

Relevant and Rigorous: Human-Centered Research and Design Education

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Introduction

The process of human-centered research and design rightfully demands the active consultation of people (users). However, the approach to research and the selection of methods employed in this process are a matter of frequent debate, particularly when placed in an interdisciplinary context. Bartneck, for example, presents a discussion of the evident conflict between designers and scientists within the human-computer interaction (HCI) community.¹ Designers often must answer to critics well versed in research methods, and this dialogue frequently centers on issues of rigor and relevance.

If the argument were simplified into extremes, two propositions would exist. Designers could ignore the critique of the established scientific (and social scientific) disciplines, highlighting a creative process that resonates with a strictly qualitative approach, small sample sizes, and anecdotal evidence, bolstered by an argument of relevance in connecting real-world research to real, human situations. At the other extreme, the design community could prescriptively follow the strategies and methods of science and the social sciences, recognizing the need for rigor in research, and understanding the necessity of employing established, replicable protocols, particularly when attempting to generalize outcomes or target design applications to large, diverse audiences.

However, holding such a polarized view of the world does little to advance the status of human-centered research and design. A more useful model is to understand all realms of the qualitative, ethnographic and quantitative experimental paradigms, and to seek balance in employing methodologies appropriate to the context and timing of research questions in the human-centered design process.

This paper will present an argument for equipping designers with such a balanced view of research for human-centered designing. The argument is grounded in several years of teaching project-based courses and studios in human-centered research and design, as well as consulting. The term “human-centered research and design” is used here to indicate an integrated process that includes active consultation with people (users) through various means of primary research during all phases of design development. Expertise is based

1 Christoph Bartneck, “Notes on Design and Science in the HCI Community,” *Design Issues* 25:2 (Spring 2009): 46–61.

primarily on experience in industrial design, communication design, and interaction design. Furthermore, the author's perspective is informed through interdisciplinary interactions with students and professionals that commonly intersect with design, including those from human-computer interaction and the social sciences. Finally, it is acknowledged that the arguments presented here are primarily applicable to North American design curriculums, recognizing that schools in Asia, Europe, and elsewhere may present very different experiences and viewpoints, and that there are exceptions even within North America.

Science and Design: The Relevance of Rigor

The measure of good research often is associated with a rigorously scientific process, and this is justified for many areas of inquiry, such as medical science. Typically, the scientific method involves a process of identifying a problem or question, forming a hypothesis, testing the hypothesis by conducting an experiment or study with proper controls, checking and interpreting results, and communication.² The established research practices of the sciences and social sciences have built their credibility on an extensive history of disciplined methodology that attempts to isolate cause and effect, eliminate bias, maintain objectivity, and generalize findings. These hallmarks of scientific inquiry are important for designers to understand, and to strive for in practice when and where appropriate.

However, approaches and methods from non-scientific disciplines are equally valid, with particular merit for the purposes of design. Methods created by design or those adapted from other human-centric disciplines such as ethnography correspond to the requirements of design as a creative process, and in holistic content inclusive of relevant, emotive human concerns. For example, the intent of exploratory research in design is clearly exemplified in this definition of ethnography: "The study of people in their natural settings; a descriptive account of social life and culture in a defined social system, based on qualitative methods (e.g. detailed observations, unstructured interviews, analysis of documents)."³

Ultimately, there is benefit in utilizing a wide range of methods throughout the process of human-centered research and design. For example, design ethnography is appropriately employed in exploratory research, while other qualitative methods describe participatory design techniques, and experimental models of research often are most appropriate in product testing.

Excellence in the conduct and methods of research should be the goal of any researcher, scientific or otherwise. As Robson describes, a scientific *attitude*—being systematic, skeptical, and ethical⁴—will serve to elevate the conduct of research by any profession. Designers with a solid and broad understanding of research can successfully conduct their studies with a degree of rigor appropriate to the situation. They will understand the

2 There are several sources that provide an overview of the scientific method. See, for example, Centers for Disease Control and Prevention (CDC) at: www.cdc.gov. Complete reference at: www.cdc.gov/ncbddd/folicacid/excite/Files_in_use/steps_of_the_scientific_method.htm (accessed 6/15/2009).

3 Ann Bowling, *Research Methods in Health: Investigating Health and Health Services* (Buckingham: Open University Press, 1997).

4 Collin Robson, *Real World Research: A Resource for Social Scientists and Practitioner-Researchers* (Oxford: Blackwell Publishing, 2002).

principles of good research and learn when and how to reduce bias, maintain objectivity, produce replicable or generalizable results, and relate research findings to design outcomes. Equipped with the right knowledge and tools, they also will know what limitations are imposed on their studies when they depart from established principles, enabling them to communicate their research appropriately, and to answer their critics with authority.

Likewise, the sciences have much to learn from research of the humanities and arts, including design. On the spectrum of relevant and rigorous, qualitative methods and studies can legitimately claim success in the former realm, with well-founded criticisms of the reductionist research often conducted in the sciences and social sciences. Regardless of approach and methodology, designers are accountable for the research they conduct, and for advancing the credibility of the profession through the application of sound methods, and a clear articulation of their grounded, creative work.

Exposure: Research Methods and Design Education

Clearly, this comprehensive understanding of research has implications for the fundamental education of designers. Designers must be taught and must experience the underlying philosophy and methods of qualitative, ethnographic approaches, and of science and the experiment as a research strategy. Armed with this knowledge and experience, designers will be equipped to make informed decisions when planning and presenting their own research, and to intelligently critique research conducted by others, in the human-centered process of design.

While many post-secondary students gain exposure to research methods through a fundamental core of their education, this is not consistently true for designers. A student educated in the sciences, including computer science and human-computer interaction, or in the social sciences, frequently will be required to take courses in research methods and statistics, and to apply this knowledge in proposals and the actual conduct of experiments or scientific studies. Through their education and practice, students of these disciplines will learn how to design credible research studies, and to critique studies on the basis of methodology.

Design students, on the other hand, are rarely introduced to research methods in any formal sense; there are few required methods courses taught in design schools, particularly at the undergraduate level. The National Association of Schools of Art and Design (NASAD), responsible for accrediting a vast number of North American design schools, includes the following competency requirement under “Essential Competencies, Experiences, and Opportunities” for most professional baccalaureate (undergraduate) design degrees: “The ability to solve design problems, including the skills of problem identification, research and information gathering, analysis, generation of alternative solutions, prototyping and user

- 5 National Association of Schools of Art and Design, *NASAD Handbook 2009–2010* at: http://nasad.arts-accredit.org/site/docs/Handbook/NASAD_Handbook_2009-2010.pdf. (accessed 6/15/2009).
- 6 Brad Weed, "The Industrial Design of the Software Industry," *SIGCHI Bulletin* 28:3 (July 1996): 8–11.
- 7 Bruce Hanington, "Human Centering Design across Dimensions," *Proceedings of the Design Research Society DRS conference, Wonderground* (2006).

testing, and evaluation of outcomes."⁵ While this implies that students must become generally competent in conducting research, it does not explicitly require courses or content in methodology. Requirements for research methods education are made more explicit in graduate and doctoral program descriptions.

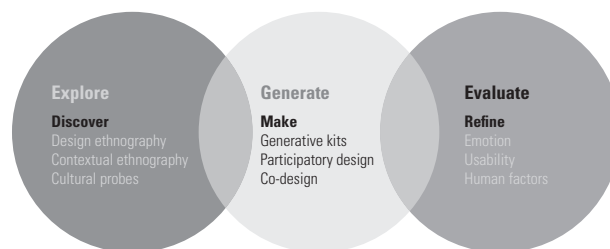
Specific exposure to methods also varies by design discipline. Human-centered design is most evident in industrial design and, more recently, interaction design through well-established connections to human factors.⁶ However, even traditional courses in human factors have a disproportionate reliance on testing of existing products or design outcomes, rather than on early user research to inform or inspire design directions, or participatory design for generative purposes. Graphic design has an even shorter history of experience with human-centered research; courses in human factors are significantly absent from most graphic and communication design curriculums.⁷

Differentiating Design: Research and the Creative Process

One reason why many design schools do not have explicit instruction in research methods is that there are few design instructors that have the experience or educational qualifications to teach research methodology. Furthermore, many programs, particularly those situated in art colleges, have a skill-based portfolio emphasis in their curriculum, and may be limited to two years for vocational student training. In the university or college setting, disciplines such as psychology and sociology offer suitable methods courses, yet these are not integrated into the creative process of design. It is critical that research be integrated into the creative process, and not isolated from it. This argues for a model of teaching that supports direct experience in research by design students, rather than relying solely on other disciplines for research support.

A successful model of education employed at Carnegie Mellon University is process-oriented, defined by the integration of methods and creative development through specific phases of exploratory, generative, and evaluative research and design. Each phase is generally characterized by approaches, while not limited by specific methods. As indicated in Figure 1, the three phases blend in their transitions, and are each iterative in nature.

Figure 1
Model of Design Research



The model has been used successfully for several years at the graduate level to frame a required course in research methods, linked with a studio project. The model also has been used a limited number of times at the undergraduate level in a human-centered research and design project course. In the following sections, the three phases of exploratory, generative, and evaluative research will be presented, along with a discussion of corresponding research methods and approaches including commentary on the necessary balance of ethnographic and scientific, qualitative and quantitative, relevant and rigorous research in the process of human-centered design.

Exploratory Research: Ethnography and Design

Within exploratory research, students develop questionnaires and conduct surveys, observe and talk to people, and shop for and try products. Methods are typically ethnographic in nature, and may include participant observation, artifact analysis, photo and diary studies, contextual inquiry, cultural probes, and other methods designed to sample human experience. Exploratory research culminates in a comprehensive understanding of the people and the area under investigation, and ideally results in implications for design.⁸

Even the most basic of methods included in this phase of research warrants instruction and experience. For example, surveys, questionnaires, and interviews must be well-designed, not only to achieve good response rates, but also to avoid asking leading questions, to minimize bias, and to ensure that the right research questions are being asked in ways meaningful to participants and researchers.⁹

It also is important to distinguish between ethnography as practiced by professional ethnographers or anthropologists, and design ethnography. While true ethnographers may immerse themselves in a culture or specific population for months or years at a time,¹⁰ designers are more typically seeking adequate information from time-sampled observations of behaviors. For example, designers conducting immersive research may “sample” real experiences of participants through contextual inquiries, combining observations and conversational interviews, analyzing video footage captured during key moments of behaviors or interactions, or relying on self-report diaries and photo journals provided by participants.

The largely qualitative nature of exploratory research, and the adaptive versions of true ethnographic methods by designers, should not be viewed as an excuse for lack of rigor in this phase of research. As Fetterman states in his description of ethnography:

Ethnographers are noted for their ability to keep an open mind about the group or culture they are studying. This quality, however, does not imply any lack of rigor. The ethnographer enters the field with an open mind, not an

8 Bruce Hanington, “Generative Research in Design Education,” *Proceedings of the International Association of Societies of Design Research IASDR Conference* (2007).

9 JoAnn T. Hackos and Janice C. Redish, *User and Task Analysis for Interface Design* (New York: John Wiley & Sons, 1998).

10 Margaret D. LeCompte and Jean J. Schensul, *Designing and Conducting Ethnographic Research, Ethnographer’s Toolkit Vol. 1* (Walnut Creek, CA: Altamira Press, 1999).

empty head. Before asking the first question in the field, the ethnographer begins with a problem, a theory or model, a research design, specific collection techniques, tools for analysis, and a specific writing style.¹¹

Designers are equally accountable for the conduct of good quality research and, in particular, for being systematic in their approach to information collection, recording, synthesis, and analysis. As with surveys and questionnaires, the design of journals or other cultural probes must be carefully considered for collecting the necessary information while respecting ethical boundaries, and for reducing bias through carefully constructed prompts.

Furthermore, understanding the context and limits of this type of research is critical. Based on smaller samples and conducted for an appropriate level of design inspiration, results should not be communicated in deceptive forms, nor misconstrued as generalizable or presumed to have replicable findings. For example, exploratory research based on the input of five or six participants should not be presented using percentages or statistical results, and should be clearly identified as sample evidence designed to provide baseline familiarity with a topic area for subsequent phases of design.

Generative Research: Participatory Design

Generative research opportunities are set by the exploratory phase, and may include similar methods. Diaries, with or without a photographic or imaging component, may be favored and often are issued as an advance probe or instrument to sensitize participants to the topic area and prepare them for participatory exercises. Participatory methods may include toolkits such as card sorting with images or text, collages, cognitive mapping or other diagramming exercises, experience drawing, and flexible modeling or “Velcro” modeling. Generative methods may be projective, designed for participants to express feelings and desires, or constructive, providing a configuration of design components for physical concept ideation.¹²

While this phase of research is rightfully perceived as qualitative, elements of rigor and good practices of systematic investigation are no less critical. In fact, sophisticated models of analysis for generative research do exist, such as multidimensional scaling, to reveal patterns in images and words chosen for collages and diagrams.¹³ However, analysis more typically involves simple occurrence counts of images or toolkit elements, and content analysis of transcripts recorded during participant presentations of creative exercises.

To ensure that research methods are well-planned and executed, it is necessary to develop a research protocol, and to conduct pilot tests of research sessions. A thorough protocol will detail, among other things, planned activities and samples

11 David M. Fetterman, *Ethnography Step by Step*, 2nd ed. (Thousand Oaks, CA: Sage Publications, 1998).

12 Bruce Hanington, “Generative Research in Design Education,” *Proceedings of the International Association of Societies of Design Research IASDR Conference* (2007).

13 P. J. Stappers and Elizabeth B.-N. Sanders, “Generative Tools for Context Mapping: Tuning the Tools” in *Design and Emotion: The Experience of Everyday Things*, eds. Deana McDonagh, Paul Hekkert, Jeroen van Erp, Diane Gyi (London: Taylor & Francis, 2004): 77–81.

- 14 The phrase “useful, usable, desirable” was first coined by Elizabeth B.-N. Sanders, and has since been in popular usage throughout design research. See Elizabeth B.-N. Sanders, “Converging Perspectives: Product Development Research for the 1990s,” *Design Management Journal* 3:4 (Fall 1992): 49–54.
- 15 Bruce Hanington, “Generative Research in Design Education,” *Proceedings of the International Association of Societies of Design Research IASDR Conference* (2007).

of participatory toolkit materials, number and description of participants and how they will be recruited, roles of researchers, how sessions will be documented, and methods of analysis. Pilot testing the protocol will provide a final check of materials and time demands, interpretation of instructions by participants, and possible outcomes. Furthermore, a well-developed protocol will ensure a measure of consistency across research sessions conducted by different designers.

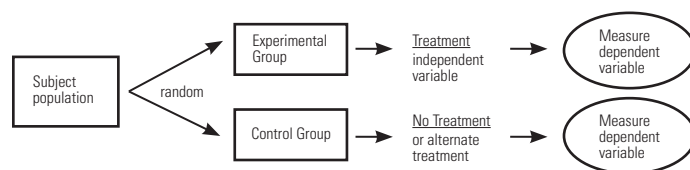
As with much qualitative research conducted with a limited number of participants, generative methods often are criticized for the meaningfulness of information collected, and for the extendibility of results. However, designers well trained in research methodology will be able to present a well-documented systematic approach, appropriately contextualizing the research as guiding information for design inspiration, not generalizable results, in the process of concept development.

Evaluative Research: Testing Design

Evaluative research, as one might expect, attempts to gauge human expectations against the designed artifact in question, determining whether something is useful, usable, and desirable.¹⁴ The methodology may be tightly controlled, corresponding to an experimental model of lab testing, or may involve flexible evaluations by people using products or prototypes in context, or some combination thereof.¹⁵ The protocols of science are common here owing to the nature of questions, more specific now that they may be directed at specific, existing design proposals or artifacts, and also because there is a greater history of “testing” established through human factors in design.

Given the predominance of the experiment as a research strategy in evaluation research, this is where designers are most likely to need exposure to some of the critical features of scientific research. First, it is important to understand what it means to conduct an experiment, and to not misuse the term. While it is beyond the scope of this paper to fully detail the elements of an experiment, Figure 2 illustrates the essence of this approach to research, including key terms likely to be encountered.

Figure 2
The Experiment as Research Strategy



Regardless of whether or not the designer is conducting a true experiment, there are features of this established model that translate to all good practices of research. For example, an operational definition is necessary to define exactly what is being measured. Is a “better” input device, for example, defined by performance speed on a particular task, or ergonomic comfort? Threats to validity are merely anything that can affect the ability to state conclusively that outcomes (dependent variables) are the result of the manipulated (independent) variable, or the particular item under study (for example, a specific design element). Validity, therefore, argues for consistency in research design—for example, if testing a digital interface, the researcher must keep the computer platform and operating system the same in every test. Similarly, research protocol must be explicitly spelled out so that each test is conducted in a similar manner, whether by the same researcher each time (intra-rater reliability), or by several different researchers (inter-rater reliability). In comparison tests, understanding how exposure can affect outcomes may require that some participants experience design “A” then “B”, while others have the reverse presentation (AB | BA) to counteract a potential “order effect.”

While these conditions may not be applicable in every design evaluation, once again, adherence to or departure from established principles of research should be well understood so that selected methods and procedures are conducted without sacrificing research integrity, and are appropriately portrayed with convincing authority. This not only lends credibility to the evaluation research (testing) of the design at hand, but ultimately to the discipline of human-centered research and design.

Conclusions

It is not necessary for designers to become scientists, but they ignore the tenets of good science at their peril. Designers engaged in research need a comprehensive understanding of research encompassing the range of qualitative, ethnographic methods, as well as those of science and the experiment. This understanding is necessary to conduct good, credible research, to enhance the reputation of research in the design disciplines, to argue the merits of design research even in the context of critics from other disciplines versed in scientific pursuits, and to persuade others of the usefulness of design methods for their own use.

To reach this goal, designers need explicit, quality education and experience in research methods. Ultimately, this argues for the qualification of key design faculty to teach methods and guide projects in human-centered research and design, and for specific courses to be integral to design curriculums. While research education currently is more common at the graduate level, undergraduate students also should have required courses and project work in research methods. Various models promoting

an integrated approach to research methods education within the creative design process should be explored and evaluated for effective translation to successful design practices. One such model has been presented here in an effort to reinforce the need for a comprehensive understanding of research in design, and ultimately to advance the credibility and outcomes of responsible human-centered design.