Inspiration, Interpretation, Explanation

Inference in Constructive Design Research

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Abstract: User research has become a commonplace in design for a reason. It has several functions in design, and gives design intellectually agility. However, inference, procedures that take researcher from data to conclusions, has received little attention in literature on design research. This paper reviews the structure and functions of inference in three traditions of constructive design research: laboratory-based tradition building on experimental methodology; empathic tradition building on interpretive social sciences; and an inspiration-centered tradition building on art. The paper is based on exemplary cases from each tradition. The conclusions discuss the differences between the traditions; the overall importance of inference in the changing institutional landscape of design; and possible design specificities of inference.

Key words: industrial design, methodology, constructive design research

1. Introduction

User research has become a commonplace in design for good reasons. It has several functions in design. Minimally, designers who dive into someone else's world and learn things they could not imagine, making them inspired; at the more extreme end, it creates trust among stakeholders, functioning as glue that keeps the design process in focus. User research helps designers understanding of complex systems and what humans do with them. It also helps them to argue their positions better for researchers, businessmen, and government officials. In brief, research has added intellectual agility and reflection to design.

However, literature on design research is mostly descriptive what comes to methodological issues of research. Literature concentrates on data gathering, prototyping, and cases [for example, see 3, 13, 21, 25]. Another crucial component of any research, inference, or procedures that take researchers from data to conclusions, has received far less attention. Still, clarity about inference is crucially important in two fronts: in getting the research process better in control, and in arguing research to scientists and strategic managers. Understanding inference is a necessary step towards a more believable design research.

This paper reviews two aspects of inference in constructive design research, i.e. design research that borrows techniques from design and integrated models and prototypes to research process (for an analogue, see

Frayling's [9] discussion of "research-through-design"). The two aspects are the structure and functions of inference. The paper focuses on three traditions in constructive design research: an inspiration-centered tradition building on situationist art; laboratory-based tradition typical to emotional design; empathic tradition building on interpretive social sciences.

There are several reasons to focus on these by now complex research traditions. First, they have their origins in industrial design rather than media or engineering, which gives them specific value in understanding how design research could become a new science. Second, they are successful in that there is a continuous line of development that spans over several academic generations (hence the word "tradition"). Third, they are integrated in that they provide tools for every phase of the design process, i.e. they do not narrow their focus on just one particular phase from a question to an answer. Fourth, they are research-based rather than build on practice alone. Mere practice does not make research; these traditions have a significant publication track record and also following. These traditions do not shy away from theory, and are reshaping design practices in their home communities.

2. Inference in Constructive Design Research

In some of the best cases of constructive design research, the line between design and research is blurred. Researchers borrow most of their research techniques from design, and even the research process is modeled after design processes. For example, Wensveen [36] built a prototype of a sensitive alarm clock through a process of sketching, building mock-ups, and finally prototyping his ideas. However, the difference to professional design is still clear. Wensveen's work was not meant to be commercially viable, or finished by professional standards. He constructed his study to contribute to an understanding of tangibility in interaction design. His process was aimed at contributing to knowledge openly, not to create property rights or increase market share. The ethos of his work was scientific; it was not based on professional design [see 19].

Of particular interest to us is the way in which Wensveen evaluated his designs. After building his prototypes, he evaluated it through a series of laboratory-like tests. Roots in ergonomics and later, human-computer interaction, one tradition of constructive design research proceeds by through a laboratory-like research model exemplified by his work. No doubt, this laboratory-style approach is the mainstream in constructive design research, but it is not the only way to conduct constructive design research. Others have successfully built their research models after artistic practice and professional design, usually seeing research as a source of inspiration rather than a way to produce knowledge [see 7, 8, 29]. Still others have built on interpretive social sciences. The interpretive tradition was first born in computer-supported collaborative work [for example, 6], and became popular in industry through contextual design [3], but methodologically, it has come of age in industrial design [see 17]. Table 1 provides a breakdown of the three traditions along four main categories.

These traditions also differ in how inference is put to use. The "functions" of inference can be classified into three main classes. Primary functions are functions that the traditions put to the fore, like creating ideas for design, or explaining and understanding how designs work. Secondary functions place designs into context, stressing decision-making and creating knowledge. Tertiary (or latent) functions are rhetorical and political [31].

Table 1. Three traditions in nutshell

	Key words	Models	Institutional grounding
Inspiration	Probes, design noir	Builds on art world metaphors and examples	Art worlds, professional design
Explanation	Design and emotion	Modeled after cognitive and experimental psychology	HCI
Interpretation	Empathic design and sociological concepts.	Builds on sociological theory	Design research

In terms of sheer volume, the explanatory tradition is no doubt the mainstream in design research, mainly due to import from software design and human-computer interaction research (HCI) [for example, 28]. Historically, inspiration is a deliberate response to the scientific claims done in HCI [see 4, 13]. As we shall see, the anti-scientific tenets of the inspiration tradition are in large part construed as an antithesis to cognitive psychology and its exceedingly narrow understanding of science and knowledge. The interpretive tradition is the least known of these three. It builds on interpretive social science, which has a long and distinguished history, but its position is unclear. The reasons are beyond the confines of this paper, but we can speculate that its conscious avoidance of statistical means of analysis feels anti-scientific for research-oriented designers, but still too systematic for the artistically minded set. Still, it has a firm grounding in industry and some universities alike (see Ethnographic Praxis in Industry Conference at www.epic2008.com).

This paper is based on exemplary cases from each tradition. Using traditions as a unit of analysis is a particularly informative way to look at constructive design research. If one knows someone's position in the rows of Table 1, he knows many other things as well, including way to understand knowledge, the role of theory, and many if now most aspects of methodology. For example, interpretive researchers see knowledge as construed, and concepts as sensitizing devices [1, 2], while people working in the explanatory tradition see concepts as constructs that, once validated, are to be treated as facts. In the explanatory tradition, theory provides a bird's eye view over activities, phenomena, and processes and that way, a firm grounding for thinking and makes predictions possible, while in the inspiration-oriented tradition, theory is suspect, and deconstructed to maximize freedom of exploration. Methodological fault lines go deep as well. For example, interpretive researchers stress studying people and technology over time in natural situations (i.e. in non-manipulated and non-controlled situations), and work inductively from data towards abstractions. The experimental tradition builds on existing body of knowledge, constructing causal explanations in laboratory-like settings.

3. Inspiration: Bringing Art to Design Research

The best-known examples of making art as the basis of design research come from Royal College of Art, London. When Gillian Crampton-Smith got a research grant, she hired a group of researchers with a background in psychology and design. However, instead of basing user research on cognitive psychology, they built an explicitly anti-scientific methodology based on cultural probes, analysis through gossip, and prototyping [7, 8, 13, 29]. Outstanding studies have also been done in Aarhus and in Interactive Institute in Sweden [24, 32].

Although the original British group has lives in only a truncated form today, it has a massive following in design and HCI.

This tradition was built to be anti-scientific from the beginning, as its key texts witness. The next quote refers to the "Placebo Project" in Royal College of Art, London, which was a study of electro-magnetic fields with a series of "placebos." Placebos were design objects that were not meant to provide any actual guard against EM radiation, but to function in many ways as art pieces that made people stop and think about roles ubiquitous electro-magnetism plays in their lives.

> The Placebo project is definitely not scientific. … We accept that the group of adopters was self-selecting. We also accept they are probably exceptional people. But they are real people, anything we discovered would be grounded in reality rather than fiction. [8: 75; 31].

This ethos goes beyond ideology. In particular, the driving metaphors and sources of inspiration are artistic and design-based. For example, they built on surrealism in an attempt to get into dream-like qualities of existence. Their sources of inspiration came from several artists, including the situationist (mainly Guy Debord's book *The Naked City* and his "psychogeographique" [5]), Gillian Wearing, and Sophie Calle. Finally, whatever theory there was, it was loosely interpreted post-structuralism, which helped to deconstruct theory rather than build yet another theoretical house.

As a consequence, there is no systematic inference in this tradition. Instead of analysis, "design proposals" are arrived at through a series of tactics rather than systematic analysis. Instead of talking about analyzing data, this tradition originally talked about "responses to [probe] returns," replacing conclusions with design proposals and thus making the claim that there is no need for a structured step between user data and concepts. Gaver once explained the "tactics for using returns to inspire designs" in the following way:

1. Find an idiosyncratic detail: look for seemingly insignificant statements of images.
2. Exaggerate it: Turn interest into obsession, preference to love, and dislike to terror.
3. Design for it: imagine devices and systems to serve as props for the stories you tell.
4. Find and arteface a location. Deny its original meaning. What else might it be? Add an aerial. What is it? Juxtapose it with another. What if they communicate? [12]

Of course, *something* inevitably takes place between the arrival of probe returns and design concepts. In a presentation given in 2002, Gaver used the word "gossip" to describe inference in the Presence project. As data (or "returns") were mailed to London from various parts of Europe, they were spread to a table at the university, where researchers were able to read it. Researchers who came by simply discussed pieces they saw and people who had sent them over the next few weeks, trying to create a coherent story – just like gossipers do. Researchers were not interested to know whether their story was correct or not. Again well in line with the anti-science ethos of this tradition, there is no way to know whether the outcomes of this process are better than some other outcome: no systematic methodological justification is spelled out.

Recently, some researchers have added an evaluation phase, but with a twist. Art and design have long since been expanding beyond the gallery space to other sites and situations, and this expansion also occurs in research. In his study of electronic objects, Dunne suggests that design research should explore a new role "that facilitates more poetic modes of habituation: a form of social research to integrate aesthetic experience with everyday life through 'conceptual products'" [7: 29]. These conceptual products can be subjected to not only other researchers' and artists' judgment, but also to that of the public:

> The space in which the artifacts are shown becomes a 'showroom' rather than a gallery, encouraging a form of conceptual consumerism via critical 'advertisements' and 'products'. New ideas are tried out in the imagination of visitors, who are encouraged to draw on their already well-developed skills as window-shopper and high-street showroom-frequenter. [7: 78].

The showroom metaphor exposes design to complex social processes. The showroom metaphor situates design to commercial surroundings, which is something any design object has to face. If one follows design in showrooms, one gets at the commercial and meaning-making aspects of design better than in academic conferences, a critique, or a board meeting. Naturally, this metaphor has its limitations. It still keeps design within the commercial cycle, which is only one way to look at design. Also, this metaphor covers only one and very particular stage in the life of a design. Further, this metaphor is relevant to a particular class of design products only. However, in later studies, showroom has changed into actual places – homes, offices, corridors – in which proposals are to be used [33]. These developments make it possible for researchers to see how people understand and adapt to proposals outside the institution called the market. Larger socio-cultural studies are still missing.

4. Explanation: Understanding Design through Experiments and Statistics

Another successful way to do constructive design research originally borrowed its main signposts from human-computer interaction (HCI) and beyond it, experimental and cognitive psychology. Later, this tradition first turned into ecological psychology (i.e. Gibson), and then to emotional psychology and the notions of experience and interaction. Today, research centers on enriching these notions, including concepts like rich interaction [11], and intuitive interaction [23]. Recently, the tradition has been informed by 20th Century Continental philosophy [27].

Studies in this tradition are conducted in laboratory-like conditions by introducing explanatory variables like gender or lighting conditions systematically into the laboratory, and by observing what happens to the outcome variable as these parameters change. The aim is to identify causal mechanisms that could provide a solid ground for design. However, the best work in this tradition borrows most of its research techniques from design, and always places sketches, mock-ups and prototyping into the center of the tradition. Perhaps the best recent example is Frens [10, 11], who studied "rich interaction" to create objects that make us to use perceptual-motor and emotional rather than cognitive skills. In his study, he built a tangible a camera. The phases of his study are described in Table 2.

Table 2. Methods and user involvement in Frens [10, 11]

Phase	Content of the phase	Methods	User involvement
Theory	Tangible interaction, rich interaction	Conceptual and theoretical work	-
Scenarios	Five scenarios to study rich interaction	Rough 3D sketches of cameras	Only scenic, as players in scenarios
3D sketches	Studying the form factor	Detailed interactive 3D models made of cardboard	Studied with TU/Eindhoven students
Prototype	Building a prototype	Physical and electric engineering work.	-
Testing the prototype	Testing hypotheses about rich interaction with the prototype	Set-up of a laboratory. Specifying a causal system. Constructing indicators. Studying user data with t-tests, ANOVA, Tukey post-hoc tests.	Studying 24 users recruited from TU/Eindhoven's Architecture department.
Conclusions	Discussing results and hypotheses.	Discussing rich interaction. Discussing research-through-design.	-

Compared to the inspiration-centered tradition, this mode of analysis makes the step from data to design structured scientific rather than artistic. The focus is on explanation, not on inspiration. Essentially, research helped Frens to make decisions about whether his thinking was correct of not. There is no certainty that the results are correct, but due to statistical techniques used, the likelihood of them being wrong is small. Compared to the showroom metaphor in the inspiration-oriented tradition, the "tail" of design at lab is considerably shorter and more controlled. Here designs are placed outside commercial environments – unless commercial aspects are brought as stimuli into laboratory – but studied only in terms of cognitive and emotional reactions rather than social and commercial processes. The assumption has been that knowing how people react to designs in cognitive and emotional terms helps one to generalize results and predict future uses. Strong theoretical assumptions need to be evoked to account for generalization. Generalizing from laboratory results to actual use may be relatively straightforward, as in Wensveen's [36] alarm clocks, but with objects like mobile phones and cameras, more caution is needed. Maybe for this reason, some recent work tests the results in natural environments [16, 23]. Obviously, as in the inspiration-oriented tradition, socio-cultural studies are still missing.

However, we find an inconsistency as soon as we look at the details of the master studies of this tradition. It concerns early stage user studies that tend to aim at inspiration. They tend to be qualitative, have a small number of cases, and are often done using probes and contextual inquiries. For example, Wensveen [36] borrowed cultural probes from the inspiration-oriented tradition to his early-stage research, but later phases of the process were very different. When one looks at the functions of inference in this tradition, one needs first to make a distinction between inference as a whole, and inference in specific parts of research. Thus, although studies in this tradition are modeled as experimental studies as a whole [35], in specific parts of research, inference may fall outside the scope of experimentation. The experimental phase characterizes the final stage after a prototype is finished. At this stage, theories in this tradition tend to be testable theories of the middle-range. In this sense, this tradition has a more complex functional landscape than the inspiration-oriented tradition.

5. Interpretation: Induction and Fieldwork

The third tradition joins the "interpretive turn" in the social sciences [see 30]. Precursors to this approach come from ethnomethodological research carried out in Palo Alto Research Center, participatory design, and activity

theory [6, 15, 26]. In addition to this foundation, more recent work also builds on pragmatism and symbolic interactionism [see 1, 2], and is better known as an empathic tradition [see 17]. The main difference between the precursors and recent work is the positioning of field studies. In the early work, it informed the early stages of design. In more recent work, research is conducted across the whole research process, leading to the notion of co-design [23].

The driving belief of the interpretivist tradition is that the meaning of any design gets constructed in a social process. People use designs, experience them in many ways, construct definitions, and act on these definitions. They talk about their experiences, learn from each other, and thus come to construe joint lines of action. In methodological terms, understanding these social processes requires that designs are placed into social situations in which people are free to use designs for quite a long time. Designs are placed into ordinary social settings in which they are followed using naturalistic research design and methods over a sufficient time span so that social processes have time to evolve. Under these conditions, the meanings of designs get construed naturally, and these meanings can be studied empirically [cf. 20].

Analytic processes are built to reflect this belief. Though designers know them best from "affinity diagrams" [3], interpretive designers prefer to build on interpretive social sciences instead [18: 181-182]. Koskinen describes the analytic process as a series of steps from subsamples to more encompassing interpretations:

1. Analyze a small number of cases (typically, people) closely. Push hunches and inspiration too far: at this stage, it is important to be creative. Unworthy ideas are dismissed later.
2. Create a set of hypotheses from this analysis.
3. Test these hypotheses with the same data.
4. When a hypothesis stands this preliminary test, analyze negative cases that fit to the emerging hypothesis only with difficulty. If the case does not fit the hypothesis, discard or revise the hypothesis, or add a new dimension to the analysis. Typically, negative cases come from secondary and deviant user groups.
5. Proceed until all cases have been analyzed, and you have a description that describes all data. Typically, this is a conceptual framework that is ordered from the most important concepts to less important ones. This conceptual framework can simply be called "an interpretation."

Up to this point, the designer has been working with a subsample of data. There is no way of knowing whether this interpretation is correct for all data. Thus, the final step:

6. Finally, generalize the interpretation with all data that has been gathered, with comparative data from other studies, and with experiences from other design processes. [17: 62-63]

Such inductive process goes on until the dimensions of the description are internally consistent, differ meaningfully from each other, and form a coherent interpretation. An important difference to the inspiration-oriented tradition is that the step from data to design is not direct, but takes place through the inductive process

described above. In contrast to the explanatory tradition, structures in data are explicated rather than explained with statistics. Unlike the explanatory tradition, the interpretive tradition normally uses people's own terms instead of researchers' concepts in explicating data. Also, like the explanatory tradition, the interpretive tradition aims at creating a parsimonious framework and believes in Occam's Razor. The price of information is the loss of some specificity [17: 63-64].

In terms of the functions of inference, the interpretive tradition has many similarities with the explanatory tradition. Like in its explanation-oriented cousin, inference functions at two levels. Overall, the tradition aims at understanding how people relate to a design proposal, but specific studies leading to design may have other functions. Like in the explanatory tradition, there is typically an early-stage user study that aims at inspiration, usually done either with contextual design techniques or probes [3, 13]. Also like in the explanatory tradition, the interpretive tradition also provides knowledge that can be re-used. As the aim is to create a "thick" description [14: 3-30] rather than universally valid knowledge, the problem of external validity (the step from sample to population) is understood as a possible additional problem. However, few comparative studies have been done so far, even though some quasi-experimental research designs have recently been reported [22].

6. Discussion

Design research is a fairly new academic field, but it has matured significantly over the last decade. While the field initially borrowed most of its practices from other, more mature fields of research, design research today has a set of distinctly design-specific practices that respond to the needs of design better than the early borrowings that typically came from ergonomics and cognitive psychology. Though design research may look like quasi-ethnography to an anthropologist, mediocre art for a fine artist, and amateur psychology for a psychologist, we think the field is coming of age, and will serve design in years to come better and better [19]. As we have seen, there are several traditions in the field. These traditions have achieved a level of complexity suitable for design, and they work at a high level of methodological sophistication. We welcome this proliferation of sophisticated traditions as another sign of maturity; it is not a pitfall.

What animated this paper was the observation that methodological debate is largely either missing or worse, builds on dangerously simplistic models borrowed from human-computer interaction in which being scientific is usually equated with experimental research. This is clearly not just narrow-minded, but also dangerous. After all, astrophysics would not be a science by this standard.

To correct for this gap in knowledge, this paper has studied three successful traditions of design research. It has explored two things in these traditions:

— The forms of inference. We have seen how for the inspiration-oriented tradition, the primary value of research lies in inspiration for design, making inference a background issue. For the other two traditions, inference plays a more crucial role in directing designs, in communication, and in creating knowledge. These differences reflect ways in which these traditions see their primary audience and in which they situate themselves institutionally: to art and design, or to the (social) sciences primarily.

— What functions inference has? The primary use in which all traditions converge is that research creates ideas for design. They vary in whether inspiration is enough, or whether they also see explanation and understanding as crucial elements of research. Secondary functions relate inference to decision-making and creating theory. Here we see more variation. The inspiration-oriented tradition plays down these functions, while the other two traditions function in a scientific mind-set, linking new studies to tradition. What comes to the "latent" functions like rhetoric, commitment, and politics [30], there is not enough material to analyze these functions in the key texts of the traditions. However, it is clear that these functions are relevant in understanding how inference is construed in each tradition. In the inspiration-oriented tradition, inference is framed as a creative exercise. In the other two traditions, inference provides credibility and validity to researchers' claims.

This paper not only aimed at explicating inference and its functions in user-centered design, but also makes a call for more methodological reflection. The better we know how we do research, the better we are able to design our work, to keep it in control, and to tell about our work to fellow designers, companies, and to fellow academics. It also calls for methodological tolerance. There are successful ways to do constructive design research. As the inspiration-oriented and the interpretive tradition show through their existence, design research can build on many bases. By accepting this fact and welcoming it, we are able to get contributions from artistically and design-minded designers, and also from those who see themselves as interpreters, not only from those coming from human-computer interaction and its dominant experimental research paradigm. We hope that we have shown that there are many possible ways to do research in design. Each of these ways responds to problems faced by designers with many likings.

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