

A Second Path to HCI Innovation: Generative Theories Tied to User Needs

Ben Shneiderman
Department of Computer Science
University of Maryland
College Park, MD 20742 USA
(301) 405-2680
Email ben@cs.umd.edu
homepage <http://www.cs.umd.edu/~ben>

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What is the Next Generation of Human-Computer Interaction?

The most frequent source of innovation in many fields, including human-computer interaction (HCI), is by proposing a novel technology approach, such as tangible, embedded, embodied, ubiquitous, or pervasive user interfaces. Other popular proposals in recent years include context-aware, perceptual, mobile, and handheld. The resulting systems are sometimes described as invisible or disappearing, and may include attributes such as affective, ambient, and implantable. Media features can also lead to innovations such as visualization, animation, sonification, haptics, gestural, and multi-modal. These sources of innovation are effective in suggesting new products and services, but technology-centered approaches need to be supplemented by user-centered approaches to provide a more complete guide to the future.

The second path to HCI innovation starts from user-centered approaches and leads to novel products and services based on a deep understanding of human needs. I explored these approaches earlier in *Leonardo's Laptop: Human Needs and the New Computing Technologies* (MIT Press, 2002) by proposing a generative theory of HCI tied to an Activities and Relationship Table. The activities included collect, relate, create, and donate, while the relationships were described as self, family & friends, colleagues & neighbors, and citizens & markets. The resulting 4 x 4 table can be helpful in suggesting new products and applications, tied to new market segments.

This Activities and Relationship Table is not a yellow brick road or golden path to produce new products and services, but can be helpful in structuring innovation by guiding designers to opportunities to serve different markets with novel services. For example, this generative theory could be applied to personal medical devices that support health monitoring to enable users to collect information, such as blood pressure, temperature, or insulin levels. The generative nature of theory guides innovators to consider convenient sharing of information with healthcare professionals or family members, enabling users to analyze their own data or and compare their readings with others with similar age, gender, and health conditions.

These generative theories are a compass to guide designers to think about user needs. These needs may be tied to personal use domains, as they are in *Leonardo's Laptop*, such as education,

healthcare, e-commerce, and government services. Other fresh discussions of user needs are emerging in many circles as evidenced by the appearance of conferences and workshops on topics such as persuasive computing, that is meant to alter user habits about healthcare, nutrition, or personality, and human sexuality, that covers educational, social, and therapeutic themes.

Other second path topics that show growth are enhancing trust and privacy in e-commerce website design, and supporting empathy while controlling anger in online communities. These affective issues deal with emotional relationships between two people, and enable more fruitful outcomes for patient support groups with nurturance for caregivers, as well as more effective mediation and conflict resolution.

Online security researchers are increasingly aware of the HCI issues tied to responsibility, accountability and anonymity in discussions of spam, viruses, and hacker attacks. While anonymity is important for some forms of freedom of expression, it becomes a shield to hide behind for those bent on destructive and violent use of the internet. Enhancing responsibility and accountability could accelerate acceptance of e-commerce applications, as ebay has done so successfully with its trust management and mediation methods.

The negative emotional side of human nature is surfacing in HCI design discussions, as issues such as anger, credibility, risk, and fear become more common. Discussion groups can quickly be disrupted by a single hostile act and chat rooms become dangerous for children who become victims for child abusers.

The reality of user frustration is also gaining attention in studies that reveal how much time is wasted by most computer users [1, 2] and how often they fail to accomplish their goals in e-learning, e-commerce, and e-healthcare or other web sites. Long delays, dropped phone lines, and dead links are widespread, as are application crashes and operating system problems. Improvements in reliability would do much to improve the user experience.

Other generative theories come from discussions of universal usability [3] that propose innovation in three areas:

Technology variety: Support broad range of hardware, software, and network access
{e.g. fast/slow computers, fast/slow networks, small/large screens }

User diversity: Accommodating users with different skills, knowledge, age, gender, disabilities, literacy, culture, income, etc
{e.g. design for screen readers, user control over font size, contrast, etc. }

Gaps in user knowledge: Bridge the gap between what users know and what they need to know
{e.g. novices/experts, newcomers, cross cultural visitors }

Universal usability concepts guide innovators by reminding them of the diverse needs of novices vs experts, so that they consider multi-layer designs of interfaces. They also remind users to consider the differences between users of consumer electronics (cellphone, music players, digital cameras, etc.) and professional workstations (air traffic control, radiology, programming environments), as well as the differences between self-confident highly literate users of multiple

devices in developed nations and frightened users with low literacy of wholly new technologies in developing nations.

In summary, technology-oriented thinking is one path to innovation for advanced user interfaces, but a second path is defined by generative theories that guide thinking in structured ways. These orderly approaches, based on taxonomies of human values, needs, roles, and tasks may also be helpful in shaping the future.

- [1] Ceaparu, I., Lazar, J., Bessiere, K., Robinson, J., and Shneiderman, B., Determining causes and severity of end-user frustration, *International Journal of Human-Computer Interaction* 17, 3 (2004), 333-356.
- [2] Lazar, J., Jones, A., and Shneiderman, B., Workplace user frustration with computers: An exploratory investigation of the causes and severity, *Behaviour & Information Technology* (to appear, 2006).
- [3] Shneiderman, B., Universal Usability: Pushing human-computer interaction research to empower every citizen, *Communications of the ACM* 43, 5 (May 2000), 84-91.
- [4] Shneiderman, B., Promoting universal usability with multi-layer interface design, *ACM Conference on Universal Usability*, ACM Press, New York (2003), 1-8.