'historical judgement', historians make judgement on the importance of all these events to construct an explanation. However, it is impossible to erect a hierarchical systematic theories or making reliable predictions. (p.41).

3. There is always an element of teleological cause in technological explanation. Range between historical and scientific explanations. But in all cases, "the test of a satisfactory theory is that it should enable the engineer to design a

> piece of equipment which will give the performance required of it. If an addition to a technological theory makes the whole theoretical structure more widely applicable this is a welcome added bonus, but it is not the prime object of the work as it is in science" (p.51).

The narratives produced by user study are usually not accepted as a good explanation in the social sciences, in history or in technology but they are often sufficient for design practice. User study results should not be seen as non-rigorous (according to scientific standard), but rather as serving the objective of design. This conclusion is important to advance our understanding on user study. Current user study is modeled from the social sciences and in the main part run by social scientists turned design researchers. Despite some comments here and there, (see for example Koskinen 2003), to a large extent, this practice is unquestioned and unchallenged. It might be unfair and too quick to suggest that social scientists might bring scientific values to run user study and might fail to attend to the possible differences between scientific research and user study for design. But it is proper to say that the user study based on the social scientific model requires further examination before we stay confident about its appropriateness for design.

11.5 Summary

By the definition of design as an inquiry oriented toward a specification that fits, it is interpreted that current user study informs design by providing a user context. In order to be useful for design, user context ought to be oriented also toward a specification. User study produces a highly selective, particular, reasonable and at times compelling narrative of user situations, not a casual explanation. And as such, user study is different from social scientific study.

12 CONTEXT DOES NOT GUARANTEE DESIGNS

In Chapter 9, I have pointed out that central to design discourse is the cause of design. To recap, there are different concepts or explanations used to describe this including 'abductive reasoning', 'ill-defined problem solving', 'wicked problem solving', 'construction', 'conceptual repositioning - placement', 'letness', 'innoductive reasoning', judgement-imagination and ‘disclosure’. The cause of design, from my own interpretation, can be understood by drawing on medieval philosophy and it has some advantages over other conceptualizations for our current discussion.

12.1 Causes for design

For Aristotle, everything exists in form and of matter, and in brief, everything is a formed matter. We might take the example of wood. Wood, as matter, exists in the form of tree. When we cut down the tree, wood exists in the form of log. We cut the log into pieces of various shapes and put them together to make a table. Now the wood exists in a form of table. Wood exists in a form of tree, a form of log as well as a form of table, among others things we might create. From a tree to a table, only the form changes but the matter, wood remains. Wood, exists in a form of tree, is determined in its natural form, but indetermined in form of a table, an artificial form. We determine the table form. Aristotle described types of cause more liberally than modern scientists. As we know, they are formal cause (what is it?), material cause (what is it made of?), efficient cause (what made it?) and final cause (what is it for?). The change of the form of tree to the form of table requires more than the four Aristotelian causes, however.

Nelson, in his inquiry into design, adds two more causes that he believes are associated with design. Nelson (2002) suggests that change in design is not dealt with chance or necessity, but rather it is intentional change. According to him, design capacity links to ‘design cause’ that, in addition to the four Aristotelian forms of cause, integrates ‘intentional cause’ with ‘particular cause’ resulting in our adequacy

to fulfil our inherited role as world creators. Nelson's suggestion is laudable but I have some difficulties with it. First of all, intention is not a cause as such, but a state of mind. The literary scholar Swinden (1999) tries to resolve the problem of authorial intention by drawing on quite a number of philosophical sources, including Wittgenstein, Ryle, Goldman; and comes to this conclusion:

> 'The concept of intention has been carefully examined in the philosophy of mind and the philosophy of action, and though there is no more settled positive opinion in this than there is in any other field of philosophy, it would be true to say that there is a settled negative opinion to the effect that it is a mistake to describe intentions as causes, and either it is a mistake to describe intention as actions or it is necessary to be more than usually circumspect in so doing'. (Swinden 1999:25).

If intention is not a cause, not an action, and but rather 'a positive state of mind' that accompanies an action, then what is left of intention in our theory of design? As I see it, not very much. Intention has no real meaning without an action being interpreted. Without an action, intention cannot be thought of, identified, and examined. In other words, intention is post-facto. As such, how can something post-facto be a (pre)defining characteristic of the meaning of an action, such as design? Intention is subsumed under action, and cannot be used to pre-describe or to define design without substantial qualification. Besides, Aristotle's final cause seems to be inclusive of what Nelson means by 'intentional cause'. And for the second concept, 'particular cause', it seems to me to be redundant for all causes must be particular in real life situations. A general cause is an abstraction, and an abstraction has no function other than giving us a grasp of reality. Instead of Nelson's causes for design, I find Thomas' exemplary cause more promising.

Thomas introduced an additional cause – exemplary cause - in his attempt to develop an argument that not everything exists in formed matter. Exemplary cause is the idea or the blueprint of a potential being exists in the mind. The exemplary cause

is concerned with what is potential, not there yet. The exemplary cause is more commonly called imagination or other concepts that have been described above.

Exemplary cause, however, is a concept that ties with the concept of 'being'. Dilnot (1998), Nelson & Stotlerman (2003) and Fry (1999) among others, have suggested that science is about the *true*, concerned with epistemology and understanding. And design is about the *real*, concerned with ontology and being. Some current design discourse draws upon Heideggar's philosophy of being to illuminate our understanding on designing. Thomas' philosophy of being, as far as I know, has not been invoked. But Thomas' philosophy of being is very consistent in its conceptualization that make pairs of concepts compatible with one another, including undetermined/determined, potential/actual, unformed matter/formed matter, non-existent/existent and general/specific.

The concept of exemplary cause is useful for our discussion here. A form of table exists in the mind or representation first before its exists actually in the world. The exemplary cause determines the potential formed matter. Exemplary cause is essential to the change in artificial form. For a table, the wood is its matter, the table is its form, the carpenter is its efficient cause, the client has the final cause, and the designer provides the exemplary cause. Purpose (final cause) is not the same as an idea (exemplary cause) that leads to a design - a specific form that fulfils the purpose. There cannot be a specific form without an idea of what the form is, no matter how much we understand the purpose or have a sense of purpose (intention). Although exemplary cause is intimately related to final cause, it is independent from all other causes. It is the most essential for artificial form making – bringing something non-existent to existent.

In current discourse, identifying the intention, purpose, needs, wants or final cause of design is considered very critical, and this is the belief that drives current user study.

However, Thomas' exemplary cause allows us to see that final cause is not the same as the idea that leads to an artificial form. By implications, context although highly related is not the same as specifications. A context, however important, does not guarantee generating of designs nor making good judgements about their fitness. Creating a context for designing a table is different from generating possible forms of table and these two activities are also different from judging whether a particular table is fitting to the context. Description or explanation of any kind, as important as they are in giving directions, only sets the problem to which a design addresses. Designs can not be deduced from them. No amount of information generated from user study is sufficient in bringing out designs. There is always a gap between description and creation, problem and solution or context and specifications. Recognizing this gap is important for it directs us to suggest different approaches to construct user study in relation to designing.

12.2 User study is a design project

If user study is oriented toward a specific narrative, then user study is also a design project, not a scientific project. It seeks to create a *specific* context rather than a general context. In order to create a specific context, there ought to be evaluation criteria for judging the fitness of context; therefore, a meta-context is therefore implied. Practitioners in user study, similar to designers who design a table, require a meta-context, generate various possible specific contexts, and finally evaluate how fit these are to the meta-context. In business or product development, the meta-context for user study is often a business plan. In the case of the design of an electronic screwdriver described in Section 11.3, the business agenda is to design a cordless screwdriver and therefore it is the meta-context of that particular user study. However, creating the meta-context is also a design project where possible meta-contexts are created to fit a specific eso-context. Creating context is, in conclusion, infinite. There is no end in creating context and therefore, there is no *certain*

beginning. The beginning of creating a context is arbitrary. In product development practice, an eso-context is often a vague idea or gut feeling.

The characteristic of an arbitrary beginning is not confined to context creating but rather it is a general characteristic of inquiry. Inquiry always begins with uncertainty. From a constructionist point of view, there is no ultimate context to be discovered, but rather an arbitrary context is constructed to begin an inquiry. The beginning of inquiry is random in the sense that the starting point is not logically deduced. This observation coupled with the discussion about the independence of exemplary cause has some interesting consequences.

12.3 Design depends on itself

First of all, inquiry has an arbitrary beginning. We have demonstrated that design is a form of inquiry, by definition, design has also an arbitrary beginning. And as a form of inquiry, design involves creating context and possible specifications; and making judgment on the fitness between context and specification. We also demonstrated that these three activities are related but independent process of designing and that having a context does not guarantee the generation of possible specifications or good judgements. A design project, in principle, can as well begin with possible specifications to an unspecific (or unspecified) context, or unspecific meta-context or unspecific eso-context. It might be concluded that design does not *necessarily* begin with a specific context, a specific meta-context, or a specific Eso-context. In short, generation of possible designs can be an arbitrary beginning of a design project. This suggestion is opposite to and inevitably challenges the common belief about the sequence of the design process in general, and the place of user study in the design process in particular. This questioning also opens up new vista for seeing user study, which is the goal of this investigation.

The majority of design models, linear, iterative or circular, often begin with analysis to create a context to which designs must fit. Besides or under this general belief, there is the common idea of user-study-first-then-design. Some even claims that user study or research in general is 'pre-design'. Within or outside the field of design, there is an assumption that we need to understand *before* we can design; that researchers need to collect information from users, and once this information is established and handed to designers, designers can then construct designs. It is indeed the most commonly held belief. However, due to the gap between description and creation, there can never be enough information to be gathered before designing. Jonas (2002) calls this 'unknowledge'. In other words, designers have to decide and assume that there is adequate information upon which to propose designs. This is not unlike scientists who generate hypotheses believing that there may be correlations or causal relations among phenomena and subsequently test the hypotheses through research. But unlike scientists who seek to further explain the phenomena, designers rather use the sufficient information to propose designs for solving situated and specific problems.

And the proposed designs is not-yet-exist, by implication, the context in which it is a part cannot be known, cannot be fully described. The non-existing context can only be imagined or hypothesized. The introduction of something new or different creates unforeseeable effects and changes in the environment. This claim does not need elaborated argumentation as case histories of technology and products (in the widest sense) demonstrate its truthfulness. What is important and worth emphasizing is that environment is dynamic. It changes and is subject to change by human intervention, intended or unintended. The creation of possible designs, in principle, can trigger changes in the environment out of which user study seeks to create contexts. In other words, the introduction of possible designs creates new contexts. And these new contexts can not be understood without the introduction of new designs. All these observations imply that designing is a way of constructing (non-existing)

specifications-in-context. Thus user study (context creation) in design should not be conceived as outside of designing or precede designing. User study is *inside* of designing and evolves with designing. Therefore, the permanent separation in time and space of understanding and designing does not make sense for design. Nor does the complete separation of context creation and specification generation. Our conclusion suggests that this common belief in the sequence of analysis-synthesis, understanding and change, research and design is not to be taken for granted any more. Instead of creating a specific context to evaluate the fitness of possible designs, the reverse is as sound. One can create possible specification-in-context to guide user study. The whole idea of user-centered design can be reversed. Besides user-centered design, there can be design-driven user study.

12.4 Summary

ST. Thomas's exemplary cause is invoked to characterize the cause of design. Exemplary cause is related but different from final cause. Exemplary cause is the very cause that leads to a design. This insight is important for us to understand that no matter how successful we can identify users' needs and desires, it does not guarantee design or good judgement. Not only that, we can see that the assumed sequence of user study first and design later is not a necessity. As much as user study can inform design, design can drive user study.

13 DESIGN DRIVEN USER STUDY

We have been saying that design is an inquiry oriented toward a specification. However, it does not mean generalization has no place in design. It is not too far fledged to say that design is redesign. Design always begins with what exists. Although we do not normally speak in these terms, design basically goes in two directions from what exists. What is to be designed gets either more specific than what there is or it gets more general. Remember that being general and specific is relative. A specification can be a generalization (to others) in a different context. A yellow table is a specific form to the category of table. And table is a specific to the more general category furniture. And furniture is a specific to an even more category product. Being general and specific is context dependent and relative.

As figure 10 shows, there is existing a mobile phone. In the direction toward more specification, the existing category mobile phone can be made more specific. For example, the design of mobile phone particularly for elderly makes it a more specific mobile phone. But in this case, the phone as a (general) category does not change. In other words, the context for (re)design is (relatively) determined/specific.

Figure 10 Design gets more general or specific

	More general	**Communication** *(Sending and Receiving/Knowing Position)*
Existing	specific	**Mobile Phone**
	More specific	**Mobile phone for elderly**

Many professional (re)design practices are of this kind, including the example given by Ulrich and Eppinger mentioned in Section 11.3. In their case, user study begins with the goal of creating a cordless electronic screwdriver. This goal is the beginning context for their user study and is rather determined/specific. The user study is to increase even more the level of specificity about this context. User-centered design is very established in tackling this kind of design situation. Ulrich and Eppinger give a full account on the procedures of user study. But then there is design situation where the beginning of design is more undetermined where the product to be designed is not specified. Currently this type of design is also being handled within the user-centered design approach. We might take Beyer&Holtzblatt (1998) as an example.

13.1 The case of Beyer & Holtzblatt

As mentioned in the Introduction, in Human Computer Interaction (HCI), there are more formal discourse and research on user study. There are also quite a number of publications that focus on user study and user-centered design in general. Notable are the Morgan Kaufman Series in Interactive Technologies, the Software Quality Institute Series by Prentice Hall and the proceedings of the ACM Computer-Human Interaction annual conferences. If one compares the reasoning and the types of methods employed for user study in HCI with those in Industrial Design, then one will find no big difference. I have chosen to examine the approach Contextual Inquiry established by Hugh Beyer and Karen Holtzblatt (1998) for designing computer products, both softwares and hardwares. What makes their account stand out is the excruciating details and examples Beyer and Holtzblatt provide in their book. More interestingly and importantly, their account devotes a lot of attention to interpretation and organization of the collected data. It is the more detailed if not the most detailed discussion and documentation on the final product of user study that I could locate.

Although often being referred as a method of user study, Contextual Inquiry is more an approach to design. Its primary data collecting method is on-the-field interview and observation. Beyer and Holtzblatt recognize the importance of interpretation of data to guide design and they make it a step in user study to cross check with users. Users are asked to confirm whether the interpretation of the interviewer is indeed correct. Besides, they have developed a very systematic way to interpret and organize the data that have been crossed checked by users. They name the product of interpretation and organization of user study data 'work models'. There are five types of 'work models' and each provides a particular dimension about user's work[1].

- *The flow model* describes the various roles a person plays and the communication and coordination flow a person has with others as a function of these roles. The flow model allows a bird eye view over the organization whose communication pattern the new design must support.
- *The sequence model* describes the different tasks to be done and the order in which they occur. The sequence model can reveal the intent, strategy and important matters that drive people's actions.
- *The artifact model* represents the things users make up to support their work. An artifact reveals the assumptions, concepts, strategies, and structure of work people have.
- *The cultural model* is aimed to describe the organizational culture that affects how people work. It is suggested that a design that accounts for the work culture is more likely to succeed.
- *The physical model* depicts that physical environment that either support, enable or hinder how people work.

[1] Beyer and Holtzblatt use the term 'work' to mean everything users do, such as playing games, shopping, etc.

These models direct the attention of the user study practitioners in collecting data and create the ‘work models’. And from these ‘work models’, they take a further step to create 'the affinity diagram' and 'consolidations of work models'. In general, data samples presented by Beyer and Holtzblatt are similar to those given by Ulrich and Eppinger in terms of quality: concrete, particular and historical. The ‘work models’ are similar to the ‘statement of needs’. And the 'affinity diagram' is similar to the 'hierarchy of needs'. Therefore, there is no need to examine the quality of the 'work models' and the 'affinity diagram' as they have been discussed in the Chapter 11.

However, what is worth examining is the 'consolidation work models'. The 'consolidation work models' are representations that are intended to derive and organize meanings from different 'work models' collected from various users. In other words, a 'sequence model' represents only the work of one user, and a 'consolidated sequence model' represents the pattern of work of several users. Corresponding to the five different 'work models', there are five different types of 'consolidation work models'. The value of 'consolidation work models' is that they reveal general and abstract pattern of work and allow higher level of manipulation. As explained by Beyer and Holtzblatt, in order for a new design to address a class of users instead of just one user, the commonality in intent, strategies, structures, concepts and mind-sets shared by different users must be uncovered across 'work models'.

'Consolidation work models' are aimed to 'induce' more abstract statements that are implied and hidden behind the collected concrete, specific, and situated data.

> ‘Consolidated sequences models bring together many instances of many individuals accomplishing the same tasks, revealing what is important to doing the work: what need to be done, the order and strategy for doing it, and all the different motivations driving specific actions. A consolidated sequence model shows a designer the detailed structure of work they need to support or replace. It shows all the different intents that must continue to be accomplished in the presence of the new system or rendered unnecessary. It shows the overall structure of the task, which may be mirrored in the system

> to make it more useful and intuitive. And it shows where the task is needlessly complex and could be simplified by a new system' (Beyer & Holtzblatt 1998: p.171)

To create a 'consolidated sequence model' there are four steps:

- Collect various sequence models for the same task performed by different people.
- Identify the common activities to perform the task in sequence.
- Make an 'abstraction step' that describes each activity.
- Derive 'intent' from each 'abstraction step'.

According to Beyer and Holtzblatt, each level of interpretation allows redesign. However, it is the final step - the abstraction of the data to the level of intent, strategies, structures, concepts, and mind-set that allows design team to move toward innovation. Generally an innovative product renders intent irrelevant and very likely change the way 'work' is done. Innovative designs are the ones that replace or remove 'work'. The example given by Beyer & Holtzblattz is about how two managers diagnose problems (P.172).

The intent 'learn about problem quickly' is a result of interpretation on the original data 'person walks into office to report problem - can't access files on another machine'. It is also more abstract and more general. The advantage of the 'abstract step' is that it sets the invisible goal that drive actions that are visible. These are often referred as the 'latent needs' or 'hidden intent'. These are seen as the most important understanding of users that drives innovation.

What we can learn from this example is that the level of interpretation of raw data increases as the innovative level of design increases. Raw data is abstracted to a more general level. However, this abstraction is still not a scientific causal explanation, but rather a more general narrative of a particular user context. It is still

rather situated and bound by space, time and actors. This more general narrative is the context to which a design must address. In design situation like this, the design is often referred to as 'conceptual design'. I would refrain from calling this 'conceptual design' for the fact that all design proper is conceptual. Although it might seem again like word play, we might like to follow the language developed here and call this type of design, 'essential design'.

'Essential design' signifies that the essential/general form of the design is determined, but not the more accidental/specific forms. If we look at figure 10 again, then we might suggest that 'essential design' is an example of a design getting more general. There exists a mobile phone, but we would like to replace it with something else to improve or remove 'work'. But we do not know what this something else is. The product to be made is not determined. User-centered design practitioners tackle the problem of 'essential design' by abstracting users needs, (their essential needs, if you will) by providing a more general narrative. But as argued earlier, context and design are independent. Context does not guarantee designs and user study does not necessarily precede designing. Another way to approach 'essential design' is through what I might call a 'design-driven user study' approach.

13.2 The case of 'knowing position'

Design-driven approach to user study might seek to reconceptualize the existing on(to) a higher level of category and to determine the 'essential design'. And once 'essential design' is determined, then more specifics of its forms can be conceived. And these prototypes can be used to guide user study. Here, I will use the example of 'knowing position' in the design of communication products for illustration.

We might again look at figure 10. A mobile phone can be seen as a specific form of communication device. Since it is a specific form, the essence of communication exists in the mobile phone (an accidental form of communication). If we are

interested in 'essential design', then we might consider examining the essence of communication. The idea of *sending-receiving* is our current default conceptual model of communication guiding the designs of communication devices. I see that changing the concept of communication as *sending-receiving* to *knowing positions* is a form of 'essential design' that might open up new channels for more 'accidental design'.

The Shannon and Weaver communication model is considered outdated, however it is still alive in our conceptualization of Information Communication Technology (ICT) products. If we take a look at the latest personal ICT products, we will find that, although they now come in many forms, such as audio, video, color, faster, greater storage for memory, bigger bandwidth, smaller to carry, easier to use, better interface, etc., etc.; all these varieties and 'improvements' (in accidental forms) are primarily designed to enable sending and receiving messages. Conceptually, they are still anchored on the notion that communication is accomplished by sending and receiving messages. While these products give important support for communication, they are not without shortcomings. Sending and receiving messages does not guarantee effective communication. If communication is understood to be a means to other ends, then communication is not considered complete unless and until the desired outcomes are produced. We send email, fax or make phone calls to others with the hope that they do something. But experiences tell that many emails, faxes, and phone calls are simply ignored or receive superficial responses. Sending and receiving messages does not necessarily bring about desired outcomes.

Therefore, I propose to experiment with the idea of *knowing positions*[2]. We know that communication is more complicated than is represented in the Shannon and Weaver

[2] The concept of position is articulated as essential to the nature of communication by David Sless in "In Search of Semotics". He has suggested that communication requires participation and thus everyone

model. The recipient of messages is as much a creator as is the sender of the messages. As the communication designer and theorist David Sless (1986) has said, communication is something that we do together. It is interesting and useful to note that both the words communication and community in English denote the idea of common, something we share and something public and open. Communication requires a community of people who will, desire and are able to share publicly and openly their ideas, their time, their efforts or in other words their beings. The involvement of all parties makes communication possible. Their intention, their interest, their abilities, and their physical and mental state affect communication. And all of these elements we might call 'position'.

I hypothesize that knowing people's positions increases the chance of successful communication. The more positions are made clear, the more we share in public openly; the more likely the communication will be successful because it helps us to determine mode of action. Knowing where someone is helps us to determine if sending an email, making a phone call, or creating a web site is necessary, desirable, or simply useless.

Under this idea of communication as 'knowing position', a communication device called a Personal Tracker Software (PTS) is designed (Chow et al 2003). The PTS is loosely based on personal messaging applications such as MSN Messenger. PTS combines this functionality with a global positioning system (GPS), allowing for access to the location of any individual logged into the software. Certainly this product involves sending and receiving in a technical sense, but the design is conceptualized under the model of 'knowing position'.

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involved in communication has a position and takes a point of view. Although my use of the term "position" deviates from his original idea, it is nonetheless informed by it.

This case of 'knowing position' is merely to illustrate a possible way if we are to take seriously a design-driven approach to user study. What design-driven means is that we recognize that context creation does not necessarily guarantee or precede designs. And when the product to be made is uncertain, another way to approach 'essential design' is the reverse of user-centered design.

13.3 Already practiced

What I have been saying is not unfamiliar. Various forms of design-driven user study have already been practiced and documented by some practitioners and researchers. While the particular practice and goals are different, they have in common the design process beginning with creating specifications before user study is carried out. A notable example is that of Dunne (2001) who makes observation of the environment and identifies opportunities for new designs to be tested with users. Also Manzini's major works focus on creating scenarios for sustainable futures (2003). He believes that designers might stock up various scenarios so that when the opportunities come, there are materials to choose from. This is not unlike those advocates of knowledge for knowledge sake who believe in stocking up knowledge that might one day be of use. And this line of thinking can be supported by Bateson's idea on inquiry. The inquirer, as Bateson claims, needs to be 'ready' to select the 'components of the random which thereby become new information'; however 'always a supply of random appearance must be available from which new information can be made' (1980:P51). A stock of scenarios might well serve different contexts in the future.

Furthermore, design-driven user study can be seen as embedded in traditional design practice. In every design situation, designers must invent specification-in-context for every time when a new design is introduced, it will also bring with it a new context. Even when a highly specific product, such as a phone, is being redesigned, the designer also needs to imagine how the new phone will be used in new context.

The method scenario-building is a particular type of method suited for generate possible specification-in-context and is practiced on different levels of sophistication. A scenario is a narrative about a hypothetical situation or event – a "what-if" story. It might represent a hypothetical past, present, or future, depending on the interests of the people involved. As a tool for thinking about the future, scenarios have taken a variety of forms, depending on the nature of the task and the requirements of the people working through the scenario. Scenario building has been used in design practice for a long time although how systematic or how rigorous might vary. The major contribution of designers has always been, in my opinion, generating possible specifications amid insufficient knowledge. However, what some or many design practices suffer is that the possible specifications do not fit. In other words, some design practice is weak in testing the designs. Possibilities are introduced, but contexts are poorly developed and thus decisions on possible specification are poorly made. It should be emphasized that design-driven user study must generate the same kind of information as user-centered design: possible specifications, a specific context, and evaluation of the fitness of possible specifications and context. The significant difference is the sequence of which information is to be generated. A design-driven user study begins with generating possible specification-in-context.

13.4 Summary

Basically, design is re-design. We either aim to further specify an existing design or to replace it with something else. In the former case, the product to be made is relatively determined/specific and most design practice fall in this category. In the latter case, the product to be made is relatively undetermined/general and 'essential design' needs to be created to guide 'accidental design'. Current user study is established to handle both design situations. I propose an alternative – design-driven user study.

14 JUMPING THE 'APPLICABILITY GAP'

As noted in the Introduction, user study has opened up or diversified. We are getting better and better in expanding the content of user study to match our understanding of design. The earlier user study has focused primarily on usability, but then it moved to include pleasure and emotion, and now it includes much boarder issues and concepts such as experience and culture. The content of user study seems to be much in line with the advance in exploring the nature of design. But what is less examined is the gap between user study and design in terms of its form. Up till now, the gap has never been explored further than seeing it as a problem between description and creation or between problem and solution. The gap between description and creation is a gap of categorical difference. It can never be closed. However, answer to the second research question might help jumping over it.

The gap can be jumped over with the help of the concepts of generalization and specification. User study produces a specific narrative of some particular user situation. However, there is a spectrum of specificity in these narratives, ranging from more specific to more general. To manage the gap, one produces a user narrative on the level of specificity that is suitable for the design project. For example, the (re)design of a cordless electronic screwdriver is already specified at the beginning of a design project, so it requires user narrative that is nothing more general than the use of electronic screw driver. Current user-centered design approaches and methods seem quite effective in creating this type of user narratives. However, if the goal is to replace an existing screwdriver with some undetermined product, then user narrative will be more general. 'Essential' information about users using screwdriver needs to be produced. As noted in Chapter 13, this practice is carried out by using the user-centered design approach. More general and more abstract user information allows more possible specifications to be made, but it also increases the chances for mismatch. There is not specific enough information to make decision on

whether the designs fit or not. As such, the design-driven user study approach is an alternative, as illustrated in the 'knowing position' example above.

It is important to pause and say that user-centered design and design-driven user study are products of human invention. They are two approaches to designing. Like all designed products, they are more suitable to some projects than to others. I conclude here that user-centered design is suitable to designing when the user context is more determined and design-driven user study is suitable when the user context is more undetermined. Since generalization and specification are relative, these concepts allow us to treat jumping the gap as a matter of aligning the level of specificity between user study outcomes and designs.

CONCLUSIONS

This investigation into the nature of design to draw implications for user study leads to some unexpected insights. The question “How does user study inform design?” seeks to understand how design practice benefit or might benefit from user study. Based on our understanding of design, it is suggested that current user study provides a context for design. For the question “What are the formal characteristics of user study outcome?” It is concluded that the outcome is a specific reasonable narrative rather than a general causal explanation. At this point, we might have been satisfied to call it quit. However, more interestingly, the inquiry makes us realize that context creation and specification generation although highly related is independent from each other. Subsequently, it is found that user study does/ought not necessarily precede (and does not guarantee) the generation of possible designs. Thereby, these insights call into question the assumption on which the research questions are based. It is revealed that as much as user study might inform design, in principle, design can drive user study. Besides user-centered design, design-driven user study is also possible and might well be particularly desirable for certain situations. User-centered design is suited for design situations where context is quite determined/specific, and design-driven user study is suitable for context that is highly undetermined/general. These principle conclusions allow us to re-conceive the problem of “applicability gap” as a matter of aligning the level of specificity between user study and design.

This study, as an attempt to bring the discourse on user study onto a deeper level, gives an account of user study in the language and perspective of design. It provides needed arguments to complement informal observations. Its results are a set of coherent concepts that can be used to strengthen communication and inquiry among designers, user study practitioners and researchers. This study, however, does not venture deeper into understanding of design-driven user study nor develop specific design-driven user study methods. These are left for future research. With the support of the research results, we might focus on asking, “How does design inform user study?” “How *might* design-led user study *be?* Further studies might identify and analyze existing practices and might also develop more specific design-led user study approaches and methods. The research results might also allow us to extend the implications beyond user study. We might investigate its meanings for education, theory, practice and research. While these investigations require extensive efforts, here I would speculate on its meanings for design research in general.

15 EXTEND THE IMPLICATIONS

15.1 Design research

In recent years, the design community has been actively exploring the notion of design research. Frayling (1993) makes distinctions among research of design, research for design and research through design. Dilnot (1998) differentiates knowledge of design from design knowledge. Buchanan (2001c) introduces basic research, applied research and clinical research. Jonas (2001) highlights the difference between mode 1, the 'ideal, purified version of knowledge' and mode 2, the 'heterogeneous, transdisciplinary, project-oriented' way of knowing. Krippendorf (2005) suggests that a design science should focus on observing what can be altered and how. The meanings of design research and design knowledge are open for reflection and debate. The problems and opportunities described between user study and design can be extended to a larger picture of research and design.

I suggest that if design-driven user study is thinkable, then design-driven research is as thinkable. It is often assumed that understanding necessarily comes before design, and research comes before design. But as argued, this assumption is misleading. Through the process of designing, a new condition emerges and offers new opportunities for new understanding of the problem at hand. We might not want to spend all our efforts in understanding or in giving a problem a theoretical grounding before we design. Instead I suggest that we follow the opportunistic nature of design. Design research might focus on generating possible specification-in-context.

If research is to produce usable information for design, then it must also be oriented toward a specification. However, the level of specificity can vary, as of user study. Like user study and design, the relation between research and design can be seen as a problem of alignment. Theory, a very general form of description, will not be matching to design situations when the design goal is aimed for more specification.

But it will be more fitting if the design situations are focused on creating 'product' category that is very general. That means, instead of suggesting that generalized theories be irrelevant absolutely, we might suggest that they are potential materials from which design practice extends to more abstract level of experiment. This kind of experimental design practice entails conditional adoption of habits and knowledge established in the sciences and in the humanities. These include reading and thinking in abstraction. However, the objective of reading and thinking is not to generate more generalized knowledge, but rather to create concrete specification-in-context, as illustrated in the "knowing position" case story in Chapter 13.2. These experiments, I might call, design research. It cannot be overemphasized that this type of design research is different from scientific research although both involve the use and manipulation of generalizable knowledge. Design research is oriented toward a specification, not more generalization. This type of design research becomes connecting lines between science, humanities and design, between generalization and specification, between the abstract and the concrete, between knowledge and change. It might become a paradigm of inquiry.

In the social sciences, there is a branch of research practice called action research. Action researchers believe that theory is not enough, action must be taken to materialize theories. As Swann (2002) argues, action researchers, like designers, intervene with the world. Since the purpose and practice are similar, the suggestion has been made that designers can adopt action research as a methodological model for design research/practice. I believe this is a reasonable suggestion, since the design field can certainly learn from other disciplines that have a longer history of practicing research. However, if design is to stand as a discipline to complement or supplement the scientific and humanistic way of inquiry, then we must do more than borrowing from others. As Dilnot (1998) argues quite convincingly, without *design knowledge,* the design field will always find itself subsumed under other disciplines; it will have knowledge without power. To justify and reward our efforts, we must create

alternative approaches and methods to research that are designerly. Using Dilnot's words, this knowledge must not only contribute to design practice, but also to knowledge in general. In order to develop a more suitable research practice for design and to help establish design as a distinct discipline, instead of seeing action research as a method, we may consider it as a paradigm of inquiry. The goal of action research is beyond understanding and knowledge building: it aims to make changes to present situations in a participatory and emancipatory fashion. In many situations, it requires creative designs and making value judgements. Action research is a particular approach to inquiry, with its own assumptions, values and goals.

If we perceive action research as a paradigm of inquiry, then instead of seeing design practice merely as a practice, we may view design practice, as a potential basis for shaping this paradigm. Design is and has been oriented toward action and change. As John Seely Brown (1996) identifies, "a fundamental push for our design work (as well) is to honor the notion of action, situated activity…". Design practice can be a basis for action research, and design research can lend itself to actualizing reality in ways beyond (theoretical) knowledge building.

If research is understood as gaining new knowledge, how can knowledge be constructed through design-driven research? What form can this knowledge take? I do not intend to delve into the concept of knowledge here (it will require another dissertation), but I will again take a short cut through the scientific definition to shed some light on knowledge that can be constructed through designing. Science prides itself on its generalizable and reliable knowledge to predict and control. Regardless of how successfully the scientific community fulfills this claim, I contend that generalizable and reliable knowledge is an inappropriate notion for the outcome of design research, and I propose some different perspectives.

15.2 A form of design knowledge

Design knowledge means different things, so it is necessary to elaborate on what I mean to minimize misunderstanding. For some, design knowledge is the procedural knowledge (know how) that enables designing. And procedural knowledge includes both tacit and explicit knowledge. For some, it is declarative knowledge (know that) that is needed for designing, such as knowledge of ergonomics. And for some, it is the knowledge of the nature of design and design practice. And for some, it is knowledge generated by designing. And it is the last meaning to which I refer when I talk about design knowledge.

Within design discourse, knowledge has also been examined in relation to science. And this is hardly surprising at all because science has claimed a privileged position to knowledge production since the 17th century. Science dominates the discourse on knowledge and a newcomer such as design research must seek relevance to the established discourse. Knowledge in western societies has been equated to science. Scientific knowledge production has been the center of philosophical concern. Indeed western philosophy is focused on epistemology and philosophy of science is well developed. One may say that our understanding of knowledge is an understanding of scientific knowledge. Scientific knowledge is characterized by being, to say it simply, theoretical – general description and explanation of phenomena to allow prediction and control. So one may conclude that theoretical knowledge, as a result of scientific inquiry is considered as the most valuable, if not the most valid.

However, the preference for theoretical knowledge has been challenged and the work of Michael Polanyi, among others, is often cited in design. (It might be because the field of Knowledge Management has taken on board Polanyi). Polanyi developed the notion of 'tacit knowledge', when formulating how the mind recognizes a problem,

Polanyi assumed that all knowledge is personal in the sense that someone must participate in the process of knowing. He suggested that personal knowledge 'accredits man's capacity to acquire knowledge even though he cannot specify the grounds of his knowing and it accepts the fact that his knowing is exercised within an accidentally given framework that is largely unspecifiable' (Polanyi 1969:p.134). This accidentally given but largely unspecifiable framework is what he called 'tacit knowledge'. According to Polanyi, tacit knowledge is necessary for the recognition of a problem or formulation of a hypothesis. 'No rules can account for the way a good idea is found for starting an inquiry… Discovery must be arrived at by the tacit powers of the mind, and its content, so far as it is indetermined, can be only tacitly known' (1969:p138). Polanyi concluded that '(w) hile tacit knowledge (subsidiary and focal awareness) can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge' (1969:p144). The ideas of Polanyi, in design discourse, are often used to argue for the knowledge gained through design practice in context. 'Design knowledge' is then seen as the executive skills or know how designers possess or embody. This type of knowledge is proposed to differentiate design knowledge from scientific knowledge.

There is little doubt that designers acquire tacit knowledge through practice and scientific knowledge is theoretical and explicit. But as people, scientists, like designers, must also have practical, tacit and know-how in order to perform scientific research. But we don't call scientists' practical, tacit and know-how 'scientific knowledge'. Scientific knowledge does not refer to procedural knowledge, tacit or explicit, that enables doing science, rather it means the knowledge generated by doing science. If comparison is to be meaningful, categorically comparable, then when one refers design knowledge to the tacitly acquired knowledge through practice, one should compare it to the tacit knowledge scientists acquire through practicing scientific research. When scientific knowledge is understood to be the

product of scientific inquiry, design knowledge must also be understood to be the special distinguishing product of designing rather than the procedural, either tacit or explicit, knowledge designers possess. If we are to compare tacit knowledge with explicit knowledge, then we can compare tacit knowledge and explicit knowledge in design; or compare tacit and explicit knowledge in science, but not compare tacit knowledge in design and explicit knowledge in science. I therefore maintain that to refer design knowledge to tacitly gained knowledge through practice and compare this with scientific knowledge is mixing categories. I will suggest that the problem of comparison also exist when 'design knowledge' is meant knowledge of everything.

Some would like to call declarative knowledge for design, design knowledge. However, when or how will some content knowledge be called design knowledge? When and how, for example, does ergonomics become design knowledge? One might suggest that when knowledge of ergonomics is used for designing. But this answer takes us from talking about content to talking about know how. No content knowledge is necessarily related to design. In my opinion, all content knowledge becomes relevant to design when someone makes use of it. Designing is always situational, strictly speaking only (content) knowledge in use can be logically called design knowledge. If this is the case, it is more accurate to leave ergonomics be ergonomics instead of calling it design knowledge. At least, this is my position. At any rate, whether one agrees with me or not, if design knowledge is meant to be a type of knowledge comparable to scientific knowledge, it is knowledge generated by design. And for this reason, I suggest that a design, a specification, a product of inquiry as a type of knowledge, design knowledge. It is a type of knowledge that directs actions to bring something into being.

As mentioned earlier, scientific knowledge is necessarily de-contextualized by its aim to generalize; in contrast, design knowledge is context sensitive. If we accept that the world is fundamentally uncertain, unpredictable and can be changed by design, then

the notion of generalizable knowledge seems out of place for design. The idea of building a body of cohesive, unified and generalizable knowledge to explain a certain world is not compatible to design goals and can be left to scientists. Instead, what is more appropriate is the notion of historical, transferable and socially robust knowledge.

Design knowledge as historical, transferable and socially robust

If design is situated and context bound, one must raise the question as how these fragments of specific knowledge be applied in other situations? Jonas (2000) claims that design is a 'historical discipline' as he argues that design has accumulated 'quasi-objects': an archive, this archive is the only basis for knowledge of design. It differs fundamentally from the basis of knowledge of the sciences, because it is a construction kit with no strict rules or refined conventions. In view of the creation of new things, infringement against the rules is even imperative'. What Jonas calls the 'quasi-objects' are what I have been calling 'specification'.

Given that specifications are only fitting to specific contexts, these contexts are likely not be repeated as designs change the world that requires continuous redesigning. Designing is living, as John Chris Jones says, thus it is continuous. Design knowledge is a statement of a historical event that is bound by time and space. Since every context is different, we can only hope for a history of design.

When we conceive design knowledge as historic, no specifications can be generalized but they can be transferred or extended and eventually left behind or re-invoked one day. Transferable means that knowledge can be passed to others and used by them. Design knowledge is not able to predict, but it allows implications to be drawn so others can *anticipate* what might arise in other contexts. I believe that designers, consciously or unconsciously, have always drawn implications from design knowledge to anticipate the outcome and risks. (Otherwise, the profession

would have been dead a long time ago). Design knowledge is being transferred from one context to another. However, what designers have not done so successfully is to systematically reflect, document and disseminate this knowledge. In other words, the design field has fallen short of constructing explicit and public knowledge to build consensibility and consensuality.

According to Ziman (1991), consensibility and consensuality are what make scientific knowledge reliable. The key to building a body of knowledge is that research/design activity is replicable and communicated among people. In other words, I am suggesting some disciplines. Once a design problem is identified, specifications proposed and tested, then the experience and knowledge gained need to be documented and disseminated.

Collective exchange and implementation of design knowledge in various contexts will help establish the robustness of this knowledge. Nowotny et al. (2001) point out that the scientific notion of reliable knowledge must be extended to what they call "socially robust knowledge." This knowledge will be context-sensitive, and instead of assisting prediction, will provide a domain of possible implications that others can draw upon in order to establish the grounds for anticipated outcomes.

The documentation must enable designers to take action (do or make), not to develop more generalized theory. In other words, as described by historians about engineering theory, design knowledge must mediate the tension between abstract and concrete knowledge, between general and specific knowledge (Staudenmaier 1985 p. 113).

> " An engineering theory is a body of knowledge using experimental methods to construct a formal and mathematically structured intellectual system. The system explains the behavioral characteristics of a particular class of artifact or artifact-related materials. Most commonly, these theories are understood to be the intellectual articulations of various branches of the engineering

> profession as they have developed in the United States and Europe after 1850" (p. 108). And "The experimental procedures are intrinsically related to practical application. Thus; the content and procedures of engineering theory are, like the ad hoc style of problematic data, intellectually structured by the demands of technological praxis rather than by the more abstract demands of a scientific discipline" (p.109).

15.3 Final Remarks

I have argued that the design field has different objective from that of the sciences. I contend that scientific research approach is not necessarily the model to follow. I propose to take seriously a design-driven approach to research. Design knowledge must go beyond the personal private knowledge of individual designers and also the definition of scientific knowledge; it needs to be transferable and socially robust.

Of course we can not ignore the fact that design-driven research can be quite limiting, especially when the research agenda is narrowly defined. But at this stage of design research, if we can capitalize on what the design field has been practicing and consciously document and disseminate design results, I believe that it is beneficial to the field. More importantly, what I propose is to think of the design-oriented approach as a paradigm of inquiry with its own assumptions, values and goals and not as a method or a specific domain of inquiry. Under this paradigm, any research method can be relevant as long as it is used to produce transferable and socially robust knowledge. This conception releases us from the discussion on the compatibility of scientific methods to design research and practice. It is a matter of alignment and goodness of fit. Furthermore, given it is conceived as a paradigm, any subject matter can be investigated under it. Therefore, I am hopeful that this approach will lead to more interdisciplinary cooperation and exchange rather than narrowing the areas of design research.

I have used science as a way to discuss design, design practice, design research and knowledge through the whole thesis, but I do not imply that comparisons to

sciences are the only comparisons worth making. I do, however, recognize that science is given priority in our culture (or more precisely in universities), and has dominated research thinking. Like it or not, design research and knowledge are judged by institutions dominated by scientific thinking; the associated values and practice can not be ignored and need to be addressed.

I have not attempted an explicit definition of design research because I believe that the definition of design research is not only a matter of reflection but also a result of action. Design research will continue to change and it will not be only defined by reasoning but also through our imagination and design. Besides, we can define design research all we want, the judging requirement is not really about truth, but rather to what extent the definition can direct and assist the advancement of knowledge in the name of the field. If the hypotheses put forward are intuitively appealing, then in the spirit of our discussion, we should test the hypotheses through practice and define design research and knowledge through action.

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