

# Crafting a Place for Interaction Design Research in HCI

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## Introduction

In recent years, a number of academic institutions around the world have worked to integrate design practice and thinking with engineering and behavioral science in support of Human-Computer Interaction (HCI) education and research. While the HCI community generally has been enthusiastic about the benefits that design can bring to this developing interdisciplinary field, tension exists around the role of design in research, because no agreed upon model for a design research contribution exists. Over the last three years, we have undertaken an inquiry to understand the nature of the relationship between interaction design and research in HCI, and to discover and invent methods for interaction designer researchers to more substantially collaborate and contribute to HCI research.

Through our inquiry, we learned that many HCI researchers' commonly held view of design is focusing on the surface structure of products. This echoes Blevis et al's claim that most people in the world view design as adding decoration.<sup>1</sup> This limited view of design makes it difficult for HCI researchers to articulate how they would like designers to participate in research. In addition, the interaction design community lacks a unified vision of what design researchers can contribute to HCI research, and to interaction design at large. The current lack of design participation in HCI research represents a lost opportunity to benefit from the added perspective of design thinking in a collaborative, interdisciplinary research environment. The HCI research community has much to gain from the addition of design thinking; a design perspective that employs a holistic approach to addressing under-constrained problems, and that adds a needed counterpoint to the reductionist approach favored by the scientists and engineers.

To address this situation, we have developed a new model of interaction design research in HCI intended to allow designers to participate more evenly. While this is not the only way for designers to participate in HCI research, we wanted to create a method that allowed designers to make a design contribution without imitating the methods of other disciplines. Our model builds on Frayling's<sup>2</sup> idea of "research through design," stressing how interaction design-

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- 1 Eli Blevis, Youn-Kyung Lim, and Erik Stolterman, "Regarding Software as a Material of Design," *Proceedings of Wonderground* (Lisbon, Portugal: Design Research Society, 2006).
  - 2 Christopher Frayling, "Research in Art and Design," *Royal College of Art Research Papers* 1:1 (1993): 1-5.

ers can engage wicked problems.<sup>3</sup> In addition, we also have created a set of criteria to evaluate this type of research contribution. This approach stresses a transformation of the world from its current state to a preferred state through the creation of design artifacts that provide concrete framings of messy problems. In addition to bringing design thinking to HCI research, this model offers an easy way to transfer research findings to the HCI practice community.

In the next section, we present a brief overview of the evolving relationship between design and HCI. We then present five models of design research that currently exist within HCI. And we present our model, which is intended to complement, rather than replace, currently existing models. Finally, we provide a set of four criteria for those in the community to evaluate an interaction design research contribution that follows this model.

### The History of Design within HCI

The field of HCI emerged out of collaborations between psychologists and engineers.<sup>4</sup> Early contributions such as the Differential Analyzer, a large-scale log computer that used mechanized pens to output text, provided feedback from the computer that people could more easily understand and process. The PDP-1, an industrial computer featuring a display for feedback and a keyboard, light pen, and paper tape reader for input also was an advance, framing the interaction in terms of both input and output. Englebart's invention of the mouse—a graphic input device that remains the standard today—and Nelson's early work in the area of hypertext both brought consideration of the human into computing. These key advances in humanizing the interaction between people and computers created the first opportunities for the HCI community to consider the need for collaboration with designers.

Early HCI researchers and developers recognized a need to distinguish interfaces for programmers, used to develop and test an application, from those for users, needed to understand how to operate the application. The issue of how people would access and control early computers created the first opportunities for design where the term "design" was used synonymously with usability engineering: "... the process of modeling users and systems and specifying system behavior such that it fitted the users' tasks, was efficient, easy to use and easy to learn."<sup>5</sup> This emerging focus on users as separate from developers and operators created an opportunity for cognitive psychologists to play an increasingly important role. Stu Card and Tom Moran's *The Psychology of Human-Computer Interaction* summarized the literature on human information processing, and offered a model of human processing that could be applied to predict how people would both learn and efficiently interact with interfaces.<sup>6</sup>

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3 Horst W. J. Rittel and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4:2 (1973): 155–166.

4 Richard W. Pew, "Evolution of Human-Computer Interaction: From Memex to Bluetooth and Beyond" in *The Human-Computer Interaction Handbook*, J. A. Jacko and A. Sears, eds. (Mahwah, NJ: Lawrence Erlbaum Publishers, 2003), 1–17.

5 *Ibid.*, 1.

6 Stu Card, Thomas P. Moran, and Allen Newell, *The Psychology of Human-Computer Interaction* (Hillsdale, NJ: Lawrence Erlbaum Associates, 1983).

In the late 1970s, when command line interfaces were standard, the first notions emerged that some user-oriented design principles might be applied to the design of the screen.<sup>7</sup> At this time, design guidelines and style guidelines gradually emerged. This advance helped the computer move more rapidly into work environments, and shifted the use of computers from an operator model with a focus on making a machine work, to a worker model with a focus on using the computer as a tool to get work done. This transition created a need for anthropologists to join in the HCI collaborations. HCI researchers and developers needed their skills at understanding the culture of the office environment to help inform the design of computing systems that could be successfully integrated into office culture and work practice. The interpretive methods used by anthropologists provided the first example of nonscientific research in HCI. However, the kind of research contributions anthropologists can make have been limited by the research community. In general, anthropologists must frame their research in terms of implications for the design of technology instead of implications in terms of theories of human behaviors.<sup>8</sup>

The invention and rapid acceptance of graphical user interfaces helped to increase the role that designers, particularly graphic designers, played in the HCI community. This advance made the computer much more accessible to people, helping the computer spread from the office to many other contexts. Suddenly, many HCI practitioners found themselves working with designers; however, the two groups had radically different ways of approaching problems. Jonas Löwgren coined the term “creative design” to distinguish the ideation and problem-framing used by designers from the engineering approach of developing to a predefined specification.<sup>9</sup> In creating this term, he argued for a culture change to allow the benefits of design thinking to have a greater influence on the design of interactive products.

The next huge advance for designers undoubtedly was the emergence and meteoric acceptance of the World Wide Web. This huge collection of interconnected pages that included links, buttons, dropdown menus, applets, and multiple paths through a given set of information required the skills of information designers and newly minted interaction designers. Within a few years after its invention, almost all companies felt the need to have a digital presence on the Web, creating huge opportunities for designers to apply their communication skills. At first, much of the content on the Web consisted of print material simply ported to an electronic form. But fairly quickly, entirely new classes of applications and interactions emerged such as online shopping, online banking, project pages for coordinating work activities at multiple locations, wikis, social networking applications, etc. Today, almost all HCI practitioners find themselves working collaboratively with designers in the development of digital products and services.

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7 Peter Wright, Mark Blythe, and John McCarthy, “User Experience and the Idea of Design in HCI,” *Lecture Notes in Computer Science*, Stephen W. Gilroy and Michael D. Harrison, eds. (Berlin and Heidelberg: Springer, 2006), 1–14.

8 Paul Dourish, “Implications for Design,” *Conference on Human Factors in Computing Systems* (New York: ACM Press, 2006): 541–550.

9 “Methodology to Software Development,” *Designing Interactive Systems* (Ann Arbor, MI: ACM Press, 1995), 87–95.

Recent developments in mobile computing, contextually aware devices, and intelligent environments have given weight to a transition from the HCI's early obsession with usability to the social and emotional impact products have, and their ability to improve people's lives. This new design space, often referred to as "experience design," has helped to increase the influence of designers in the HCI product development process. Designers are increasingly playing a more important role, as witnessed by new academic conferences and publications focused on design and interaction design in HCI, an increasing number of advocates for design within the HCI community, and the movement to integrate design into HCI education.

### Models of Design Research in HCI

While the role of design continues to increase in the HCI practice community, design as a research discipline has had less impact. Today, five distinct models of design research are known in the HCI research community: project research, design methods, pattern finding, design as research service, and critical design.

In casting HCI as a design practice, Daniel Fallman created the term "research-oriented design" to describe the upfront research HCI practitioners and interaction designers do to inform their design process.<sup>10</sup> This term describes the user-centered design approach generally applied in HCI practice through methods such as contextual inquiry,<sup>11</sup> or in the construction of personas.<sup>12</sup> Similar to Buchanan's idea of "clinical design research"<sup>13</sup> and to our previous work on opportunities for design cases to produce knowledge,<sup>14</sup> this type of research in the HCI community is limited to the ethnographic styled or participatory work done before the design of any artifacts. While the HCI research community understands this model, it is viewed strictly as design practice, and not considered a research contribution because the focus is on the development of a commercial product, not the production of knowledge.

Probably the most recognized model of design research by the HCI research community is the development and evaluation of new design methods intended to improve the process of developing interactive products. Examples include methods for the upfront research in a design case such as contextual inquiry and the personas mentioned above, and the increasingly popular cultural probes;<sup>15</sup> methods intended to increase empathy between designers and users including bodystorming<sup>16</sup> and experience prototyping;<sup>17</sup> and methods intended to extend the creative ability of designers such as interaction relabeling<sup>18</sup> and transfer scenarios.<sup>19</sup> An important role for design researchers to play is in the development of new methods. However, this method represents the only research contribution most HCI research venues will accept for publication, and thus severely

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- 10 Daniel Fallman, "Design-Oriented Human-Computer Interaction," *Conference on Human Factors in Computing Systems* (Fort Lauderdale, FL: ACM Press, 2003): 225–232.
  - 11 Hugh Beyer and Karen Holtzblatt, *Contextual Design* (San Diego, CA: Morgan Kaufmann Publishers, 1998).
  - 12 Alan Cooper, *The Inmates Are Running the Asylum* (Indianapolis, IN: Macmillan Publishing Co., Inc., 1999).
  - 13 Richard Buchanan, "Design Research and the New Learning," *Design Issues* 17:4 (2001): 3–23.
  - 14 John Zimmerman, Shelley Evenson, and Jodi Forlizzi, "Discovering and Extracting Knowledge in the Design Project," *Future Ground* (Melbourne, Australia: Design Research Society, 2004).
  - 15 Bill Gaver, Tony Dunne, and Elena Pacenti, "Cultural Probes," *Interactions* (1999): 21–29.
  - 16 Marion Buchena and Jane Fulton Suri, "Experience Prototyping," *Designing Interactive Systems* (New York: ACM Press, 2000), 424–433.
  - 17 *Ibid.*, 424–433.
  - 18 John Partomo Djajadiningrat, William W. Gaver, and J. W. Fres, "Interaction Relabeling and Extreme Characters: Methods for Exploring Aesthetic Interactions" in *Designing Interactive Systems* (2000): 66–71.
  - 19 Sara Ljungblad and Lars Erik Holmquist, "Transfer Scenarios: Grounding Innovation with Marginal Practices," *Proceedings of the Conference on Human Factors in Computing Systems* (San Jose, CA: ACM Press, 2007).

limits opportunities for designers to participate in HCI research. It does not facilitate the application of design thinking to the problems faced by the HCI research community.

Recently, the HCI research community has recognized the use of pattern languages as an area of design research.<sup>20</sup> This interest stems from the tremendously popular 1995 book *Design Patterns: Elements of Reusable Object-Oriented Software*, which documents a small set of software development design patterns commonly found in object-oriented programming.<sup>21</sup> In general, this topic has been explored as a design method with researchers investigating how to best apply it in the interaction design space.<sup>22</sup> In addition, researchers have engaged in pattern finding. For example, they have documented the emerging patterns and documented these in a book to aid practitioners in the design of Web sites.<sup>23</sup>

Recently, HCI researchers have been exploring how design patterns can be extended to become pre-patterns.<sup>24</sup> One of the challenges in the interaction space is the rapid emergence of new classes of products and services such as smart environments and mobile computing. Generally referred to as “ubiquitous computing,” researchers have explored the development of pre-patterns, indications of the emergence of design patterns by examining proof of concept prototypes. Designers using these pre-patterns to inform designs in the ubiquitous computing space have found that they help to reduce usability problems.<sup>25</sup> This work of pattern finding represents a connection between design research and HCI research, but the practice of pattern finding does not in itself require expertise in design thinking.

For many years, industrial research labs have employed interaction designers to work in the service of researchers. Designers work on research teams, engaging teammates in problem-framing exercises to help the team to both ground their research in terms of user needs and to frame the research around a preferred state it helps to achieve. In addition, designers working on these teams develop prototypes intended to communicate the value of the research contribution to stakeholders such as other researchers, product managers, and executives within the company.<sup>26</sup> At the CHI conference in 2006, the premiere venue for HCI research, one paper argued that designers working in this capacity employ a process of rationale judgments in contrast to the belief that designers employ “black magic.”<sup>27</sup> The intention was to convince researchers that bringing designers into a research project would not corrupt the contribution. While recognized as a role that designers can play in HCI research, the work really is more about bringing design practice into HCI research, and does not provide an opportunity for designers to shape and drive the focus of the research.

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- 20 Christopher Alexander, Sara Ishikawa, Murray Silverstein, Max Jacobson, Ingrid Fiksdahl-King, and Angel Schlomo, *A Pattern Language: Towns, Buildings, Construction* (Boston: Addison-Wesley, 1977).
  - 21 Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, *Design Patterns: Elements of Reusable Object-Oriented Software* (Boston: Addison-Wesley, 1995).
  - 22 Thomas Erickson, “Lingua Franca for Design: Sacred Places and Pattern Languages,” *Designing Interactive Systems Conference Proceedings* (New York: ACM Press, 2000): 357–368.
  - 23 Douglas K. van Duyn, James Landay, and Jason I. Hong, *The Design of Sites: Patterns, Principles, and Processes for Crafting a Customer-Centered Web Experience* (Boston: Addison-Wesley, 2002).
  - 24 Eric S. Chung, Jason I. Hong, James Lin, Madhu K. Prabaker, James A. Landay, and Alan L. Liu, “Development and Evaluation of Emerging Design Patterns for Ubiquitous Computing,” *Designing Interactive Systems Conference Proceedings* (New York: ACM Press, 2004): 233–242.
  - 25 T. Scott Saponas, Madhu K. Prabaker, Gregory D. Abowd, and James A. Landay, “The Impact of Pre-Patterns on the Design of Digital Home Applications,” *Designing Interactive Systems Conference Proceedings* (New York: ACM Press, 2006): 189–198.
  - 26 Tracee Vetting Wolf, “The Role of Design in Research,” *HCI Research Seminar* (2004) Carnegie Mellon University, Pittsburgh, PA.
  - 27 Tracee Vetting Wolf, Jennifer A. Rode, Jeremy Sussman, and Wendy A. Kellogg, “Dispelling Design as the ‘Black Art’ of CHI,” *Proceedings of the Conference on Human Factors in Computing Systems* (New York: ACM Press, 2006): 521–530.

Finally, critical design, where design researchers play the role of a social critic, recently has gained a foothold in the HCI community.<sup>28</sup> Designed artifacts such as the Drift Table, a coffee table designed to support interaction where the designers have purposely avoided specific tasks a user might complete, work to expose the HCI community's obsession with task-specific work.<sup>29</sup> While critical design projects traditionally have had little success in gaining access to mainstream HCI research publications, recently some have had success framing themselves as research methods to gain insight into how end-users will react to technology.

These current research models provide some opportunities for design research in HCI practice, but few opportunities for research collaborations in the HCI research community. In addition, these models, with the exception of critical design, do not allow designers to participate from their position of strength, from their application of design thinking; to address problems and frame problems.

### A Model of Interaction Design Research within HCI

Based on our synthesis and analysis of the literature review presented in the previous section, and on an iterative process of design and evaluation with researchers in HCI, we have developed a new model for interaction design research in HCI that advances Frayling's "research through design" concept.<sup>30</sup> In following this model, interaction design researchers focus on making the *right* thing; making transformative artifacts that move the world from the current state to a preferred state. The model depicted in Figure 1 shows how interaction design researchers engage wicked problems found in HCI. These problems arise from groups of phenomena, rather than single phenomenon in isolation. They have too many dynamic and interconnected constraints to accurately model and control using the reductionist approach found in science and engineering. Instead, our model asks researchers to select the appropriate placements:<sup>31</sup> lenses through which to view and constrain the problem, and with which to construct transformative artifacts. This model, with its focus on artifacts, builds on Cross's concept of design knowledge residing in the product.<sup>32</sup> The artifacts generated during interaction design research represent a specific framing of the problem, and are situated among other research artifacts that may require different lenses for approaching the problem. The artifacts serve as catalysts for continued discourse in the community. After a series of artifacts have been generated, they can be analyzed in order to understand approaches that have been taken in addressing common problems. Ultimately, patterns begin to emerge from these artifacts.

28 Anthony Dunne and Fiona Raby, *Design Noir: The Secret Life of Electronic Objects* (Basel, Switzerland: Birkhäuser, 2001).

29 William Gaver, Phoebe Sengers, Tobie Kerridge, Jofish Kaye, and John Bowers, "Enhancing Ubiquitous Computing with User Interpretation: Field Testing the Home Health Horoscope," *Conference Proceedings on Human Factors in Computing Systems* (San Jose, CA: ACM Press, 2007).

30 Christopher Frayling, "Research in Art and Design."

31 Richard Buchanan, "Wicked Problems in Design Thinking," *The Idea of Design*, Victor Margolin and Richard Buchanan, eds. (Cambridge, MA: MIT Press, 1995), 3–20.

32 Nigel Cross, "Design Research: A Disciplined Conversation," *Design Issues* 15:2 (1999): 5–10.

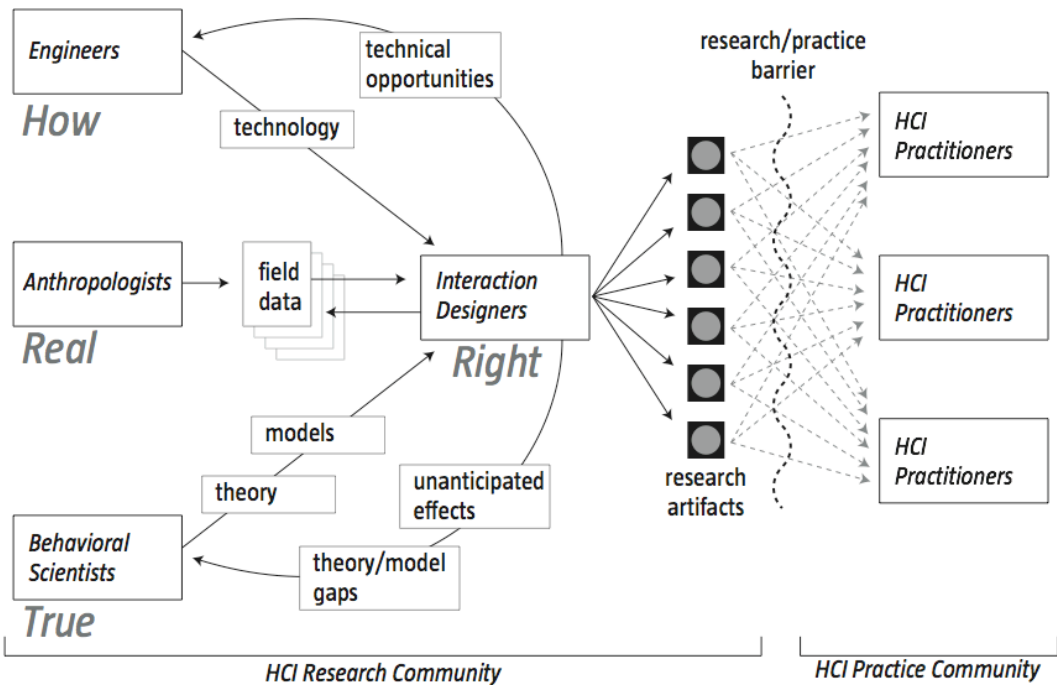


Figure 1  
A model of interaction design research in HCI.

Our model allows interaction designers to integrate “true” knowledge in the form of models and theories from human scientists with “how” knowledge in the form of technical opportunities demonstrated by technologists. Design researchers perform explorations in the wild, grounding their explorations in “real” knowledge. Through an active process of ideating, iterating, and critiquing potential solutions, design researchers continually reframe the problem in their attempt to make the “right” thing: a concrete problem framing and articulation of the preferred state.

The HCI community can benefit from a research through design approach in a number of ways. First, this type of research can provide engineers with information about what to build. Second, it can provide human scientists with indications of where important gaps exist in their theories and models. Apple’s Guides project provides an example.<sup>33</sup> In this project, researchers wanted to address the emerging problem of navigation in large, multimedia databases, so they constructed a full system that used black-and-white images of characters from different historic periods to work as visual navigational guides for users. However, when they evaluated this system, they noticed that people interpreted the content not as encyclopedia content, but as the opinion of the visual guide. By focusing on the construction of the whole system, the researchers identified an unanticipated social effect for the behavioral community to explore, and provided motivation for the engineers to construct systems that could support embodied computer agents.

33 Tim Oren, Gitta Salomon, Kristee Kreitman, and Abbe Don, “Guides: Characterizing the Interface,” *The Art of Human-Computer Interface Design*, Brenda Laurel, ed. (Reading, MA: Addison-Wesley, 1990), 355–365.

The artifacts produced by this model are concrete embodiments of theoretical and technical opportunities. They also serve as channels for the transfer of research knowledge to the community of practice. For educators, artifacts serve as ways of helping students understand how design activity unfolds. In design research, artifacts describe a vision of what might be; increasing the chance of knowledge transfer to the research, practice, and education communities. Artifacts teach the practice community how to more easily observe the value of different theories, models, and technology; and this can motivate them to follow the threads back to the original research that might most impact their work.

Our model adds an additional method to the five design research roles described above that is particularly suited for interaction design researchers working in HCI research, and allows design researchers to work more as a collaborative equal with other HCI researchers. An obvious criticism of this model is how design researchers using it can distinguish their contributions as research and not as practice. This is a concern raised by Nigel Cross, who does not consider normal works of practice to be research contributions.<sup>34</sup>

We differentiate research artifacts from design practice artifacts in two important ways. First, the goal of interaction design research is to produce knowledge for the research and practice communities, rather than make a commercially viable product. Therefore, research projects that take this research through design approach will likely de-emphasize certain perspectives in framing the problem, such as the detailed economics associated with manufacturability and distribution, the integration of the product into a product line, and the effect of the product on a company's identity, etc. In this way design researchers focus on making the *right* things, while design practitioners focus on making *commercially successful* things.

Second, research contributions should be artifacts of invention, representing novel integrations of theory, technology, needs, and context rather than incremental modifications to products that already exist in the research literature or commercial markets. Novelty makes particular sense in the interaction design space of HCI. Meteoric technological advances in hardware and software result in aggressive invention of novel products in HCI and interaction design domains that are not typically experienced in other design domains. For example, while appliance designers might find themselves redesigning a refrigerator to meet the changing needs of a family, interaction designers more likely would find themselves inventing whole new product categories to serve these families.

Our model of design research allows interaction design researchers to excel at studying the world and making artifacts intended to affect change. It represents a new channel to illustrate

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34 Nigel Cross, "Designerly Ways of Knowing: Design Discipline versus Design Science," *Design Issues* 17:3 (2001): 49–55.



how the power of design thinking can be used in a research context. As a result, design researchers make their own revolutionary contributions, rather than copying the methods of other disciplines as a means of justifying a research contribution.

### **Criteria for Evaluating Interaction Design Research within HCI**

We have illustrated how the research through design approach is a viable means for making contributions to the evolving landscape of design research. Yet within the interaction design and HCI research community, we have yet to agree upon a standard for what research through design is, or what might comprise a high-quality contribution. As a result of our research, synthesis, and analysis, we propose a set of criteria, or lenses, for evaluating a research contribution in interaction design. These are process, invention, relevance, and extensibility.

### **Process**

The design process is a critical element in judging the quality of an interaction design research contribution. Simply stated, reproducing the same design process cannot be expected to produce the same results. This idea has been discussed in the domain of interface design and software engineering, where the process of undertaking interface design is likened to craft.<sup>35</sup> Rather than replicability, part of the evaluation of the work is to understand the rationale for the selection of given methods, and the rigor with which these methods are applied. Therefore, when interaction design researchers document their methods, they must do so with enough detail so that a particular design process can be replicated. In addition, a rationale should be provided for why specific methods were selected and used.

### **Invention**

A significant invention must be discovered as an outcome of the interaction design research. Invention is defined as addressing a specific situation through a novel integration of subject matters. In articulating a contribution as an invention, the interaction design team must undertake an extensive literature review, and discuss in detail how advances in technology contribute to the invention. It is here that details about technical opportunities are communicated to engineers and computer scientists in the HCI research community, providing information and guidance on what to build.

### **Relevance**

While scientific research has a focus on validity, interaction design research has a focus on relevance. In engineering, validity often takes the form of a clear performance increase or in the technical functionality of a contribution. In human (behavioral and cognitive)

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35 David Wroblewski, "The Construction of Human-Computer Interfaces Considered as a Craft," *Taking Software Design Seriously*, John Karat, ed. (Boston: Academic Press, 1991), 1–19.

science, validity takes the form of an experiment that disproves the null hypothesis. In both cases, work is archived in a way that peers can reproduce both methodology and results.

However, this approach makes less sense for interaction design's research through design approach. As stated earlier, there can be no expectation that two interaction designers who have been given the same problem will produce identical or even similar outcomes. Therefore, relevance, rather than validity, is the second criteria for interaction design research. Validity constitutes a shift from what is *true* to what is *real*, signifying that the work is framed and conducted within the messiness of the real world. Additionally, interaction design researchers should articulate why the outcome of the work is a preferred state, and provide information to help the HCI community understand why this is so.

While many contemporary design research contributions follow a research-through-design approach, they neglect to characterize the outcomes in terms of relevance. Often, the motivation for their work, the detail on the current situation, and information on the preferred state of the world are missing. Without these critical components, a research through design approach appears to be self-indulgent; taking the form of a personal exploration that informs the researcher, but cannot inform the research community and the world at large.

### **Extensibility**

"Extensibility" is defined as the ability to build on the resulting outcomes of the interaction design research. For example, the community may leverage the knowledge created by the resulting artifacts, or the process employed may be used again for a future design problem. Extensibility means that the design research has been described and documented in a way that the community can leverage the knowledge derived from the work.

### **Conclusion**

The landscape of design research is changing, and interaction design research in HCI is undergoing a transformation. In this essay, we have presented our efforts to explore and advance knowledge about research in interaction design as it relates to human-computer interaction. Our work has resulted in a new model of interaction design research within HCI, and a set of four criteria that help evaluate what constitutes good interaction design research.

We hope that our model will provide several benefits to both the HCI and design communities. For the HCI community, the model provides a way for engaging with messy (or wicked) problems that are not easily addressed using traditional science and engineering methods. Hopefully, use of the model will motivate new research by highlighting both technological opportunities and places where

gaps in theories of human behavior exist. For the design community, the model articulates how interaction designers can make research contributions through reframing problems and making innovative artifacts.

Our hope is that, through proposing this model, we can add to the growing number of ways to discuss design research, and to continue a much-needed discussion of the role of design thinking and interaction design research in HCI.