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THCI

Research Commentary

HCI Research: Future Directions that Matter

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In this essay, I briefly review the dominant perspective in Human-Computer Interaction (HCI) research and its underlying research questions as currently pursued in the field of Information Systems (IS). I discuss its strengths and weaknesses and conclude that it is reaching the state of a decreasing rate of returns due to significant changes in computing environments and computer use. Three emerging themes are noted to address this challenge: 1) concern for environmental validity, 2) richer notions of cognition, and 3) growth and access to new sets of data. I suggest that these themes will shape the research in HCI in this decade, and, if addressed properly, will improve the relevance (and rigor) of future research.

Research in HCI dawned in the late seventies when computers moved from the back office to the organizational frontlines in the form of time-sharing systems, and later in the form of office productivity tools on personal computers. The earliest topics focused on material features of computing, like keyboard design or ergonomic factors affecting user efficiency (e.g. screen size). Much of the later research that ultimately distinguished HCI as a separate field focused on how forms of computer interaction enabled or impeded user behaviors due to the availability of designed computing features (e.g. formats, query language constructs, etc). Likewise, early HCI research on information systems (the Minnesota experiments) examined human-computer interaction and task performance. The bulk of this early research relied on experimental approaches and consequently adopted simple stimulus-response models of user behaviors. In the 80's and 90's, HCI research enriched the literature by producing several general, powerful theories about human behavior and cognition that explain human responses to computer use. These include theories of reasoned action, self efficacy, and habituation. These theories have been largely validated, as expected, in this experimental context, and we now know a great deal about critical predictors of adoption and effective use in the context of a single system (i.e., tool used by an individual). Typically, explanations come in the form of a cognitive state (CS) like intention explaining IT use or adoption, or, more rarely, a computing feature like functionality explaining cognitive state (intention to use).

This research approach has offered ample avenues for strong and cumulative research. It adds rigor to the research process by relying on strong, general theories about human cognition and behavior, implementing effective experimental designs, and using relatively well tested instrumentation. As a result, it has offered credible, theoretically founded and plausible results that have clear face value and internal validity. This approach is a relatively coherent way of approaching issues related to human-computer interaction and has advanced cumulative learning in the community. Overall, it has significantly advanced our understanding of factors that can explain the likelihood of adopting a computer tool or continuing to use it.

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Despite these benefits, this research design has become a straitjacket for understanding and explaining current, more complex forms of computer use. The interest is shifting away from the single user/single tool paradigm and the challenge of a user adopting or using a specific computer function for the first time. Instead, the current environment is characterized by the following key features:

1. Because nearly all workers already use several computer tools daily (Gaskin and Lyytinen, 2010), the question is less and less about adopting or initiating a use process in a green-field. The focus has shifted to adapting, integrating and orchestrating computer tools and capabilities in an already rich computer environment. Questions about replacement, unlearning and adaptation are dominant.

2. The form factors and functionality of computer tools are no longer uniform. There is a rich variety of capabilities, features, and functions (Yoo, 2010). Device convergence and service convergence explain it all: the same computing function can be carried out across multiple devices at hand, and the function itself can be offered by multiple types of tools. Thus, factors other than just functionality or ease of use may explain adoption or use, such as position in the task environment, specific use context, past learning, habituation, or random effects.

3. The computer-rich environment needs to be understood as an evolving ecology of functionalities that offers a set of affordances as created by users in their specific environmental niches, rather than as a collection of independent tools for users to adapt (Jung and Lyytinen, 2010),.

4. Improvement and expansion of use processes across multiple tools in richly featured computing ecologies is of greater concern than adoption or single use.

5. There is less concern for specific general interactions between certain sets of use modalities (e.g. text vs. graphics); instead, we are interested in how rich combinations of such modalities are created under specific circumstances and in contexts where multiple interactions take place simultaneously.

Due to this combinatorial explosion of use situations and their complexity, there are decreasing returns from a static single tool/single user approach to understanding critical issues of HCI. While established theories are capable of explaining those issues for which they were constructed, they are inadequate when it comes to explaining how and why current users use computers. One challenge is that the current research model offers little explanation of what human-computer interaction *means* (i.e., what people do with computers and why they do what they do). Also, the current model is relatively static in terms of types of uses and evolution of use behaviors and in explaining and analyzing explanations of the evolution of human-computer interaction across contexts. Clearly, something different and complementary needs to be envisioned to help us understand and explain emerging patterns of computer use and human-computer interaction. Next, I present three emerging themes that may offer some directions for improving our understanding of these issues: 1) concern for environmental validity, 2) richer notions of cognition, and 3) growth and access to new sets of data.

ENVIRONMENTAL VALIDITY

The first challenge is improving the environmental validity of our explorations. Do the applied theories integrate key aspects of human-computer *interaction* with their proposed theoretical language and related analysis logics? To answer this question, we need to understand and take more seriously what defines and constitutes the environment of computer use. This concern needs to permeate both our theory building and our research design.

To address this challenge, we need to further analyze the constitution of user and use environments and how computer-based, cognitive, and material features interact and influence what people do with computers. We need to more carefully ask important questions such as: what are the affordances that are being enacted in the context of computer use? How do such sets of affordances constitute an ecology, and how does it evolve as a system? How do these affordances relate to changing IT capabilities and functionality? How are IT capabilities presented at the interface? How do IT capabilities and their representations interact and affect the creation of affordances? Are there different ways of presenting IT capabilities; if so, how do these relate to what people do with computers? How do simple and unusual contexts of interactions (e.g., pervasive, mobile) affect use processes and interactions? Studies addressing these questions need to go beyond the currently dominating quest to explain computer adoption or use. The focus should be on learning to use computers differently, learning to assimilate new use behaviors, and improving the overall effectiveness of use in a specific task environment.

RICHER NOTION OF COGNITION

Classic cognitive models and theories related to computer use take one of two approaches; they either apply state-oriented representations of beliefs or attitudes guiding user behaviors, or they represent the user as yet another 'computer' with memory, a processing unit, and a computational process. Use happens in the brain and associated cognition is confined to the realm of inaccessible, abstract states of the mind. While such approaches are useful in explaining or predicting certain aspects of use processes, they are inherently limited to the mentalistic and Cartesian views of use. Yet, as computer use becomes increasingly convivial and opportunistic and use environments grow richer and more complex, the cognitive processes associated with HCI (mainly seeing and writing) are becoming intertwined with the physical, haptic and audio-based interactions, triggering new experiences and emotions (Yoo, 2010). Much of this type of behavior can now be traced by collecting sensory data; therefore, theories and explanations of human-computer interactions need to seek a better understanding of interactions between physical, motor, and cognitive levels and also how the "virtual real" (i.e., what you see while you interact with the computer) and the "real real" (i.e., what happens in the other parts of the environment) become intermingled during the process of use. This is paramount in studying pervasive or mobile applications where external conditions affect use processes to a larger extent.

Another issue is that computers are no longer just reactive devices that are optimized to respond to user requests (e.g., query processing), but more proactive devices that affect the user environment based on specific models or conditions that represent the very use processes they enable. Hence, interactions need to be understood as two-way transactions influencing the overall effectiveness of the use process in complex ways. Finally, users are not sole automatons or cogs to the computer; they constantly narrate and make sense of what they are doing. However, we know relatively little about how ongoing sense-making and framing affects use processes.

ACCESS TO NEW SETS OF DATA

Most of the data available in HCI studies comes in three main forms: 1) state-based information that captures latent beliefs, dispositions and attitudes of users; 2) user interactions at specific time points (in logs); and 3) organizational outcomes, like task performance or satisfaction, in either perceptual or objective form. These data sets match well with the expectations of current theory and related instrumentations because they have enabled us to find significant interactions among these three states (beliefs, levels of use, outcomes). Unfortunately, they revealed little about how each interaction unfolded, what the possible paths were, and what the users actually did. Due to extensive digitalization (see Lyytinen, 2009) we currently have a wealth of use data collected through digital traces. While some of the uses of this type of data are well known, for example, in optimizing the use and effectiveness of search engines (Google), much more can be achieved with these data sets. We are now able to analyze them with network-based or event sequencing techniques to distinguish alternative patterns of use, evolution and change. Such data sets can also be combined with traditional psychometric measurements to explain variations or the emergence of some attitudes or beliefs. This data can also be combined with new dependent variables like effective use, improved task performance, or aptitude for learning or change. I surmise that making extensive and shared longitudinal data sets on digital use traces more available offers one sure way to advance new theory and its validation.

A ROAD AHEAD

While addressing these three sets of issues, the HCI community also needs to address issues of relevance and external impact more effectively. Several alternatives come to mind. First, HCI scholars need to seek more collaboration with the Design Science community to improve the ecological validity of their studies, and for the development of new ways to integrate HCI knowledge and theory to design effective interventions. Second, though HCI research has not been strongly influenced by economic theory, integrating relevant economic perspectives on the study of use processes, outcomes, and learning can greatly improve the external validity of the results. For example, asking about the economic consequences of offering easy-to-use tools and the impacts of learning to use rich computing ecologies effectively should drive the research agenda. Finally, HCI should focus on technologies that really matter, i.e., are highly established and widely accepted and used. Instead of examining how users adopt or start to use new technologies, we should examine why the use process of readily established technology in a specific context makes a difference.

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