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Understanding, Fostering, and Supporting Cultures of Participation

Cover Story by Gerhard Fischer

Association for Computing Machinery

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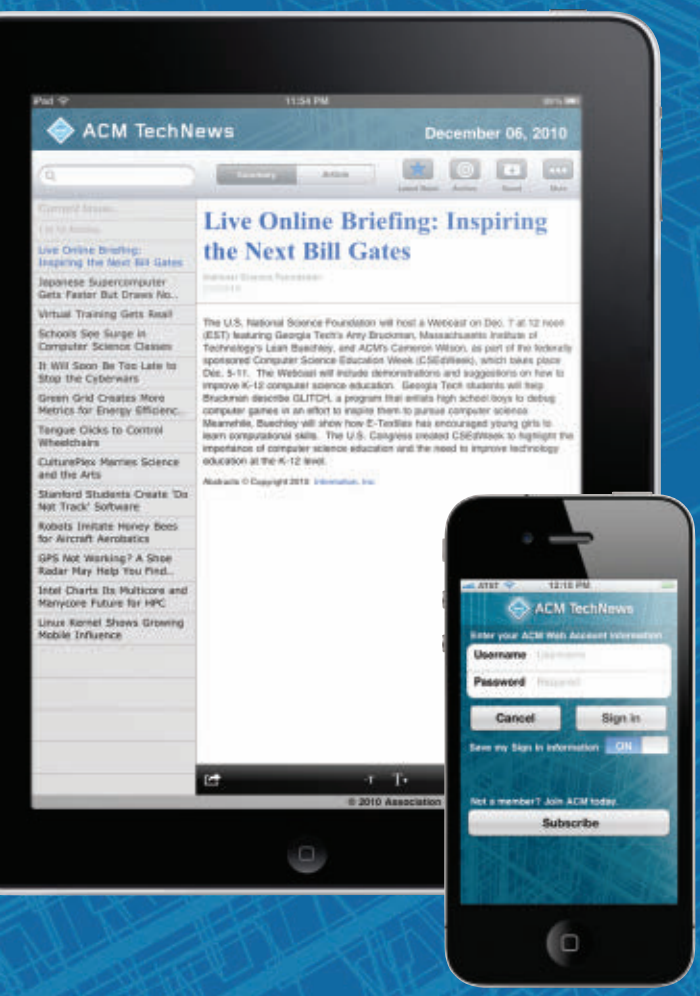

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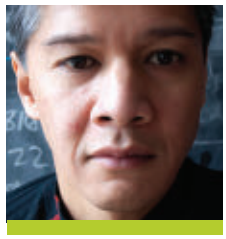

RON WAKKARY

ERIK STOLTERMAN

Participation, Technology and Interaction Design

As a reader of this magazine, you are probably involved in some new forms of social participatory work made possible by the Internet and interactive technology. Many of us are working to achieve some common goal by using technology that helps us conquer distance and time. It seems as if an increasing part of our daily communication is done through technology in some form. This development challenges many traditional assumptions about how to communicate and collaborate, but maybe even more interesting, it challenges our way of understanding processes of discovery, creativity, and development. In this issue's cover story, Gerhard Fischer examines this new reality by discussing the concept of cultures of participation.

Technology plays a central role in our field, not only as a means to manifest designs but also as a precondition that shapes our way of thinking about what is or is not possible to design. Sometimes ideas of what is possible might lead to unrealistic expectations from clients and users, as discussed in the article "How High Can Expectations Go?" by Pedro Campos, Miguel Campos, and Joaquim Jorge. Technological inventions and developments open up new design spaces, changing fundamental preconditions for design. So the question becomes: How should or can interaction design as a field relate to technology? To what extent should our field be involved in technology development? And do you really need to know technology to be an interaction designer? As editors-in-chief, we are looking for more articles that take on issues of technology and technology development and how they relate to HCI and interaction design. Is the field handling this well today? Are there other directions to explore?

In this issue we are also pleased to introduce a new forum, Health Matters, with Elizabeth Mynatt as editor. We also reintroduce and rename a forum on sustainability—Sustainability in (Inter) Action—now with Elaine Huang as editor.

We are slowly making changes to the magazine based on our overall vision, but we need your help. Write to us about the magazine, what you miss, what you find exciting, and whom you would like to read.

There will be an opportunity to discuss the status and future of ACM *interactions* with us and several of our regular contributors at a SIG meeting at CHI this year. We welcome all of you to come to the ACM *interactions* SIG meeting on Wednesday, May 11, at 11 a.m. More details will follow.

— *Ron Wakkary and Erik Stolterman*
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CRiSTAL

CRiSTAL simplifies the control of our digital devices in and around the living room. The system provides a novel experience for controlling devices in a home environment by enabling users to directly interact with those devices using multi-touch gestures on a digital tabletop. CRiSTAL consists of an interactive multi-touch surface and a camera mounted in the ceiling to capture the entire living room. The interactive surface is integrated into the coffee table and extends its functionality. The display itself is only activated on demand and still can be used as a normal coffee table. When activated, the interactive surface shows the live camera feed. To control the devices in the living room. users touch the corresponding video-image. Depending on the controlled device, different types of input are possible. A sliding gesture over a floor lamp, for example, modifies the brightness of the light source. On the other hand, a similar gesture across the floor in front of a robotic vacuum cleaner defines a path for it to follow.

Project website: *http://mi-lab.org/projects/cristal/*
Publication: *Seifried, T., Haller, M. Scott, S. D., Perteneder, F. Rendl, C., Sakamoto, D. and Inami, M. CRISTAL: Design and implementation of a remote-control system based on a multi-touch display.* Proc. of the ACM International Conference on Interactive Tabletops and Surfaces. *(Calgary, Canada, Nov.23-25). ACM, New York, 2009, 37-44.*

Michael Haller | MIT Media Lab | Michael.Haller@fh-hagenberg.at
Thomas Seifried, Stacey D. Scott, Florian Perteneder, Christian Rendl, Daisuke Sakamoto, and Masahiko Inami

Mouseless: An Invisible Computer Mouse

Mouseless is a novel input device that provides the familiarity of interaction from a computer mouse without requiring a real hardware mouse. It consists of an infrared laser beam and an infrared camera, both of which are embedded in a computer. Vision-based computer software interprets user's gestures as mouse movement and click actions. Mouseless also recognizes more complex operations such as drag and drop. It also proposes a number of novel above-the -surface gestural interactions, which a conventional computer mouse cannot support.

Project website: *www.pranavmistry.com/projects/mouseless/*
Publication: *Mistry, P. and Maes, P. Mouseless: A computer mouse as small as invisible. To be appear at CHI2011. Interactivity. Vancouver, Canada. May 2011*
Mistry, P. and Maes, P. Mouseless. Adjunct Proc. of the 23rd Annual ACM Symposium on User Interface Software and Technology *(New York, NY, Oct. 3-6). ACM, New York, 2010.*

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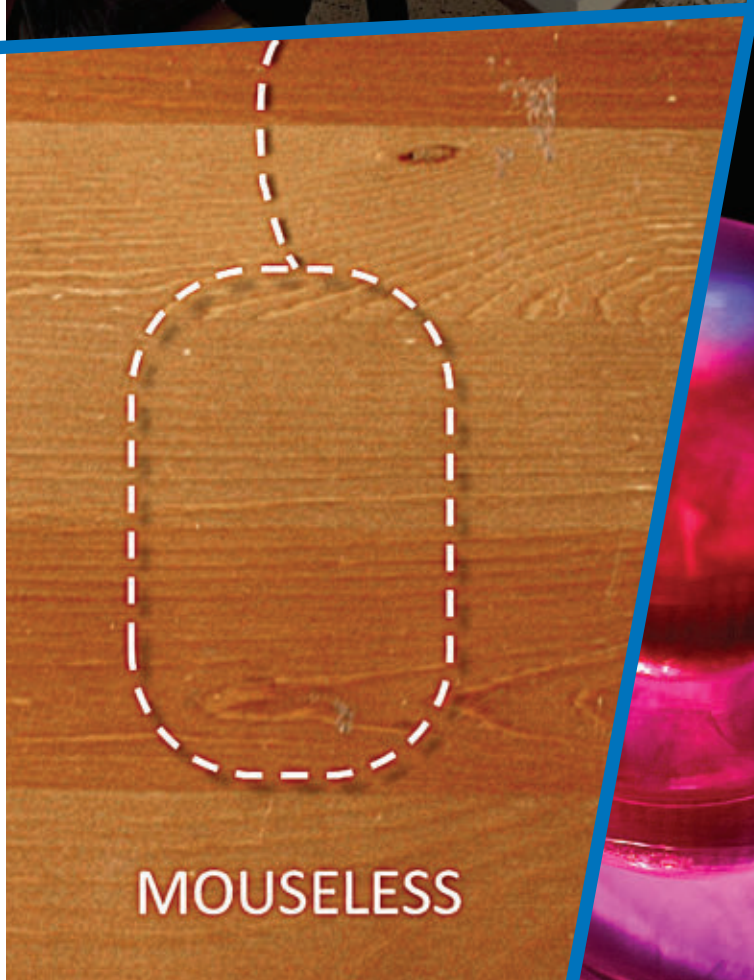

TeleStory (Siftables Platform)

Make a Riddle and TeleStory are educational applications developed on the Siftables platform for children aged 4-7 years. Siftables are tangible+graphical user interface manipulatives with motion and neighbor sensing, graphical display, and wireless communication. Siftables uniquely enables responsive feedback about the movement and arrangement of a distributed set of objects. A detailed explanation of both applications can be found at www.perspectum.com. The Siftables platform has evolved into a commercial product designed for play and learning, Sifteo cubes are available at www.sifteo.com.

Project website: *http://fluid.media.mit.edu/people/seth/past/telestory.html/*

Publication: *Hunter, S., Kalanithi, J. and Merrill, D. Make a Riddle and TeleStory: Designing children's applications for the Siftables platform.* Proc. of the 9th International Conference on Interaction Design and Children *(Barcelona, Spain, June 9-11). ACM, New York, 2010, 206-209.*

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Light Bodies

Light Bodies are portable, hand-held lighting devices, measuring 4.75" by 3.25", which visualize environmental sounds and vibrations. A custom five-channel LED panel (red, green, blue, amber, white) responds to high and low audio frequencies with colors ranging from red to blue while low vibrations interrupt the transition with a green burst. Light Bodies were tested in three different settings including a choreographed dance performance, an outdoor public installation, and an audio-visual event. In each context, people explored different ways of interpreting their surroundings through light and arranging Light Bodies to shape ambient lightscapes.

Project website: *http://www.vimeo.com/5976248*
Publication: *Seitinger, S., Taub, D. M., and Taylor, A. S. Light bodies: Exploring interactions with responsive lights*
Proc. of the 4th International Conference on Tangible, Embedded, and Embodied Interaction. *(Cambridge, MA, Jan. 25-27). ACM, New York, 2010.*

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John Zimmerman teaches and conducts research focusing on operationalizing identity and attachment theories for use in IxD, interaction with intelligent systems, and how social computing can help citizens feel like owners of their public services.

Killing Off User-Centered Design

Over the past few years, I have heard many proclamations and complaints from IxD/HCI practitioners and researchers that make me feel we have lost our way, that we have drunk a bit too much of our own Kool-Aid.

I am the user's advocate. I fight with the developers and managers to make sure the users get what they want. That's my job. —UX designer #1

The UX designers here make great designs. But no one listens to our ideas. We keep explaining why we need to design for the user's experience, but nobody cares. —UX designer #2

I know the user is not me! It would be unorthodox, inappropriate, and impure to draw on my own personal use experiences. —HCI researcher/practitioner

We do interaction design all wrong in my company. We almost never go out and conduct field studies on users before we start to redesign a product. —UX designer #3

When I hear these statements, I feel like I have failed. It's time to drop the Sharpie, set the sticky notes down, and stop sniffing the dry-erase markers.

To understand how we have gotten so far off track, I want to go back in time, to the early, early days of interaction design. These were golden times when computers moved into the office; when we investigated work practices and then replaced workers with computational systems that automated them out of a job. Ah, what happy users they must have been.

The earliest computers to enter the workplace were designed by engineers who had no idea what the workers did or how these systems would fit into their work practices. Thank goodness these systems mostly failed, or we would not have much of a reason to exist. Then came the mighty HCIers and interaction designers. We applied cognitive theory to interfaces, which solved many problems. And then we started to pay attention to the social aspects of work, which solved many more problems. Computers were difficult and disruptive, and we worked to make them fit.

The Scandinavians recognized the social disruption caused by computers and reacted with participatory design (PD). Here, domain experts in the workplace (workers/users), domain experts in business (managers), and domain experts in technology (techies and designers like us) worked together to socially prototype systems into existence. With the goal of democracy and protection of worker's craft knowledge and practices, PD evolved into a type of user-centered design (UCD).

Contextual design (CD) grew out of design practices in the U.S. when much of the work was to design custom IT systems within a business. IT departments had to design and get buy-in from other departments within their own company. CD practitioners would model the communication flow to find opportunities to automate processes, and they would model the company culture to make sure their design proposals would be accepted within the organization.

In both cases the users and the client were included in the design process. So what happened? How did we forget we have a client? First, software development became more commercial. It was not IT departments making systems for internal users, but instead companies making software for other companies and individuals to buy. Second, HCI and interaction design became academic disciplines. They were taught by academics who understood the need for "user" research. However, many of these academics chose to stay in or return to school and teach so they could escape the challenges of working with clients.

When I hear UX designers complain that their company never pays any attention to their design suggestions and insights, I always ask to see the research they have conducted on their development teams and their managers. This usually leads to blank stares. But clearly these managers and developers are critical stakeholders in the design. Instead of telling them how this helps a user, why not tell them how these design suggestions and insights benefit them. We must remember to research and synthesize their needs and their culture within the process. We must go back to the past to find our way into the future.

And now, to those who claim that HCI and interaction design orthodoxy will not permit personal insights to muddy up the design

process: When I hear such claims, it makes me think of the usability aspect reports I have written as "sacred texts." This is a false, false claim and it stifles design.

Dan Bricklin combined his domain knowledge on the pain of using pencil-based spreadsheets with domain knowledge of how computers work. This is a happy marriage that leads to great ideas. PD is all about having users co-design their own tools; it's a practice of combining tech-domain and work-practice-domain expertise. If you have knowledge of the work-practice domain, you must bring it into your design process. You must draw on your tacit knowledge to find design inspiration. There are no laws, there are no HCI police… I'm pretty sure.

How can you do UCD without doing user research and going into the field? You can't. But maybe you should not be doing UCD. So why do we do this? Again, this all started with engineers in labs designing work systems for workers they knew nothing about, for workers who had never used computers, and for computers that lacked a rich set of interaction conventions. That's not the world we live in now. We are designing for users who are constantly using computers, and we have a rich set of interaction conventions to draw on (design patterns). Not every project deserves upfront user research. Let me say this again. Not every project is deserving of the time and effort of upfront user research.

Do industrial designers always conduct a study of dining before making a dining chair? No! They use their own experience and their sensitivity to design conventions to search for a balance between the comforts of convention and the stimulation of novelty. Instead of blindly following a process, we need to be more pragmatic. We need to ask ourselves, "How conventional is this product I am working on?" If the project is pushing beyond conventions or if the goal is to shake up the current state, then of course you need to go into the field and hang out with potential users. But if the project is simply to turn the crank on a website that is already working pretty well, then you need to think about your client and if the time and expense will pay off.

Photograph by Jenn Vargas

It is time to cast off the mantle of UCD before it makes us irrelevant. We need to return to the past and remember that we design for clients. We simply investigate users because doing so is in the best interest of our clients. I am encouraged by the growing interest in service design and its focus on the co-production of value between customers and service providers. This is a return to what we should be doing, to the work of finding rich intersections where the user's desire and the client's desire intersect. I don't ever want to hear another interaction designer or HCI practitioner tell me they are the user advocate fighting against developers. Complaining will get us nowhere. Instead, we need to treat developers and managers as clients and design systems in which they easily see how their needs are being met and their desires are being fulfilled.

Now repeat after me. There is no UCD. There is only CCD, and I'm not talking about religious education for young Catholics. I am talking about client-centered design.

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The Social Life of Marginalia

On a single day, I count 44 notes I've scribbled down while traveling between home and work. These notes are part private, part public, and all parts messy. These are everyday marginalia—notes in a printed book, saves in Instapaper, lists in Simplenote, snaps in Instagram, likes in Tumblr, shares in Google Reader—notes on a day in the life. These are spontaneous bursts of inspiration, stumbled upon, that I didn't want to lose track of, noted and collected across media and devices. Scattered marginalia of everyday life, saved.

But everyday marginalia has a more collected history. Sam Anderson, *New York Times Magazine* contributor, notes roughly 300 years ago marginalia was sort of a slow-motion Twitter or Facebook. Marking up the margins was fashionable, if not, socially expected [1]. Even earlier, in the mid-17th century, John Locke's marginalia were so elaborate that a man named John Bell published a notebook called *Bell's Common-Place Book, Formed Generally upon the Principles Recommended and Practised by Mr Locke,* which outlined instructions for how to navigate the messy way he and others were assembling their notes and thoughts.

"Commonplace" books, or "commonplacing," as this and these collections were called, was the act of collecting bits of inspirational quotes and passages from disparate reading sources in one place. The result is what Steven Johnson refers to as "a personalized encyclopedia of quotations." Popular in 17th- and 18th-century England, it was a way for readers of all kinds to track their paths. Historian Robert Darnton reports on this nearly 250-year-old overlap of reading and writing behaviors [1]:

[Early modern Englishmen] read in fits and starts and jumped from book to book. They broke texts into fragments and assembled them into new patterns by transcribing them in different sections of their notebooks. Then they reread the copies and rearranged the patterns while adding more excerpts. Reading and writing were therefore inseparable activities.

Sound familiar?

For all its mustiness, the commonplace book is still a truer and more efficient collector of marginalia than our modern digital marks. While marginalia-making may be on the rise in forms unexpected by our Enlightenment-era predecessors, its diverse and frenetic recordings still remain vastly disconnected and uncollected. Should we be considering a collected place for our scribbles?

Common Behaviors

"Marginalia" refers to the notes and scribbles made by readers in the margins of their texts. The reader's ongoing dialog with a text can take different forms—drawings in illuminated manuscripts, decorations, doodles, and occasional flights of fancy.

Blackwood Magazine most likely introduced the term in 1819, but Edgar Allan Poe popularized it some 25 years later with some of his published material: *Marginalia*. Since then, authors have had varying degrees of success creating their own collections of published marginalia. Among them is Walter Benjamin, who struggled after 13 years of research, leaving behind *The Arcades Project*: "the theater," he called it, "of all my struggles and all my ideas" [2].

Outside the Margins

But it's not just authors who have seen value in marginalia. When a consumer encounters marginalia in a used book, it has the potential to change their perception of a book's worth. Microsoft researcher Cathy Marshall found students evaluated textbooks based on how "smart" the side margin notes seemed before purchasing. In an effort to discover methods for using annotations in eBooks, Marshall stumbled upon this physical-world behavior, an approach to gaining a wisdom-of-crowds conclusion tucked away in the margins [3].

What can we tell about a text from its notes? About readers from what they've left behind? And when these notes are made public—as Kindle developers and book futurists are exploring—what will emerge? How might shared reader data change readers' annotating behavior?

In May 2009, Amazon announced a new feature: Readers could not only highlight passages in their books but also review those notes online. In online Kindle accounts, readers could see all highlighted passages and books, but perhaps more interesting, readers could also see the "most highlighted passages of all time" or "heavily highlighted recently." If one of Cathy Marshall's students had highlighted a passage from Malcolm Gladwell's *Outliers*, for instance, she had see that 3,146 other Kindle users had highlighted the same passage.

While Amazon is still not allowing users to share their passages as of the writing of this article, it does seem the next logical step. Yet what will it mean to know that an arbitrary "87 other readers" have also highlighted? The real question is: What did they intend when they did so?

James Bridle, one of the people thinking about social notes of late, might suggest some answers with Open Bookmarks (http://wiki.openbookmarks.org/), a project he launched in 2010 that supports sharing annotations and reading data across platforms. These sharable bookmarks become a reference for every book a person has read—no matter where that reading took place.

Robin Sloan, a writer and media inventor, asks reviewers of his forthcoming book, *Mr. Penumbra's Twenty Four Hour Book Store*, to share their "mental state" via marginalia. Developing a visual language for real-time annotations, he welcomes people to go through his text at a reader's pace, marking their reactions in real time.

With efforts from book futurists like Bridle and announcements like this from Amazon, arguably, one of the last bastions of the printed era to be digitized—reader data—is now breaking free of its margins. Somewhere between Sloan and Kindle, there is meaning emerging.

Making Meaning

Sam Anderson pulls back the curtain to reveal patterns with his 2010 list of scribbles in the margins. From *Bleak House* to *The Anthology of Rap*, Anderson presented scans of his sidelines [4]. Reviewing the list, one begins to see patterns emerge. Categories of notes on each page, the likes of which Marshall's studies perused, are delightfully rich. Yet they also suggest that exposing the notes are not enough. It's intention that matters.

Even if we can capture patterns and overcome sharing, we might come back to consider the commonplace book. How might designers replicate its sense of wholeness and real-time cataloging online? Do we need to?

I'm not suggesting that all annotations need to be social. But it is critical for designers to consider how and where these marks might be shared. Might we become overly self-conscious in our new relationships with books? One of the principal pleasures of taking notes, after all, is the intimacy with a passage, the outright honesty with which one might scribble, "Hogwash," or "Gasp!" for later reminding. Designers will need to give equal consideration to what can be public as they will to what should remain private. Some sentiments, after all, are best left between you and your margins.

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Sustainability in (Inter)Action provides a forum for innovative thought, design, and research in the area of interaction design and environmental sustainability. The column explores how HCI can contribute to the complex and interdisciplinary efforts to address sustainability challenges.

Elaine M. Huang, Editor

Building Outwards from Sustainable HCI

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This column marks the start of a new forum for *interactions* entitled Sustainability in (Inter)Action, which considers the application of HCI and interaction design to problems of environmental sustainability and explores the ways in which knowledge and expertise from other fields can contribute to these efforts.

In recent years there has been an explosion of work in the interaction-design and HCI communities focusing on environmental sustainability. The enthusiasm for research and design in this area can arguably be traced back to the CHI 2007 conference, prior to which there had been only a smattering of papers and projects on the topic. The 2007 conference comprised two key events that galvanized the community. The first of these events was a special interest group (SIG) meeting on sustainability and interaction, which served as the community's first large-scale, open discussion of the subject [1], and the second was the presentation and publication of Eli Blevis's seminal paper on sustainable interaction design (SID), which served to identify and make explicit the critical connection between ecological sustainability and interaction design [2]. These events set forth a new set of challenges for the community and gave root to a lively discourse that has only gained in volume and momentum in the four years since.

Growing a Passionate Community

Much of the early discussion of sustainability in the HCI community focused on whether HCI could actually make a meaningful contribution to environmental challenges, and whether sustainability was a legitimate area of focus for HCI research. Arguments in favor of the area looked to the things that HCI does best—such as visualizing and communicating information in ways that people understand through interactive system design, or understanding people's practices with and perceptions of technology—and posited this expertise and set of skills would be key in finding solutions and encouraging sustainable practices. Currently, sustainability in HCI is seeing rapid growth and general recognition as a valuable and valid area of study. This is evidenced by continued and increasing publication on the topic at CHI and related venues and workshops; journals devoted to aspects of sustainability and HCI; and the integration of academic courses built around sustainability in HCI and HCC curricula. The inclusion of sustainability as a Featured Community at the CHI 2011 conference underlines the increasing attention that the HCI community is giving to the area. Furthermore, it is difficult not to notice the tangible enthusiasm and passion for the subject within the community.

Sustainably Ours, the predecessor to this column, has served as a key forum for exploring the intersection of sustainability and interaction design for the past three years. Examining the ways in which design and HCI knowledge, approaches, and methods could be applied to meet environmental challenges, the forum has been instrumental in developing the body of knowledge and ideas that constitutes a "first wave" of sustainability work. In addressing this new and unfamiliar set of challenges, the community first examined the problems and then looked to itself to start finding solutions. What aspects of the manifold environmental problems—global climate change, e-waste, decreasing biodiversity, among others—were we equipped to address? What could we draw forth from our large and diverse toolbox of skills and expertise to alleviate or simply understand these problems?

This initial wave of research in the area built up a core of knowledge that relied heavily upon the unique experience and knowledge of the HCI and interaction-design communities, generally approaching problems in various domains from an HCI perspective. These forays into sustainability included studies of human practices surrounding consumption, waste, and energy use, using methods such as contextual inquiry, surveys, and interviews. System designs and technology prototypes focused strongly on using good information visualization to increase awareness and communicate information to users in ways that were meaningful and easy to comprehend. And designs leveraged many of the media channels that have become central to the HCI community in recent years, such as online communities and social networking software, as new means of delivering information and supporting sustainability.

Building from the Inside Out

The community continues to engage in sustainability-oriented research relying primarily on core HCI expertise, creating a foundational bridge between sustainability and interaction design. However, we are at the same time discovering the need to build bridges outward to maximize the impact and effects of our work. The urgency of global climate change and related problems underscores the fact that the sustainability work undertaken by the community must have effects beyond the boundaries of the community if we are to contribute to solutions. One of the great challenges that lies ahead for sustainability work is how to assess the success of our research, not only

Photograph by Pablo Rios

in terms of evaluating interaction, but also in terms of understanding the impact of our work on everyday life and practices, behaviors, and perspectives.

Despite the increasing agreement within the CHI community that HCI and interaction design can contribute to solutions to sustainability challenges, few, if any, would argue that HCI itself is the solution, or that problems of sustainability can be framed purely as problems for HCI or interaction design issues. Rather, as this first wave has illustrated, HCI can be effective at providing certain pieces of the puzzle.

As we move forward in search of solutions with concrete, real-world impact on environmental sustainability, it is critical that we focus not only on those pieces but also on identifying and establishing the connections with the pieces that fall outside our realm of expertise. The Sustainability in (Inter)Action forum aims to continue strengthening the HCI core of SID, while finding and building connections toward more complete solutions in which HCI works in conjunction with other areas of knowledge.

Much of the current research in sustainable HCI has begun to reach outward to connect the ongoing work in HCI with other domains, such as politics and environmental psychology. Drawing and establishing these connections is essential, as it helps us address needs in which our community is inexperienced and avoid duplicating work that others have already done. One of the initial challenges, however, is simply understanding where to look for expertise so we can begin to take advantage of the vast knowledge that already exists and lend our own expertise to other communities where it might be beneficial. Sustainability in (Inter) Action aims to provide a forum for exploring these connections.

Although we do not presume to know all the directions that this next wave of sustainable interaction work will take, there are some important bridges that seem especially ready for construction. More specifically, there is a need to connect with data that other fields can provide, to look to methods and theory from other areas of research and practice, and explore new and existing infrastructure outside of our primary research community.

Much of the work in HCI and sustainability has relied upon data that we are able to collect ourselves, such as logged user data, self-reported data, or sensor data to understand various phenomena or evaluate interactive systems aimed at addressing environmental challenges. Other work has taken advantage of easily accessible data that is simple to communicate, such as measures of carbon footprint. Reliance on such data has allowed researchers to engage more deeply in the design and interaction aspects of our work. It has allowed us to focus on the user experience and perspective by dealing with types of content that do not fall far from our core expertise.

However, there is also a need for the community to look to the extensive and scientifically rigorous bodies of environmental data that are being produced by environmental science and engineering, among other fields. The ability to understand and use this data will be extremely powerful in helping us come to mature and viable solutions that go beyond proof-of-concept. As one example, work in the area of life cycle assessment (LCA) has produced cradle-to-grave data on the environmental impact of products and services, data that is regarded as arguably more comprehensive, standardized, and scientifically rigorous than measures such as carbon footprint [3]. Such data, however, is complex and less straightforward to use and access than much of the data our community currently relies on; making use of it will entail not only rethinking content, but perhaps rethinking design as well. Recent work by Bonnani and Hockenberry has made a step in this direction. They investigate the use of LCA in interfaces to support environmental awareness by examining how Sourcemap, an open source tool that supports exploring and calculating LCAs, with an emphasis on carbon data and material sources [4]. This work represents an important trajectory—the integration of the increasing wealth of data that can be gleaned from other fields that are also addressing issues of environmental sustainability, and the establishment of connections to these fields.

In addition to offering potential sources of data, other fields may also hold theories, models, and methods suited to addressing challenges of environmental sustainability that complement those in our own toolbox.

Recent work in the area of sustainable HCI has begun to identify these connections. Most notably, Froehlich et al. have made a strong argument for relying on work from the field of environmental psychology when considering the design of eco-feedback systems, largely because of the particular methodological approaches taken in that field that are often complementary to the approaches in HCI

and interaction design [5]. In a further example, work by He et al. ties traditional notions of user-centered design to models drawn from behavioral psychology and addiction therapy to address the challenges of motivating changes in energy use [6]. As the community strengthens the ties between environmental sustainability and HCI theory, methods, and models, it must also continue to look to other fields for tools and knowledge that can be applied in conjunction with them towards novel or more complete solutions.

Going forward, a third bridge that the community must continue to build is that between research and real-world situations. Although HCI and sustainability research relies on studies of existing practice and deployments of novel technologies outside of the laboratory setting, recent work by Aoki et al., which has attempted to bring novel technologies into a real-world community, underlines the novel and unexpected challenges of interacting and negotiating with various stakeholders in a municipality [7]. Notably, the work highlights the complexity of perspectives among organizations and individuals, the barriers it can create for buy-in, and the implications for how research needs to be conducted outside of the comparatively constrained and controlled settings in which many other technologies in the area have been deployed and tested. Rather than shying from the potential messiness and complications that may result from situating novel technologies in real environments and communities, we should embrace the opportunity to learn from the unanticipated challenges that such deployments afford as a way of better understanding, and thus better addressing, the domains in which we are attempting to have a positive and concrete impact.

The question of what fields, areas, and stakeholders may hold useful knowledge for interaction design and sustainability is still an open one, and the potential areas for exploration mentioned here are but a small subset of examples from a largely unknown set of possibilities. Certainly many more possibilities exist, and a recent and excellent comprehensive survey of the sustainability research in HCI by DiSalvo et al. makes arguments for additional connections with other scientific and design communities. Such connections, they argue, would encourage us to draw new conclusions through research rather than repeating the same ones we have already drawn [8]. Dourish also proffers an articulate argument for the need to consider sustainability research in HCI within the greater political and economic context so as to avoid a constrained perspective that yields a constrained impact [9].

In this still nascent area of study, we have only just begun to look outside of our own field for resources and expertise that may help turn our studies and designs into concrete solutions to problems of sustainability. As we consider how HCI methods and knowledge can be used in conjunction with those from other fields, communities, and stakeholders that are addressing similar issues, one of the key challenges is identifying what these connections will be. Although some current and potential communities and research areas are mentioned above, this list is by no means comprehensive. Sustainability in (Inter)Action is a forum for exploring these bridges and engaging with these communities while continuing to explore the critical area of sustainability in interaction design.

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On Heritage aims to offer and promote a rich discussion at the intersection of art, performance, and culture that expands the boundaries of HCI while broadening our understanding of how things of the past come to matter in the present.

Elisa Giaccardi, Editor

An Internet of Things That Do Not Exist

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What are the implications of our relationship with physical artifacts as the technical and cultural phenomenon known as the Internet of Things begins to emerge? The term, coined in 1999, is attributed to the Auto-ID research group at MIT and was explored in depth by the International Telecommunication Union in a published report bearing the same name at the United Nations Internet summit in 2005. The term refers to the shift that is anticipated as society moves to a ubiquitous form of computing in which every device is on and connected in some way to the Internet [1].

The implications for the Internet of Things upon production and consumption are tremendous and will transform the ways in which people shop, store, and share products. The analog bar code that has for so long been a dumb, encrypted reference to a shop's inventory system will be superseded by an open platform in which every object manufactured will be trackable from cradle to grave—from manufacturer to distributor, to potentially every single person who comes into contact with it following its purchase. Furthermore, every object that comes close to another object and is within range of a reader could also be logged on a database and used to find correlations between owners and applications. In a world that has relied upon a linear chain of supply and demand between manufacturer and consumer via high street shops, the Internet of Things has the potential to transform how we will treat objects, care about their origin, and use them to find other objects.

Everything will be searchable and findable, and, subsequently, the shopping experience may never be the same. The concept of throwing away objects may become a thing of the past as other people find new uses for old things.

Spimes

In his text *Shaping Things*, Bruce Sterling introduced the term "spime" to describe an object that was more digital than actual:

"Spimes are manufactured objects whose informational support is so overwhelmingly extensive and rich that they are regarded as material instantiations of an immaterial system. Spimes begin and end as data. They're virtual objects first and actual objects second" [2]

A mash-up of the words "space" and "time," spimes are objects that are in contact with the Internet all the time, constantly telling the world where they are and what time they are there, as though they are new coordinates that will define how we map reality. I describe them as new because they synthesize locative, temporal, logistical, and social data, unlike traditional forms of scientific measurement that have tended to concentrate on one aspect of the world: maps/space, clocks/time, thermometers/temperature, etc.

Although society is not yet entirely immersed within an Internet of Things, we are beginning to see evidence of the types of spimes that might emerge, so much so that we can begin to postulate a continuum of artifacts that are more or less valuable in their material or immaterial form. In order to begin identifying the poles that define a practical continuum, I would like to introduce two simple oppositions: things that are actually in the world, and things that are not actually in the world.

This basic opposition is one that formerly wouldn't have generated any particular tension—we are not used to considering the relationship between things that no longer exist and the things that do. However, for interaction designers, the significant difference in the materiality of both objects is changed by the likelihood that they may both have a data shadow, an immaterial other.

Things That Are Actually in the World

Much of what has so far been hypothesized and funded for an

Internet of Things consists of programs that are associated with logistical systems, such as stock control and product tracking. Regardless of the type of tagging technology, these systems offer the ability for the condition of an object to be recorded in a variety of forms and streamed to databases that can be correlated and mined to ensure that things, for example, are in the right place now or have been in the right place in the past, have been kept at the right temperature, and handled by the right people, etc.

From books to frozen peas, parcels, to even people, things move through scanners to update their location; if that location has particular properties, then aspects of its condition complement the data that is associated with the object. For example, fish are not individually tagged as they land at a refrigeration unit at a fishing port. Instead, a box is logged as being within a particular freezer, and the temperature of that freezer is associated with the box of fish. In this way, things carry data about the world around them.

For the many objects that move through supply chains, most of them are read-only, with tags and identities that are legible only to the organizations that care about their condition before they move into the hands of another supplier or consumer. However, we are beginning to see the opening up of these closed channels, allowing the public not only to read tags but also to add information and contribute to their identity. Platforms such as Red Laser offer smartphone users the ability to scan traditional bar codes and access product libraries that include the name of the product and its type, placing a technology that was formerly held by a checkout assistant in the supermarket in the hands of the public. Based upon this system, applications such as StickyBits (www.stickybits.com) allow users of smartphones to scan a product code and attach their own media. Short text stories, a photograph, or a video can be posted to the StickBits database, where it is made available for others to read when scanned again using the same software. Turning the bar code into a media channel, mobile phone camera scanners offer companies and individuals a conduit through which marketing materials can be fed, and social data can be attached.

While StickyBits tends toward using codes that are shared across whole product lines, other platforms offer the public a chance to create new codes for unlabelled items, and tag them with memories, stories, and media content. The Tales of Things system (http://www.talesofthings.com/) allows individuals to pick a single item, attach social data through a website that then generates a unique bar code so that others who come across the object can retrieve that data. Aimed at encouraging the public to record personal stories onto objects, the Tales of Things website demonstrates that some objects that are moving through the world not only contain quantitative data to ensure product integrity and freshness, but many are also beginning to hold qualitative data that is intended to affect how users interpret and use physical objects.

As scanners move into the public domain, and more and more people carry phones that are constantly connected to the Internet, the amount of nodes that constitute the points of scanning and posting of data about things grows. This model assumes that the things exist, and the same things can be tagged with a bar code, RFID chip, or magnetic strip to allow them to be registered as they accrue more data about their whereabouts and condition. However, there are things that remain vivid and meaningful in the public consciousness but no longer exist.

Things That Are Not Actually in the World

Memories of things that have been lost, destroyed, or even died no longer have a material instantiation and are recalled only when the memory of that thing is triggered in the mind of an individual or the public.

It has been suggested that people in general surround themselves with between 1,000 and 5,000 objects [3], many of which are discarded and replaced through consumption and subsistence. However, some objects are lost, stolen, or mislaid forever and are irreplaceable because of the memories they are associated with. But in the context of an Internet of Things, this status of absolute loss is already becoming a thing of the past, as an artifact's data is likely to remain.

As we move to a time when objects are individually tagged through their production, we can assume they will accrue more forms of data. Unlike the old adage "a rolling stone gathers no moss," artifacts within the Internet of Things *will* gather moss. As they move from one place to the next, they will gather locative data; as people interact with them, they will gather social data; and even as they sit idly on a shelf, they may well be gathering data about the objects that are around them. This data will exist in virtual form even when the actual object has been broken, lost, or thrown away. Stored safely in the cloud and accessible for eternity, the object lives on as a ghost in the machine, waiting for a chance to be exorcised.

Remember Us
QR Code Installation

Overview

Many projects that evoke the concept of the Internet of Things, hinge upon the association of a single material artefact to a single catalogue of immaterial data. In industrial contexts one bag of frozen garden peas is tagged with temperature and prices that correspond to that artifact. In an artistic context, last years project RememberMe in collaboration with the Oxfam shop on Oxford Road, successfully associated personal stories with donated items.

The RememberUs project inverts this binary relationship by introducing an object as being 'blank' and open for 'many' people to write on to it according to any associations.

The RememberUs artwork is a simple shelf of 5 completely white artifacts. Things that can be found in many homes from the present and recent past: for example a rotary dial telephone or a stiletto shoe. Hanging underneath each item is a small book containing QR code stickers. Visitors to the gallery are invited to take a sticker from the book and attach it to the corresponding object and then use the TalesofThings iPhone and Android Apps to 'record' a memory on to that object. The QR tags are technically blank and wait to be assigned a memory. Once 'loaded' with a data (AudioBoo / YouTube clip or simple text) the tag can be read by other visitors using the same Apps.

▸ Figure 1. RememberUs. Artwork allows any person to store a memory onto an object, turning domestic items into shared memorials.

Although lost in the actual world, the things that no longer exist in physical form do remain in the world in an immaterial form. These types of objects are not new—we have been using totems to evoke memories and concepts throughout the history of society. Objects such as public memorials offer a surrogate material "person" in order to evoke memories of the person who was lost. In cities across the world, the Tomb for the Unknown Soldier plays an important role in offering a point of identification through which memories of any person can be accessed. The Tomb for the Unknown Soldier is as valuable for one family who has experienced the loss of a relative as any other family, no matter the cultural background or the conflict in which a person died.

Evidently, through the example of a public memorial, we find that things that are not actually in the world are still able to find a thing to which they can be associated and therefore be remembered.

Surrogate Things

The decoupling of immaterial things from their material counterparts through loss presents some interesting design futures for both the disassociated ghosts that remain in cyberspace, and the potential for material objects that have yet to be used by people and subsequently develop a complex identity. As a means of exposition for this potential, I want to reference a piece of artwork as an example for how the gap between physical objects and their intangible qualities may not longer be tenable.

Last year's RememberMe intervention was held in a U.K. charity shop, memories of donated items were associated with the physical things using the Tales of Things (www.talesofthings.com), which represented a provocative context for exploring a social model for the Internet of Things. A year on, the team wanted to explore the further potential for physical objects to be used as hosts or surrogates for the "immaterial things" that have lost their original material partner. RememberUs is a conceptual installation that consists of a series of secondhand artifacts that have been painted completely white. Installed in a gallery, each material object is accompanied by a book of blank bar codes. Upon viewing and handling the object, the holder is invited to record a memory about the type of object onto the actual thing using the TalesofThings mobile phone application. Figure 1 shows how a rotary dial telephone might look in the gallery once it has been associated with multiple memories.

What seems apparent from the RememberUs project is the potential for one tangible artifact to be reassociated with not just one memory of another object, but multiple. For further visitors to the exhibit, the physical rotary dial telephone becomes a surrogate for memories that are recalled only once the visitor picks up and handles this type of phone that is now a thing of the past. Replaced by digital telephones, some without physical buttons or cords, the rotary dial telephone, in its material instantiation, is an object that is already lost. Even though the particular phone on show has become detached from its owner and the environment in

Within a short amount of time each object will become a host to many memories. Originally blank, and without noticeable characteristics, the white artifact becomes a physical manifestation of the 'idea' of an object. An idea that is substantiated and made real only through the accruing of peoples memories and associations with the 'idea' of an object.

The work can be understood as a challenge to a model for the Internet of Things that assumes that we know where an object is from, and that it may have physical value before it has immaterial. RememberUs relies on the volume of immaterial ideas in order to bring an object into the world. If it remains blank or with few memories, the artifact will remain deficient in meaning compared to its partners that may attract many more memories. The blank objects can also be understood to be 'physical wikis' to collate public relations with objects and offer an open memorial for personal connection.

The TOTeM project is funded through an EPSRC research grant to explore social memory in the emerging culture of the Internet of Things. Our three-year project aims to develop creative, social and technical platforms to allow everyone to tag anything with a memory, and for anyone in the future to retrieve that memory. The project team is made up of artists, designers, social and computer scientists based in Brunel University, University of Dundee, Edinburgh College of Art, University College London and University of Salford.

The RememberUs project is powered by TOTeM tagging technology and uses the www.talesofthings.com website to allow anybody to attach a memory to a thing, and receive a unique printable tag that they can attach to the object.

which he or she associated it with memories, anybody who handles the phone in the gallery is able to attach their memory of these types of phones and recover the artifact from being lost in the world.

Opportunities for Interaction Design

It is likely that memories will far outweigh the number of actual things in the world, simply because people throw so much away. If this is the case, then we are likely to see more circumstances in which physical objects will become associated with social data looking for a host. In this context we may need to design blank objects that have no other function than to become the host for memories that have lost their connection with the original physical artifact. Other times, discarded and culturally lost objects may be used because they retain some of the physical attributes that trigger associations with immaterial things (e.g., memories) that have lost their original material partner.

Whatever we do with things in the future, it will be radically different from what we've done in the recent past. Used to buying new things and throwing them away when they are no longer useful, we will see a shift in our relationship with objects. As well as becoming conduits that allow us to recall information from the past, things will help us to recover memories that have lost their physical place in the world. This world of "ready-mades" is potentially as significant to social and industrial processes as was the work of the Surrealist artists, who understood how important language is in our interpretation of the world. Artists such as Marcel Duchamp and René Magritte understood that imagery on a painted canvas was only a representation of the thing, person, or landscape that it depicted. Magritte's famous painting *Ceci n'est pas une pipe*, which depicts a pipe but claims that it isn't one, has never been an actual physical pipe; it is only the painting of one—but at least it looks like one.

In the Internet of Things, objects may end up on your mantelpiece with associated memories of completely different artifacts. The value of these vessels and our attachment to them will likely depend on the social data stored in them, rather than on their physical form.

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This forum is dedicated to personal health in all its many facets: decision-making, goal setting, celebration, discovery, reflection, and coordination — even entertainment. We'll look at innovations in interactive technologies and how they help address current critical healthcare challenges.

Elizabeth D. Mynatt, Editor

IT in Healthcare: A Body of Work

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Healthcare is both deeply personal and staggeringly complex. It starts with individual physical bodies and stretches to include an array of technologies, physical places, caregiver networks (both formal and informal), and decision-making tasks. Each configuration of body, people, technology, places, and decisions presents compelling and timely challenges for human-centered computing.

As the introductory article for this forum, my aim is to describe this landscape of challenges for our community and to invite articles on these topics.

Health Is About Sensing

In contrast to other areas of HCI, which focus on people producing digital objects, working across electronic networks, and creating virtual economies, health is fundamentally rooted in the physical world, due to its undeniable connection to the human body. With the foundation of the physical body, and branching out to the physical places that embody healthcare, current and future research seeks to sense information in this physical world and make it available for analysis and action. Sensors on or near the body attempt to assess physiological state; capture actions directly related to the physical state, such as what someone is eating; recognize key activities, from walking to taking medication; and integrate data about actions over time.

As sensing provides the link to the physical world, the need to develop reliable, robust, efficient, and acceptable sensors remains a constant challenge, especially in situations requiring around-the-clock monitoring in places outside of healthcare institutions, such as the home. Sensors must perform in difficult and dynamic physical conditions. Their signals must be reasonably reliable and amenable to effective analysis. Many sensors strive for 24/7 operation over long periods of time, hence the need for energy-efficient and energy-harvesting designs.

Sensing technology also needs to be deemed acceptable by various stakeholders. Objections to sensors can range from the sensors being physically uncomfortable to visible sensors creating social stigma. Invasive sensing in a hospital setting does not transfer to typical home environments. The relationship between sensing and privacy raises many thorny challenges that ultimately involve the use of sensed information and the elasticity of privacy concerns in the face of specific healthcare challenges. However, the base capabilities of a sensor—the capabilities of

Photograph by Katherine Nagl

video cameras in contrast to motion sensors, as well as single-latch sensors—set the stage for privacy considerations. Designers must often lean toward minimally invasive sensing, despite the overall utility of more general-purpose sensors.

While its connection to the physical world is fundamental, overall health is a combination of physical, mental, and social well-being. This "health triangle" makes it clear that health extends beyond the physical body and physical injury. Enabling mental and social well-being draws on many competencies in HCI, ranging from persuasive computing to online communities, as discussed further in this article.

Health Is About Data

Bill Stead, associate vice chancellor for strategy/transformation and chief information officer at Vanderbilt University Medical Center, spoke last year at the national meeting Discovery and Innovation in Health IT [1]. His assessment was that physicians were already faced with an overabundance of data, yet they are only at the beginning of the eventual tsunami of data coming within the next decade. Any challenge seen in data-visualization research is present in healthcare data—for example, time varying, multivariate, heterogeneous, noisy data stemming from disparate sources and utilized by, at a minimum, a host of professional healthcare providers. Additionally, data analysis is not static but needs to convey emergent phenomena. How can someone roll back time to interrogate an older visualization in the face of new data? Information-presentation techniques must also accommodate a spectrum of people who have varying levels of analytical skills and available time.

A recurring challenge in data visualization analysis is the detec-

SENSING

FitBit *http://www.fitbit.com* An unobtrusive accelerometer-based sensor that clips to a belt or pocket. Reports steps, calories burned, and sleep quality. Syncs to web service and social media.

BodyBugg *http://www.bodybugg.com* Multi-sensor armband that tracks physical activity and reports directly to a smartphone.

Adidas MiCoach *http://www.adidas.com/us/micoach/* An accelerometer-based pedometer that works with a personal training web service.

Philips DirectLife *http://www.directlife.philips.com/* An accelerometer-based pedometer that works with a personal training web service.

Ant+ Network *http://www.thisisant.com/ant/ant-interoperability* Wireless networking technology used by many sensors in health/wellness (e.g. heart rate watches, Adidas MiCoach). Useful because of its low power consumption and relative ubiquity.

Nike+ *http://nikerunning.nike.com/nikeos/p/nike-plus/en_US/* Shoe-mounted pedometer integrated with iPods/iPhone. Combined with social network features that let runners compare runs and receive real-time social support via Facebook during their run.

WiThings Body Scale *http://www.withings.com/en/bodyscal* Wifi-enabled bathroom scale that connects to a web service or iPhone/iPod and lets users visualize their weight over time and share with others. Auto-detects users in multi-person households.

DATA

Patients Like Me *http://www.patientslikeme.com* Web platform that enables people to share information that can improve the lives of patients diagnosed with life-changing diseases.

DECISIONS

Health Month; *http://healthmonth.com/* Social resolutions game. Adds a gamification layer and social persuasion techniques to everyday commitments. Wellness-centered.

PEOPLE

Online Health Communities (beyond Patients Like Me)

SparkPeople http://www.sparkpeople.com Weight loss community

dLife *http://www.dlife.com* Diabetes community

FatSecret http://www.fatsecret.com Weight loss community

tion and portrayal of trends. Many forms of healthcare assessments are based on identifying declines or improvements in people's abilities and conditions. For example, declines in physical locomotion, i.e., walking, could portend a damaging fall or could indicate the onset of disease. Detecting trends in cognitive abilities is even more challenging, as cognitive performance varies considerably due to many external and internal factors. Even the task of determining if a behavior is "unchanging" or within normal parameters is challenging, as the definition of "normal" is frequently patient-specific.

The reliance on sophisticated data analysis for healthcare concerns will draw the HCI and machine-learning communities even closer. That said, the technical capabilities to produce various forms of data analysis far exceed the human capacity and desire to attend to this information. The use of healthcare data is always embedded in constrained human environments: 15-minute physician visits, nursing shift changes, time-limited surgical procedures, busy and distracted caregivers, and simply people who would rather focus on the events of the day in contrast to monitoring and reflecting on their own health.

Health Is About Decisions

Professional caregivers rely on a foundation of education and training; individual patients rely on a foundation of customs, habits, and daily routines. From determining a diagnosis and course of treatment to deciding what to eat for lunch, the stakeholders in healthcare attempt to integrate new information in the course of routine to emergency decision making.

Integrating new information is itself a decision-making task. The search for online information brings this challenge to the forefront: how to compose a search query and then follow a thread of links while trying to determine if the advertised (not just in the commercial sense of the word) information is relevant and reliable? Frequently, the next step is to collaborate with other stakeholders, from caregivers to physicians, to assess the information and determine its implications.

The road from data to diagnosis has received considerable attention in the medical and computing communities, from imaging technologies to AI expert systems. More recently, greater attention has been paid to the process of healthcare delivery and the iterative decision-making processes it comprises. Management of many chronic diseases (diabetes, asthma, heart disease, etc.) relies on iteratively calibrating treatment factors, including medications and daily behaviors. For example, an asthmatic patient or family caregiver must integrate the use of daily and rescue medications with respect to dynamic changes in behavior and environmental conditions. That patient's physician should assess ongoing treatment plans in terms of whether the patient has returned for a routine visit or is in the emergency room.

This increasing load on patients has motivated a new generation of computing tools that enable patients to better manage chronic conditions. With a thin educational foundation, patients make decisions every day, whether implicitly or explicitly, on how to adhere, or not adhere, to a prescribed treatment plan in the face of their own behavior. These tools must acknowledge that patients will rarely be 100 percent compliant in moderating human behavior and yet provide the scaffolding so that patients can be more successful in improving health outcomes. These interfaces frequently motivate patients into becoming "detectives" in making sense of their own health data, as well as helping patients set localized goals that should lead to better health [2]

As patient behavior is more critical to the prevention and management of modern-day chronic diseases, there is growing interest in designing computing experiences that influence healthy behavior. These persuasive experiences come

in many forms, relying on play and entertainment and tapping into social support and competition. Trade-offs and combinations of interfaces that emphasize management and goal setting with interfaces that compel patients to "do the right thing" create a large design space for human-centered computing. While systems that rely on increasing amounts of personal data raise privacy concerns, persuasive systems that emphasize motivation over introspection also raise ethical concerns.

Health Is About People

Despite my emphasis on patient and providers, the reality is, of course, that health is about people. Recent emphasis on "wellness informatics" makes this point with more clarity [3]. Good health is a universal desire, and healthcare does not begin in the doctor's office with a disease diagnosis. Health is intricately embedded in daily life and the people who populate daily experiences.

Research by Consolvo and others identified the "care network" as a critical foundation for designing health-informatics applications and services oriented to people in their homes and those who take care of them [4]. This perspective is almost universal in healthcare. Although health is grounded in the body, there is almost always a network of care made up of the individual; his or her family, friends, neighbors, and colleagues; and, of course, another network of more formal healthcare providers. How this network shares information, coordinates care, builds trust (or not), and shares differing perspectives and expertise is the foundation for healthcare in everyday settings.

One critique of research in healthcare informatics is the focus on disease. Partly a result of funding agencies, as well as an overall orientation to intervention as opposed to prevention, this perspective flies in the face of everyday experiences of celebration and life satisfaction. Although people share varying degrees of aversion to risk and a desire to be healthy, daily choices regarding food, sports, sleep, social engagement, and so on are generally not viewed first through the lens of disease. The strong influence of social networks has made some in the medical community describe chronic diseases such as diabetes and heart disease as contagious. Patterns of daily behavior are profoundly shaped by the people who jointly participate in these activities. These social networks bring their own desires for an enjoyable life.

Social networks are no longer limited to face-to-face interactions. They now span the globe in many forms ranging from online communities, shared interest and support groups, and digital hubs such as Facebook—areas ripe with potential. Understanding how online social networks can support a wide range of information seeking, decisions, and social-support needs in healthcare is important. While shared-interest and support groups have been around since the very first news groups, online sites such as PatientsLikeMe.com are causing a stir in the medical community. Participants share their personal medical data in the hopes of identifying alternative treatment options, with the goal of establishing scientific evidence around the prognosis and treatment of some of the most vexing diseases in modern life.

The goal of this article is to broadly depict topics in personal-health informatics that are of interest to the HCI community. In emphasizing personal or patient-centered healthcare, I have not addressed other major areas of inquiry related to public health and medical discovery. One reason for optimism about the role of human-centered computing in healthcare research is the growing recognition of the repeated need for HCI innovation in healthcare technologies. Both the recent CCC report [5] and the U.S. PCAST report on healthcare information technology [6] call for effective interfaces for providers and patients for improving healthcare outcomes. My hope is that this forum will provide fertile ground for the HCI community in tackling the many challenges in personal-healthcare informatics.

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Technology and the Human Lifespan: Learning from the Bereaved

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Jeanine was a 32-year-old project manager, married and pregnant with her first child. She regularly posted Facebook updates about her pregnancy to share her excitement with friends and family, often with accompanying cell phone photos of her growing belly. After nine months of anticipation and a smooth delivery, she gave birth to a baby boy. Jeanine and her husband circulated a birth announcement by email and Facebook. After a few days, however, the doctors informed her that due to a rare disease, her newborn son was dying. Only 36 hours later, her son passed away. Heartbroken and devastated, Jeanine returned home to find an empty house and hundreds of text messages, voice mails, and emails—mixed messages of congratulations and condolences. Unable to handle making phone calls, she sat down to write a single mass email to her friends, family, and co-workers about her tragic loss—what she called "the weirdest email of my life." (*All names in this article have been changed.)*

As personal technologies evolve, we continually have new opportunities to capture and share our lives. Mobile phones, Facebook, and Twitter have joined older forms of communication to form a varied technological landscape. As designers we often imagine "blue sky" scenarios, in which the envisioned user's life is stable and suffused with health and happiness: a kind of designer's optimism. But as the story above illustrates, these technologies remain in play during life's tragedies and across all parts of the lifespan. As technology becomes more personal and intimate, there is a need for increased acknowledgement and accommodation of the ups and downs that occur from birth to death.

As a key example, HCI researchers and designers have recently begun to tackle the difficult issue of death. A subject often reluctantly discussed and hidden away in Western cultures, the end of life nonetheless is in part shaped by interactive technologies in unexpected ways. Understanding all of the phenomena surrounding technology use at the end of life is a daunting task, but HCI researchers are beginning to address some of the issues. Odom et al., for instance, report on ethnographic work focusing on how objects mediate the relationships between the living and the dead, and how what we design can inform and enrich social processes [1]. Brubaker and Vertesi explore the persistence of digital identities beyond death by investigating the MySpace pages of deceased users, finding significant patterns in how MySpace is used over time by the bereaved [2]. Researchers working in this space also came together at CHI 2010 in order to share early work and identify potential areas for future investigation [3], while entrepreneurs have organized an annual Digital Death Day (www.digitaldeathday.com) to bring together practitioners developing software concerning death.

In this article, we briefly describe some of the work that we have conducted in this area, with a focus on sharing the stories of the bereaved and their experiences with technology. In so doing, we hope to illustrate the importance of thinking about the entirety of the human lifespan when designing personal technologies.

Exploring Technology Practices by the Bereaved

In order to obtain a better understanding of how the bereaved dealt with personal technologies following their loss, we began by conducting a survey and interview study

[4]. The study asked questions along three major dimensions. First, how are personal technologies inherited? What properties make technologies possible (or impossible) to inherit? Second, how do the bereaved use technology to remember their loved ones? Finally, how do the bereaved shift their technology use as a result of the death? By asking these questions, we identified ways in which designers could begin to look into bereavement more deeply. Here, we retell some of the stories that participants shared with us and point out how they illustrate the confrontation and comforting role of technology.

Inheriting Technology: Ambiguity and Uncertainty

In many cases, the transfer of property from the deceased to the living is determined by the wishes of the deceased and communicated by a will or by cultural traditions. Yet while digitalization offers convenient new ways to share information, it muddles the inheritance process in critical ways. First and foremost, 79 percent of our respondents noted even though they had the experience of dealing with a deceased loved one's digital estate, they had not given any thought to how to plan for the distribution of their own digital estate. Only 13 percent of respondents had actually made plans for their digital estate by, for instance, updating their will with instructions for how to access and distribute personal files. The remaining 8 percent saw their digital estate as none of their concern; they saw the task of distributing personal data after their death as someone else's problem. This identifies a growing need for better processes to distribute data following death. Indeed, Web services such as Legacy Locker (www.legacylocker.

com) offer customers the opportunity to upload their data, passwords, and other important information to their servers with the promise to distribute this information to inheritors following the user's death. However, it remains unclear whether sites like these will still be operating over the years and whether they are a reliable place to safeguard such important information.

While such services are interesting first efforts in this space, inheriting digital information differs from inheriting physical items in other, more nuanced ways, such as our ability to identify and claim digital assets. In our study, Margaret described how, as her mother's health deteriorated in old age, she and her siblings began to claim precious items in her mother's house: "She was a good artist, and they are just small paintings she did…all of them have been scooped up. Someone's got their name on the back of it." As this quote illustrates, there is a gradual social process wherein loved ones survey the estate before distributing it; digital assets, however, do not readily lend themselves to this. An inheritor cannot easily peer onto the hard drive or email account of a loved one, and cannot be sure whether they have taken stock of the entire digital estate to be inherited.

Even if we are aware of all of the potential files to be inherited, it is difficult to determine what is important to preserve, what should be examined more closely, and what can be safely deleted. In our interviews, Lisa described how difficult it was to maintain her mother's privacy as she went through her hard drive: "There are close things that are awkward and odd to see as you go through, and you don't know if there is something later that you should see. It's tough. At least with [physical] diaries, you can recognize that they are a diary, and act accordingly." As we develop more forms of digital representation, it will become necessary to develop new social processes concerning inheritance and new software solutions that make these processes possible and visible.

Having a "Poltergeist" Moment

Betty, a woman in her late 20s, lost her mother—a busy academic administrator—to cancer. Several months after her mother died, Betty received a phone call. When she checked the caller ID, the name that appeared was her mother's. She relates her reaction: "I got a call a couple of months from her office after she died, but it was her phone number, and I thought I was having some surreal poltergeist kind of moment…I recognized she'd passed away and thought, 'My mom's calling me,' and I froze and freaked out. I remember that it terrified me, but how excited I was at the potential to talk to her."

This story demonstrates the potential for technology to act as a stand-in for the living, often resulting in confrontational situations. Another key example mentioned in our study is how Facebook sometimes suggests users reconnect with a deceased friend. In both of these cases, a highly personalized technology (a mobile phone number, a Facebook page) plays a role in the "reanimation" of the dead in order to give the impression that the owner is still alive. As designers of interactive technologies, we must be acutely aware of how software personalization and digital identities persist beyond the natural life of the user in order to avoid such strange interactions.

Considerations for Designers

Following our initial examination of some of the ways in which bereaved people deal with technology, we have begun to focus our efforts on understanding bereavement more thoroughly, and understanding how technology designers might play a role in comforting and supporting the bereaved. To that end, we have engaged in three focus groups with grieving parents at community support group centers. We have also spoken with professionals who deal with the bereaved on a daily basis, including psychologists, psychiatrists, nurses, social workers, clergy, and so on. Based on a combined understanding of both the bereaved parents' perspective and the professional community, we have come to a number of guidelines that may be helpful to designers [5]. We share some of them here.

Grief is not a problem to be solved. Many of our informants remarked on the common Western misconception that grief is a medical condition with clear stages and an end. Even the most well-intentioned consoler may look forward to a day where the grief is over, and the bereaved return to "normal." Our participants decried this kind of characterization, noting that they never really stop grieving the loss of their children. Similarly, bereavement professionals have debunked the "stage theory" (denial, anger, bargaining, depression, and acceptance) of grief suggested by Kübler-Ross [6]. Rather, bereavement professionals and the bereaved alike see grief as a lifelong shift in worldview without "closure." For designers, this means we must avoid the mistake of trying to cure grief by offering the bereaved a prescriptive solution for their emotional state (e.g., an online treatment program with the promise of recovery).

Communication is complicated. In many cultures, the days following a death involve a large number of people. Friends and family arrive to console one another, and burial and memorial services are organized in coordination with local businesses and religious organizations. While it is true that the bereaved often find comfort and strength from their interactions with other people, there are many times where isolation, disconnection, and silence are preferred. Many of the bereaved parents we spoke to remarked on their need to "hide out" at home, shut off their phones and computers, and avoid contact with people they knew. Indeed, family and friends were often of little help because they could not relate to the experience of losing a child. Family and friends were instead valued for their material and functional support roles—doing chores, organizing affairs, or offering food. The parents we spoke with found the most support from other people who had suffered a similar loss—sharing their stories, validating their feelings, and understanding that their reaction was normal. For designers, we must recognize that technology-based communication will be purposefully avoided at times. Further, when communication does occur, the most meaningful interaction can sometimes occur with people who are not friends and family; we must support multiple social circles and perhaps connect the bereaved to one another.

What interaction might look like. In our conversations with the parents and with professionals, we sought to understand what designers might choose to focus on that would be helpful to the bereaved. One of the most important activities that technology can support is storytelling. Stories help the bereaved to accept and feel the reality of the loss. They allow people to relate to one another through shared circumstances, and offer ways to explore what-if scenarios. The HCI community has examined systems of storytelling for a number of years, and there are significant ways in which technology can be applied to help the bereaved craft, share, and read stories.

A second way in which interaction designers might support the bereaved is by engaging them in meaningful activities concerning their loss. Many participants and professionals describe the need to externalize grief. This can take many forms: Participants described creating memory books, planting trees, renovating the house, painting, sculpting, quilting, establishing a charity, and so on. Technology designers can support the bereaved by offering an environment for them to create meaningful external artifacts. Further, these processes can be linked to form communities of loss. A bereaved person might create a Web memorial and then join it with other memorials along a specific theme (e.g., cancer, drunk driving, or religious affiliation). The activity then not only comforts the individual but also may also help to comfort a larger community.

Conclusion

In our work to date, we have begun to understand how we might design technologies that support the bereaved and acknowledge death as part of the design intention—a process we call "thanatosensitive design." We have shown how personal technologies can bring us comfort at the end of life but at the same time become problematic or confrontational entities. By studying the bereaved, we open up the discussion of what it means for technology to be used across and beyond the user's lifespan.

Current work on HCI at the end of life is a first step toward acknowledging and engaging the multitudinous ways in which technology affects all parts of our lives—the good, the bad, the expected, and the unexpected. Similarly, it draws attention to the various stages of life—from birth to death—and the ways that personal technologies are now often incongruent with a developmental perspective. While technology does advance rapidly, we must also begin to consider how we can create personal technologies that gracefully grow—and die—with us.

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How High Can Expectations Go? Practitioner Issues and Risks of Interactive Installations

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The experience is common: You and your interaction design teammates have collaboratively conceived, designed, and installed a fancy multimedia installation, following every important user-centered design principle, actively involving all stakeholders in the design process, validating every requirement and concern, and finally installing the myriad of equipments needed. And you did all this well before reaching the previously defined deadline. Then, when everybody's smiling and admiring the work piece, comes in the dreadful client, who starts smoothly and coldly stating the installation doesn't fulfill the established goals, proposing scary changes that you and your teammates regard as complete nonsense, or even prejudicial to the project. The client now looks like a totally different person from when you made the winning presentation and the contract was signed. You and your team are unable to understand how exactly it's possible that the interactive installation doesn't fulfill the established goals.

Truth be told, in this profession, client expectations are easily raised at the beginning of an interactive multimedia project, since everybody in general—clients, users, designers, and programmers—enjoys the flexibility and potential of recent technological advances in the field.

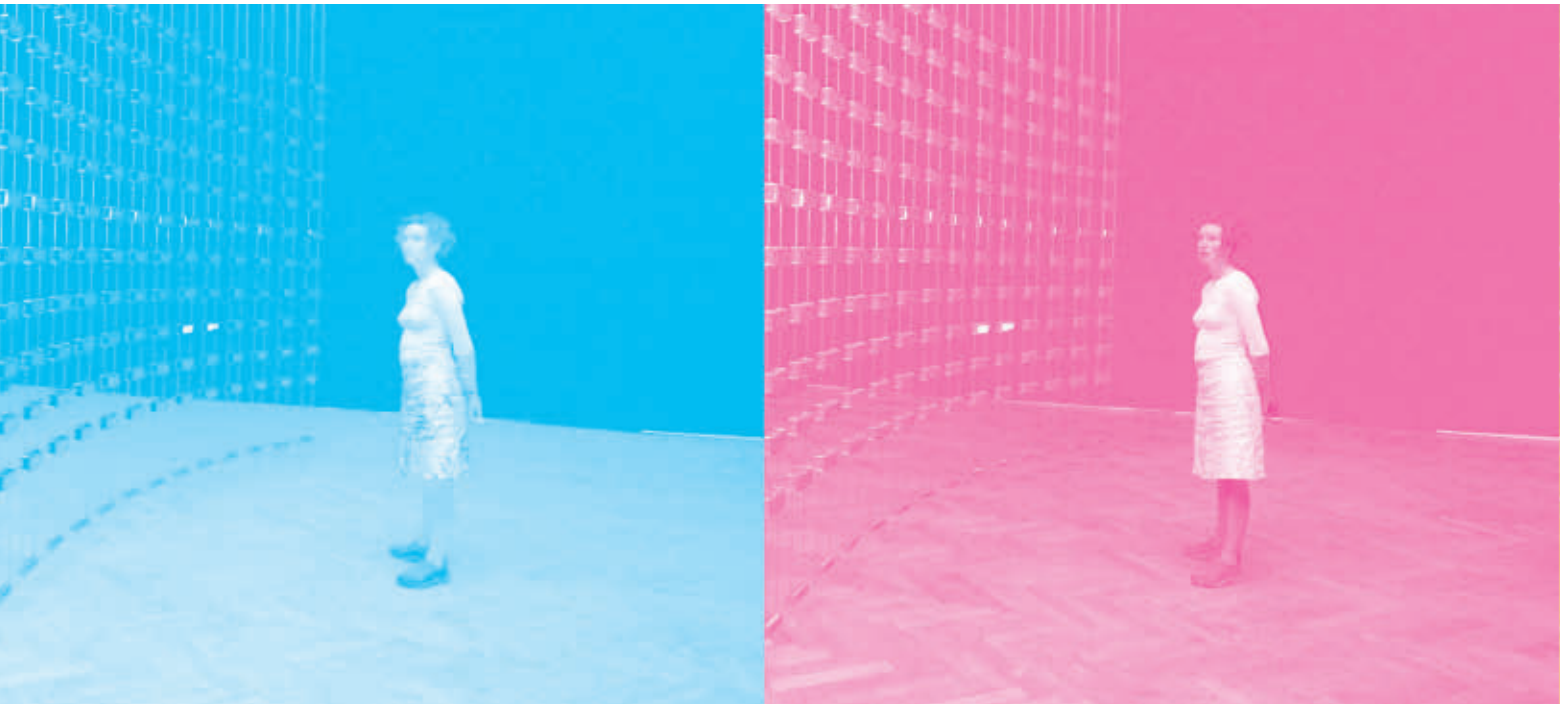
In fact, designing interactive installations for diverse venues and different contexts has become increasingly popular [1]. Science centers wish to exploit the interactive element to bring more visitors and explain difficult concepts in a more appealing way. Museums wish to attract visitors of all ages and promote collaborations between them, not to mention looking and feeling modern. Stores and shops have also started to embrace interactive installations as a way to improve relationships with existing clients as well as capture the attention and interest of new segments, exploiting installations featuring the so-called wow effect. Moreover, rapid evolution in available computing power, as well as decreasing cost in display technologies—such as projectors and LCD displays—has also led to increased interest from retailers wishing to improve their stores' attractiveness, museum curators wishing they had a nicer way to display the richness of cultural heritage, and science center managers who are technology enthusiasts and thrive with the idea of refurnishing their centers with the latest innovations. And the list goes on and on. Success seems almost certain in such a context. However, the experience is common: The project fails to deliver the intended effect.

In a recent interview published in *Wired* magazine, Fred Brooks stated, "You can learn more from failure than success. In failure you're forced to find out what part did not work. But in success you can believe everything you

Photograph by Ken McCown

did was great, when in fact some parts may not have worked at all" [2]. Certainly, both academics and practitioners have their success and failure stories (hopefully, more of the former). So, in some bad cases, you might be wondering, what went wrong?

Through our own experience, studying failures seems to effectively lead to better policy, thus increasing success rates in the long run. This idea is widely touted but rarely followed. Therefore, based on our industrial experience from more than 50 different interactive installations projects during the past three years, coupled with academic experiences from several large applied R&D projects, we analyze and share some of the issues and risks faced by interaction design practitioners working in interactive installations.



An Industrial Case of Interactive Installation Development

Portugal-based WowSystems specializes in new digital media, novel interaction paradigms, and interactive installations. The company, a spin-off from the University of Madeira, draws on several years of research around innovative interaction paradigms, like gesture-based interaction.

While in the past we have analyzed and described some case studies all about interactive installations' development [3], it now becomes more useful to reflect upon failures, following the course mentioned by Fred Brooks.

People's Expectations Have Become Too High

We live in a society full of expectations. In the past three years, people's expectations regarding technologies have never been set to a higher bar than they are today. This leads to increased pressure on interaction designers, since their work is more focused at the frontier between humans and machines. And, as we all know, the higher expectations are raised, the greater the risk faced by the project team.

A well-known risky deployment of interactive technologies occurred in 2001 with the opening of the Prada store in New York City [4]. An unexpected mismatch between the expectations of the retail technology designers and the real-world use of those technolo-gies demonstrates the difficulty in choosing the right solutions from the very large design space. As Greg Lindsay reported in 2004, a quarter of the store's budget went into IT innovations, but only three years later, "the multimillion-dollar technology spend is starting to look more like tech for tech's sake rather than an enhancement of the shopping experience" [4]. In this case, the

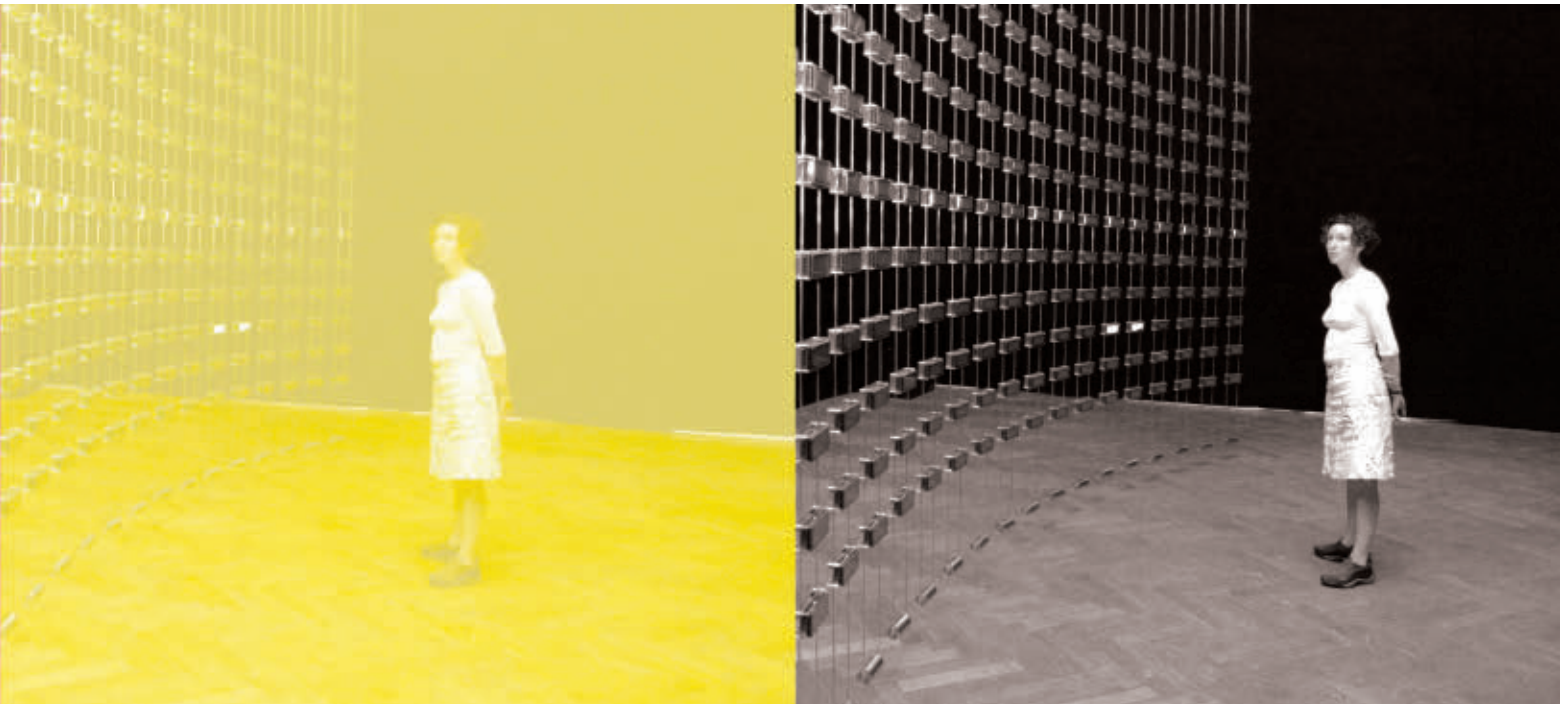
Photograph © Ars Electronica

failure derived from diverse factors, such as overflow traffic (the store designers weren't expecting so many visitors), technical failures (RFID wasn't 100 percent accurate), and interaction design flaws, such as non-intuitive controllers (e.g., floor pedals to control the opacity of a glass wall in the fitting room). The fitting room included an interactive mirror with a motion-triggered video camera that recorded the shopper and played back the video after a pause. With Prada's vast budget, we clearly agree with Brooks's statement: "We might think that the limiting factor on many design projects is money, but that's not true."

In a similar project, we designed and installed an interactive mirror for a shoe shop, illustrated in the image here. The client's expectations included the following: The shoe shoppers would step inside an RFID-tagged shoe and watch themselves inserted into real-time, virtual scenery related to the type of shoe they were trying on. Our design had the following characteristics: As a shopper walks around the experimenting floor, the shoe's RFID tag is read by the reader, and then the model's attributes are fetched from the product database and sent to the multimedia server that displays two synchronized scenarios—one for two top-down projections (left photo) and one for the front, "mirror-like" view (right photo).

The mirror-like front view displays the shopper in real time and places her in scenery by using a motion-detection and silhouette-extraction algorithm. This algorithm is adaptive regarding the different lighting conditions at the shop—usually brighter during the day and darker at dusk and night. The top-down projections are around Tokyo's neon signs and bright buildings. Simultaneously, the floor projections display a Tokyo sidewalk with Japanese signs and warnings, as well as other visual elements, and add interactivity by displaying neon lights over the floor according to the shopper's position.

Upon final installation, however, the solution didn't fulfill the client's expectations. Post-project analysis suggests one of the reasons this happened was simply because the expectations were too high. Contrary to the Prada example, however, our solution fitted the consumers' profiles very well, views of the streets or sidewalks that are typical of the city that the virtual scenery replicates. For instance, the photos show a shopper trying a shoe model that had a design inspired by modern life in Tokyo. Therefore, our interactive mirror displays scenery based



If there is too much innovation put on a given interactive product, then that product could be difficult to learn at first. This implies that innovation comes at a price.

and the satisfaction levels that shoe shoppers expressed helped us defend the project's solutions.

The Solution Space Has Become Too Large

Imagine for a second that you have to conceive 15 interactive installations for a science center. If you think about it, there are literally hundreds of different ways you can conceive, design, and develop the installations. Using infrared motion-sensors gives you dozens of different ways to control and interact with digital content, from page-flipping gestures performed with hands, to slowly triggering multimedia contents in large displays according to the users' steps. Camera-based interaction and augmented-reality systems provide another large set of possible design solutions. Combining different technologies opens up an even larger design space (3-D displays, touchscreens, multitouch surfaces—the list goes on and on). In other words, today's technology is so flexible that it becomes difficult not only to design and decide but also to present alternatives to clients.

Because of the diversity of possible technological combinations for any interactive installation, the solution space has become too large. This, we argue, is an issue that contributes to increasing risks in interactive installations' development. And it's one of the reasons why it is surprisingly easy to create bad designs.

A Crisis Context Opens the Way to Finding Excuses

Experience has shown that during an economic crisis some clients start focusing on finding excuses for not admitting a project's success—and therefore not paying.

The problem with frontline interaction design is that it's fairly easy to debate or discuss the final results of an installation: People's tastes are highly subjective and vary a lot. Requirements engineering as a discipline has many principles, techniques, and methods devoted to traditional software development. However, in terms of validating interaction design requirements, research literature is somewhat scarce. More effort should be put into how we can more effectively work collaboratively with stakeholders in order to better define the interaction design aspects of any given project's requirements. A promising approach seems to include "agile usability," which couples the well-known principles behind agile development with the familiar usability concepts. Nevertheless, the community needs to address this research challenge and find a better path to effective requirements analysis and validation, whenever interactive installations are the core of a given project.

Guidelines from our Work

Fortunately, as with any crisis, there are ways out. We have been lucky enough to work around several practitioners' issues and risky situations in this field, and we have been working toward compiling sets of guidelines based on both successful and not so successful projects. While some of the more than 50 interactive installations already deployed were solely created as experiential activities—providing an increase in the level of learning by adding facts to an already well-formed conceptual mode—others were designed to enact a reflective activity, thus supporting a restructuring learning where new conceptual frameworks need to be built. Based on this experience, we have summarized into a set of guidelines some ways to help interaction designers survive and do well when the expectations are increasingly getting higher.

Make the vision stand out. This guideline is based on the story of the bricklayers who were asked what they were doing. The first one said he was laying bricks. The second said he was building a wall. And the third said he was building a cathedral. To remind practitioners that they are "building a cathedral," it is a good idea to hang exhibition posters that feature interactive installations, photos of the visitors, and, for instance, give away free tickets, whenever applicable, so that engineers and designers can experience the installations the exact same way clients and users do. For instance, in the most recent installation (the shoe store we described), we asked the team to

take their wives and girlfriends to the interactive shoe store and gave away a free voucher as well as free entrance to the store's pre-opening party.

Make the interaction model easy to grasp. One of the most interesting conclusions drawn from our experience is the importance of the interaction model and how it is learned and reapplied. If there is too much innovation put on a given interactive product, then that product could be difficult to learn at first. This implies that innovation comes at a price. This issue should be considered, taking into account the real needs of users, at least in what concerns interactive installations. There is, naturally, a dichotomy between the usability and innovation levels of any given interactive product. However, if the team is explicitly focused on making the interaction model easy to grasp, this dichotomy will not become too harmful for the product's usability. Our shoe store example is paradigmatic: Users control the digital contents in the interactive mirror by simply putting shoes on and walking around the store.

Support collaborative activities as feedback mechanisms. Another issue that drives the development team is the observation of the visitors' and users' behaviors, particularly finding out how collaborative activities can be supported as feedback mechanisms to enhance engagement and learning motivation. As an example, in game-driven installations we note social interaction reaches much higher levels than in other installations. That collaboration clearly enhances the level of users' engagement. At the same time, we believe the social interaction was increased by that same engagement, working as a feedback mechanism, feeding the interaction and also being fed by it, reaching levels of focus that can support the formation of new conceptual models, thus enacting a reflective learning.

Know the customer from the client. Interactive installations are meant to be fun, enriching, and enticing to everyday customers. A successful installation will attract more customers and more business, therefore making your client happy. The focus should be on your client's customers and not on your clients. A good defense mechanism to support design decisions is to convincingly and accurately document the customers' satisfaction and deliver that documentation to your client with a partnership attitude. Collecting evidence such as happy customers' photos, videos of people interacting with the installations, even surveys or informal interviews, can be useful to convince your client, especially if cross-checked with sales or other business figures. Please your client's clients.

Carefully manage client expectations. One way to achieve this is to present the client with architectural designs of how the interactive installation will look at the end of the project. If we provide the client with a visual scale and 3-D layout, the idea can be conveyed in a way that gives all stakeholders a feel of how the physical space will be used for the installations, just like in architectural programs. We are currently working toward a tool that could help overcome this difficulty. In the absence of helping tools, mockups or 3-D preview videos of the installations should be shown to the client with great care to check if expectations are well understood.

In the fast evolving world of interactive technologies, it is as difficult to find silver bullets as it has ever been since the inception of computers many years ago. Indeed, excellent design, more than process is the work of excellent designers. Thus to promote good design it is paramount to encourage younger generations of students to "reach for the stars" in everything they design or develop, hiring the best and rewarding them well, to compete globally in the digital media and interactive landscapes.

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Public Policy and HCI in the U.S. Context

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Although most of us working in HCI have no background in public policy, non-governmental and governmental policy decisions have a major impact on the work that we do. This is true across the globe. As researchers we are used to collaborating internationally; therefore, I know not everyone within the research community is comfortable discussing public policy issues, which are often country-specific in focus. Whereas research in HCI tends to be international, public policy tends to be national. As an example, this article describes the many U.S. government policy actions that have impacted the field of human-computer interaction during the year 2010. Recent articles in the Interacting with Public Policy forum have discussed public policy and the implications on HCI in Sweden, Brazil, and France.

There's a misperception in the U.S. that the government takes action primarily when a bill is passed and signed into law. Yet there are many actions with a direct impact on the field of HCI that do not involve any action from the legislative branch. Furthermore, when the federal government does not take action, the states often step in and make decisions.

Much of HCI-related public policy would fall under the general category of science and technology policy. However, while there's a large community of people who do science and technology policy, there is very little out there about design policy (AIGA's Design for Democracy project is a notable exception). The science and technology policy topics that get the most attention are issues like global warming, stem cell research, nanotechnology, and genetics. Computer science is not often the topic getting lots of attention in science-policy circles, and when computer science does get attention there, it's usually over issues like encryption, cyberattacks, and digital-rights management, while HCI gets virtually no mention.

One of the biggest differences between HCI and many other science and technology policy issues (such as stem cell research) is that HCI issues are generally nonpartisan and not influenced by morality. Interface design isn't a matter of Democratic or Republican politics; there isn't anyone who considers HCI work immoral or against their religious beliefs. Generally, the arguments against HCI are related to the cost of new, more usable, or more accessible interfaces.

In the science- and technology-policy community, you often hear discussions of the differences between science for policy and policy for science. Policy for science is the implementation of policies that influence scientific research, such as research-funding mechanisms, rules on what types of research can and cannot be performed (and how they're funded), and regulations related to human-subjects research. Science for policy is the use of scientific research, such as data on climate change or data on intrusions into government computing systems, for policymaking. In the context of HCI work, an example of policy for science could be how funding mechanisms at the National Science Foundation (NSF) are changing, and an example of science for policy could be how data from the HCI community on the usability and accessibility of voting machines and government websites has been used in policymaking discussions. Since our work is a combination of science and design, I would offer that within the HCI world we often experience policy for design, in which government regulations specify how we must design devices and interfaces. And we could theoretically experience design for policy, in which

▸ Governor Deval Patrick signing legislation that bans text-messaging while driving for all Massachusetts drivers, prohibits junior operators from using cell phones, and institutes new license renewal procedures for mature drivers.

Photograph by Holland Hinman/Governor's Office


AURICE J.TOBIN
GOVERNOR

research on design could influence how policymakers communicate (although I haven't seen much of that).

The Three Branches of U.S. Government

Let me present a refresher on the basics from U.S. high school government class. There are three branches of government at the federal level: executive, legislative, and judicial. The legislative branch makes laws; the judicial branch interprets laws; and the executive branch carries out laws. Simple, right? It's actually much more complex than that. And actions in all three branches have had an impact on the HCI community.

Legislative. There are actions taken from the legislative branch that relate directly to the HCI community. The original Rehabilitation Act of 1973—amended in 1998 to create Section 508, implemented in 2001—is the foundation of U.S. laws requiring all government technology to be accessible for people with disabilities. The Help America Vote Act, signed into law in 2002, led to new voting interfaces being used by a majority of American voters. Since interface accessibility and voting machines are two areas where public policy has the largest impact on HCI, it is no surprise that these two pieces of legislation are important to the field of HCI.

More recently, the Plain Writing Act of 2010 (signed by President Obama on October 13, 2010) requires government agencies to provide information to the public (including on websites) in plain and understandable English; agency websites must provide information on the steps being taken to move toward clear language (more information can be found at www.plainlanguage.gov). The 21st Century Communications and Video Accessibility Act of 2010, signed into law on October 8, 2010, requires accessibility features on new smartphones, captioning on television shows distributed online, accessibility of emergency-warning information, and accessible menus on DVDs and televisions, among other requirements.

Other legislative efforts related to HCI in the 2009-2010 congressional session did not succeed. For instance, the Voter Confidence and Increased Accessibility Act of 2009 would have required all voting-machine interfaces to offer hard-copy verification to voters. The Technology Bill of Rights for the Blind Act of 2010 would have required the Secretary of Commerce to create standards for nonvisual access to consumer electronic devices, electronic kiosks, home appliances, or office technology devices, and require that all of those interfaces meet the new standards within two years of the date of the act's passage.

It's important to remember there is a delicate balance between the three branches of government, and a change in party power (or an election) can have an impact on HCI policy. Actions related to workplace regulation on ergonomics (certainly a topic of interest to the HCI community) in 2000 and 2001 illustrate this. The following text, taken directly from the U.S. Chamber of Commerce (a pro-business lobbying group that was against the ergonomic regulations), summarizes what happened: "Although a final regulation was issued just after the 2000 election, the Chamber [of Commerce] continued fighting. Shortly after the 107th Congress convened in early 2001 [when Bush took office], the Senate and House passed a joint resolution invalidating the ergonomics regulation under the never-before-used provisions of the Congressional Review Act (CRA). President Bush signed the resolution on March 20, 2001." There wasn't much activity on this topic in the 2000s; then, recently, officials from the Obama Labor Department publicly expressed interest in pushing for new regulation and a stronger focus on ergonomics in the workplace.

Executive. When a bill is signed into law, it is just the beginning. There's the rulemaking process, the implementation of the rules, and checking for compliance. A fair amount of policymaking happens in the rulemaking process. When a law specifies that actions take place, the law rarely specifies the details. Instead, the details are decided upon in the rulemaking process, which focuses on public comment and typically involves the following: the advanced notice of proposed rulemaking (which the public can respond to), a proposed rule, a public comment period on the proposed rule, and then a final rule.

These are all areas where the executive branch takes the lead. For instance, in 2010, the Department of Justice began a process of rulemaking on clarifications to the Americans with Disabilities Act (ADA). The ADA, which applies to any place or organization defined as a public accommodation (such as stores, restaurants, hotels, convention centers) was signed into law in 1990, before much of our current technology infrastructure existed. In 2010 the Department of Justice began the rulemaking process to clarify accessibility requirements for websites, movie and video descriptions, and next-generation 911 services and equipment. USACM (the U.S. Public Policy Committee of ACM) has been involved in crafting

a response to that advanced notice of proposed rulemaking.

Public policy also comes from the executive branch in other ways, such as executive orders and memos. For instance, in July 2010 the Office of Management and Budget and the Chief Information Officer of the Federal Government issued a memo in which they noted the Section 508 requirements for electronic and information technology had not been followed in recent years. Compliance activities required by the law had not taken place. They have since detailed the steps that will take place to move forward and improve accessibility of government interfaces. Other agencies, such as the U.S. Access Board, the General Services Administration, and the Department of Justice, have also been involved with that action related to Section 508. HCI-related issues also pop up in places that you wouldn't immediately expect. For instance, both the Department of Transportation (DOT) and the Department of Labor (DOL) have dealt with interfaces recently. The DOT has addressed the accessibility of airline websites and kiosks, and the DOL has addressed the accessibility of online employment websites.

It's also important to note that a lot of the HCI expertise within the federal government lies within the executive branch. We have had research presentations at HCI conferences for years, from individuals working at the Census Bureau, the Social Security Administration, the Bureau of Labor Statistics, the National Cancer Institute, the Centers for Disease Control, the National Institutes of Standards and Technology, the General Services Administration, and other agencies and offices. To put it bluntly, HCI expertise within the federal government is generally located within the executive branch.

Judicial. There is much less action in the judicial branch related to HCI than in the other two federal branches, but lawsuits and administrative complaints related to HCI have brought public attention. For instance, the National Federation of the Blind sued the Target Corporation in 2006 because the website Target.com was stated to be inaccessible. In preliminary court rulings in 2006 and 2007, the judge confirmed that the Americans with Disabilities Act does apply to websites of public accommodations. The case was settled out of court for $6 million, to be paid to members of the class-action suit. Separately, a number of lawsuits have taken place related to voting-machine interfaces in the past decade. The two most prominent HCI and public-policy issues in the U.S. continue to be interface accessibility and voting machines.

Other actions take place that technically occur within the executive branch but popularly (and incorrectly) are viewed as judicial actions. For instance, in November 2010 the National Federation of the Blind filed an administrative complaint with the Office of Civil Rights of the Department of Education, detailing how campus-wide information technology interfaces at Pennsylvania State University were inaccessible, discriminatory, and in violation of the law. That complaint is pending. Previous actions have jointly been taken in 2010, by the Office of Civil Rights of the Department of Education and the Civil Rights Division of the Department of Justice, related to inaccessible e-book reader interfaces. These settlements related to e-books resulted in letters being sent to all university presidents in the U.S., stating that universities may not adopt inaccessible e-book readers (such as the Kindle DX) for educational use without providing accommodations for students with disabilities. Again, while these are not technically judicial branch activities (they are executive branch activities), these tend to be viewed by the public as judicial activities.

There are lots of unfunded mandates in which a law says one thing, but there's no budget allotted for the follow-up actions so the law becomes irrelevant.

Funding Mechanisms

A large part of HCI research in the United States is funded by the government: primarily through the Human-Centered Computing Cluster and other groups at the NSF, but also through other agencies, such as the Department of Education and Department of Energy. These budgets are not protected. They can be cut at any time (and may be cut due to the 2011 political environment, encouraging responsible and limited spending). Therefore, it's important for HCI researchers and practitioners to get out into the greater community and talk to the general public about the broader impacts of your funded research. While it's not an activity that many scientists and

designers are comfortable with, it's important to help ensure continued funding for work in HCI. Keep in mind that members of the general community want to see how theoretical research can lead to applied research, innovation, and jobs. That's where the public demand is.

Policies are often implemented through the budget. You don't need to pass a law specifying that HCI research is unimportant—if the budget items for HCI research were cut, it would accomplish the same thing. There are lots of unfunded mandates in which a law says one thing, but there's no budget allotted for the follow-up actions so the law becomes irrelevant. Passing a law about an important topic is not the end; it's the beginning. Funding is important. And while the U.S. Office of Management and Budget oversees federal spending, actual research and development spending is spread across more than 20 different agencies. It's not like other countries that have a ministry of science or something similar to support research and development in science and technology.

The America Competes Reauthorization Act of 2010, which became public law 111-358 (signed by President Obama on January 4, 2011), requires that the NSF implement an increased focus on "broader impacts to society" in all grant funding. This includes increased focus on and enhanced review of all proposals based on their broader impacts to society, and requires universities to either provide or facilitate training on the broader effects of research on society. How HCI research is funded will be shifting, with more emphasis on the practical results to society than on purely theoretical research. It's important that we get involved in this discussion, as the type of human-computer interaction research that gets funded is likely to change.

State Initiatives

Historically, there's always been tension between federal-level and state-level actions. When the federal government doesn't take action, sometimes the states step in and do so. This has happened both in terms of other areas of science (funding stem-cell research), safety (clean air and cancer prevention), and even in HCI-related areas (voting machines). For instance, 33 states currently require a voter-verifiable paper record. There's no national standard (the bill that would nationally require paper trails, mentioned earlier in this article, did not pass in 2010). Maryland provides a good example of what happened: The state uses touchscreen interfaces with no paper-verification trail. It has decertified the use of this process for elections; new machines (optical scans) were supposed to be in use by 2010, but due to state budget cuts, this shift was pushed back to 2012.

Another big HCI issue at the state level is texting while driving, or at a broader level, the use of smart phones while operating machinery (see the May+June 2010 issue of *interactions* for an article about this topic). States are now passing or enhancing laws that specify what type of interaction is legal and what type of interaction isn't while operating machinery. Clearly, this is of interest to the HCI community because of both our expertise in the topic and the likelihood that public policies may influence design. Some HCI issues relate to education, and historically, states have primarily been in charge of education. Therefore, issues like interfaces for e-books and accessible educational websites have tended to be state-coordinated issues, even though federal regulations cover them. Many states have their own laws related to interface accessibility and the use of instructional technology in education.

Public policy does have an impact on the field of human-computer interaction, not only in the United States but also in other countries. Public policies change rapidly, so it's important to keep informed. You should get involved locally, nationally, and internationally and use your knowledge of science and design to inform and influence public policy in human-computer interaction. I've said it before; I will say it again. When it comes to public policy and HCI, think globally and act locally!

FURTHER READING:

http://www.verifiedvoting.org

http://www.sigchi.org/about/sigchi-public-policy

Comprehensive list of U.S. state-level accessibility laws: http://accessibility.gtri.gatech.edu/sitid/stateLawAtGlance.php/

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Understanding, Fostering, and Supporting Cultures of Participation

Gerhard Fischer
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Cultures are defined in part by their media and their tools for thinking, working, learning, and collaborating. In the past, the design of most media emphasized a clear distinction between producers and consumers [1]. Television is the medium that most obviously exhibits this orientation and has contributed to the degeneration of humans into "couch potatoes" [2], for whom remote controls are the most important instruments of their cognitive activities. In a similar manner, our current educational institutions often treat learners as consumers, fostering in students a mind-set of consumerism rather than of ownership of problems, which they carry with them for the rest of their lives. As a result, learners, workers, and citizens often feel left out of decisions by teachers, managers, and policymakers, denied opportunities to take active roles.

The rise in social computing (based on social production and mass collaboration) has facilitated a shift from consumer cultures (specialized in producing finished artifacts to be consumed passively) to cultures of participation (in which all people are provided with the means to participate and to contribute actively in personally meaningful problems) [3]. These developments represent unique and fundamental opportunities, challenges, and transformative changes for innovative research and practice in human-centered computing, as we move away from a world in which a small number of people define rules, create artifacts, and make decisions for many consumers toward a world in which everyone has interests and opportunities to actively participate.

Our research is exploring theoretical foundations and system developments for understanding, fostering, and supporting cultures of participation grounded in the basic assumption that innovative technological developments are necessary for cultures of participation, but they are not sufficient. Sociotechnical environments are needed because cultures of participation are not dictated by technology; they are the result of changes in human behavior and social organization, in which active contributors engage in the innovative design, adoption, and adaptation of technologies to their needs and in collaborative knowledge construction.


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SITE	OBJECTIVES AND UNIQUE ASPECTS
Wikipedia	Web-based collaborative multilingual encyclopedia with a single, collaborative, and verifiable article; authority is distributed (http://www.wikipedia.org/)
KNOLA	A library of articles by recognized experts in specific domains; authors take credit and elicit peer reviews. Readers can provide feedback and comments, but authority rests primarily with the author (http://knol.google.com/)
iTunes U	Courses by faculty members from "certified institutions"; control via input filters—material cannot be remixed and altered by consumers (http://www.apple.com/education/itunes-u/)
YouTube	Video-sharing website with weak input filters and extensive support for rating (http://www.youtube.com/)
Encyclopedia of Life (EoL)	Documentation of the 1.8 million known living species, development of an extensive curator network, partnership between the scientific community and the general public (http://www.eol.org/)
SketchUp and 3D Warehouse	Repository of 3-D models created by volunteers organized in collections by curators and used in Google Earth (http://sketchup.google.com/3dwarehouse/)
Scratch	Learning environment for creating, remixing, and sharing programs to build creative communities in education (http://scratch.mit.edu)
Instructables	Sociotechnical environment focused on user-created and shared do-it-yourself projects involving other users as raters and critics (http://www.instructables.com/)
PatientsLikeMe	Collection of real-world experiences enabling patients who suffer from life-changing diseases to connect and converse (http://www.patientslikeme.com/)
Ushahidi	Tools for democratizing information, increasing transparency, and lowering the barriers for individuals to share their stories; originated in the collaboration of Kenyan citizen journalists during crises (http://www.ushahidi.com/)
Stepgreen	Library of energy-saving actions, tips, and recommendations by citizen contributors for saving money and being environmentally responsible (http://www.stepgreen.org/)

Table 1: Environments created by cultures of participation with unique features.

Our emerging theoretical framework is grounded in a variety of different application contexts, including open source software, urban planning, assistive technology, energy sustainability, and learning and education [4], and it has allowed us to articulate initial design guidelines and to explore the implications of these developments for future research and advances in human-centered social computing focused on cultures of participation.

Cultures of Participation

Cultures of participation offer important and interesting opportunities to address major problems our societies are facing today, including:

- problems of a magnitude that individuals and even large teams cannot solve (e.g., to create 3-D models of all buildings in the world as addressed by Google SketchUp and 3D Warehouse)
- problems of a systemic nature, requiring the collaboration of many different minds from a variety of backgrounds (e.g., urban-planning problems as addressed by the Envisionment and Discovery Collaboratory (EDC) at the University of Colorado, Boulder)
- poorly understood and ill-defined problems requiring high-level involvement because they cannot be delegated to others (e.g., software-design problems as tackled by open source software developments)
- problems modeling unique, changing worlds that are dependent on open, living information repositories and tools (e.g., the unique needs of people with disabilities as addressed by design for diversity).

Cultures of participation are facilitated and supported by a variety of different technological environments, such as the participatory Web (Web 2.0), tabletop computing, and domain-oriented design environments—all of them contributing in different ways to the aims of engaging diverse audiences, enhancing creativity, sharing information, and fostering the collaboration among users acting as active contributors and designers. They democratize design and innovation by shifting power and control toward users, supporting them to act as both designers and consumers ("prosumers") and allowing systems to be shaped through real-time use [5].

Table 1 provides an overview of a sample of environments created by cultures of participation with unique features.

A fundamental challenge for cultures of participation is to conceptualize, create, and evolve socio-technical environments that not only technically enable and support users' participation, but also successfully encourage it. Participation is often determined by an individual's assessment of value/effort. The effort can be reduced by providing the right kind of tools with meta-design, and the value can be increased by making all voices heard by supporting social creativity. As effort and value vary greatly among individuals, richer ecologies of participation are required to identify distinct roles. These components of our emerging theoretical framework are later.

Figure 1 illustrates (using a broad qualitative representation) some of the major cultural changes caused by new media over the past few millenia. The interesting question is whether cultures of participation will cause similar transformative changes in the years to come as reading and writing did thousands of years ago. Will the power of the collective human mind aided by technology improve further or are there major drawbacks to come (as Socrates argued would be the consequences of reading and writing)? And if so, we need to investigate whether these drawbacks will outweigh advantages and how we can avoid or at least reduce their impact.

Components of a Theoretical Framework

Without a theoretical framework, the developments listed in Table 1 may be seen merely as interesting phenomena instead of what they really are: fundamentally different ways to cope with a large number of difficult problems in which new social organizations and new media can make a difference.

This section describes three major components of our emerging framework:

- *Meta-design* is aimed at defining and creating social and technical infrastructures in which cultures of participation can come alive and new forms of collaborative design can take place.
- *Social creativity,* focused on "transcending the individual human mind," makes all voices heard in the framing and solving of complex problems, supports interactions with other people and shared artifacts, and exploits new media for transdisciplinary collaborations.
- *Richer ecologies of participation* are focused on "creating different levels of participation" by differentiating, analyzing, and supporting distinct roles based on different levels of expertise, interests, and motivations that can be found in cultures of participation.

Meta-Design. Meta-design is focused on "design for designers" [6]. It creates open systems at design time that can be modified by their users acting as co-designers, requiring and supporting more complex interactions at use time. Meta-design is grounded in the basic assumption that future uses and problems cannot be completely anticipated at design time, when a system is being developed. At use time, users will invariably discover mismatches between their needs and the support that an existing system can provide for them. Meta-design contributes to the invention and design of sociotechnical environments in which humans can express themselves and engage in personally meaningful activities.

Meta-design supports cultures of participation as follows:

- *Making changes must seem possible.* Contributors should not be intimidated and should not have the impression that they are incapable of making changes; the more users become convinced that changes are not as difficult as they think they are, the more they may be willing to participate.
- *Changes must be technically feasible.* If a system is closed, then contributors cannot make any changes; as a necessary prerequisite, there need to be possibilities and mechanisms for extension.
- *Benefits must be perceived.* Contributors have to believe that what they get in return justifies the investment they make. The benefits perceived may vary and can include professional benefits (helping for one's own work), social benefits (increased status in a community, possibilities for jobs), and personal benefits (engaging in fun activities).
- *The environments must support tasks that people engage in.* The best environments will not succeed if they are focused on activities that people do rarely or consider of marginal value.
- *Low barriers must exist to sharing changes.* Evolutionary growth is greatly accelerated in a system in which participants can share changes and keep track of multiple versions easily. If sharing is difficult, it creates an unnecessary burden that participants are unwilling to overcome.
- *Designers must become meta-designers.* They should use their own creativity to create socio-technical environments in which other people can be creative by shifting from determining the

meaning, functionality, and content of a system to encouraging and supporting users to act as designers. They must be willing to share control of how systems will be used, which content will be contained, and which functionality will be supported.

Meta-design allows significant modifications when the need arises. It reduces the gap in the world of computing between a population of elite, high-tech scribes who can act as designers and a much larger population of intellectually disenfranchised knowledge workers who are forced into consumer roles.

Meta-design supports underdesign by designers at design time. Underdesign does not mean less design; rather, it is a design methodology that offers users (acting as designers at use time) as many alternatives as possible, avoiding irreversible commitments they cannot undo. Additional aspects of underdesign in support of cultures of participation include the following:

- It is grounded in the need for "loose fit" in designing artifacts at design time so that unexpected uses of the artifact can be accommodated at use time; it does so by creating contexts and content-creation tools rather than content.
- It avoids design decisions in the earliest part of the design process, when everyone knows the least about what is really needed.
- It acknowledges the necessity to differentiate between structurally important parts for which extensive professional experience is required, and should therefore not be easily changed (such as weight-bearing walls in buildings), and components that users should be able to modify to their needs because their personal knowledge is most relevant.
- It creates technical and social conditions for broad participation in design activities by supporting "hackability" and "remixability."

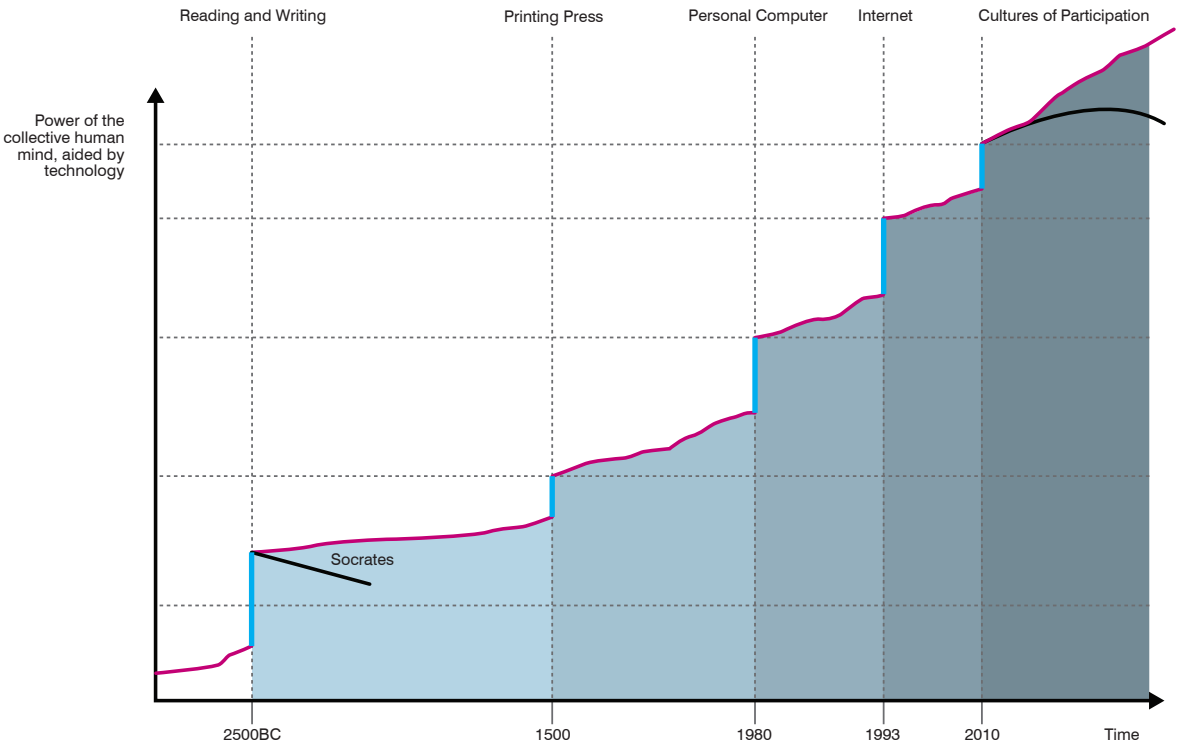
Social Creativity. Where do new ideas come from in cultures of participation? The creativity potential is grounded in user-driven innovations supported by meta-design environments, taking advantage of breakdowns as sources of creativity and exploiting the symmetry of ignorance (meaning that all stakeholders are knowledgeable in some domains and ignorant in others) [7]. Increasing social creativity requires diversity (each participant should have some unique information or perspective), independence (participants' opinions are not determined by the opinions of those around them), decentralization (participants are able to specialize and draw on local knowledge), and aggregation (mechanisms exist for turning individual contributions into collections, and private judgments into collective decisions). In addition, participants must be able to express themselves (requiring technical knowledge on how to contribute), must be willing to contribute (motivation), and must be allowed to be heard (control).

Social creativity is based on the assumption that the power of the unaided individual mind is limited [7]. Although creative individuals are often thought of as working in isolation, much human creativity arises from activities that take place in a social context in which interaction with other people and the artifacts that embody collective knowledge are important contributors to the process. The fundamental problems of the 21st century are complex and open-ended, requiring ongoing contributions of many minds, particularly from the people who own problems and are directly affected by them [8].

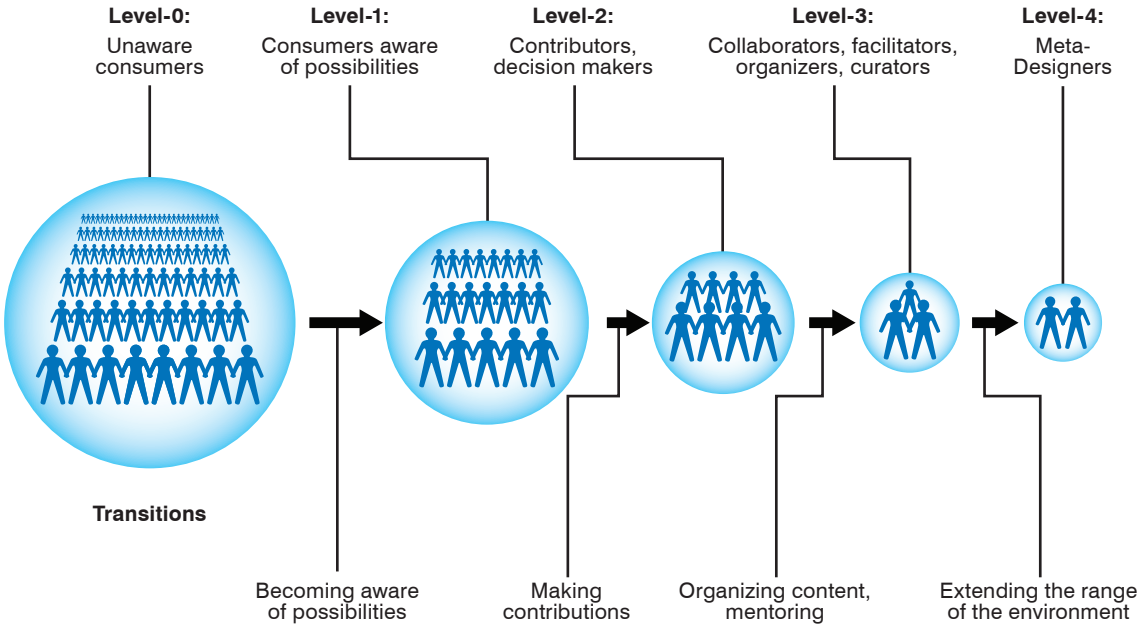
Richer Ecologies of Participation

Individual people have different motivations for doing things, and those motivations create different levels of participation. To understand, foster, and support cultures of participation requires differentiating, analyzing, and supporting distinct roles that can be found in cultures of participation: consumers, contributors, collaborators, and meta-designers. Figure 2 (inspired and derived from [6] and [9]) illustrates that most participants will start as consumers, and only a small percentage of these will eventually contribute, collaborate, and act as meta-designers, and thereby be responsible for the content that is shared with everyone. (To avoid the figure becoming overly complex, it does not illustrate that the migration paths do not always go through all stages and that people may retreat to less-demanding roles over time.)

Cultures of participation must handle the startup paradox, when early in their lifecycle they have few members to generate content and little content to attract members. To address this paradox, we have developed the seeding, evolutionary growth, and reseeding (SER) model [2], an emerging descriptive and prescriptive model that supports meta-design. Instead of attempting to build complete systems at design time, the SER model advocates building seeds (grounded in participatory design activities between meta-designers and users) that can evolve over time through contributions of a large number of people (the defining characteristics of a culture of participation). A seed is something that has the potential to change and grow. In sociotechnical environments, seeds need to



▸ Figure 1.Major cultural changes caused by new media.



▸ Figure 2. Ecologies of participation.

COLLABORATIVE EFFORTS IN LARGE-SCALE PROJECTS

In addition to our own developments, we have been engaged in collaborative efforts in large-scale projects, including the following [4]:

Modeling the Whole World in 3-D. Google's SketchUp/Building Maker + 3D Warehouse + Google Earth (http://sketchup.google.com/3dwarehouse/) is an environment in which people from around the world can create 3-D models with SketchUp or Building Maker, share and organize it in collections in the 3D Warehouse, and display them in Google Earth. The amount of work and local knowledge needed to achieve this is beyond the scope and capability of any locally operating development team. It requires the contributions of a large user base, and as such represents a unique example for assessing the theoretical framework cultures of participation.

Energy Sustainability. New developments in the energy domain, such as smart grids and smart meters, provide support for measuring and visualizing energy consumption. To take advantage of these developments, users must change from passive consumers of energy into active decision makers. Migrating toward these roles (see Figure 2) provides foundations for behavior changes to reduce energy consumption that can be fostered through social as well as technological interventions. While these developments are focused on individuals, they are complemented by supporting cultures of participation at the national and international level with the Open Energy Information (OpenEI) (http://en.openei.org/) initiative environment developed by National Renewable Energy Laboratory's (NREL). OpenEI (and other environments, such as Stepgreen, mentioned in Table 1) represents collaboratively constructed information repositories to inform participants about energy sustainability themes and allow them to share their experiences.

Community Networks. SAP's Community Network (SCN) (www.sdn.sap.com) is an example of a successful sociotechnical environment for peer-support communities that consists of more than one million registered users forming a highly active online community. To move beyond anecdotal examples, we have analyzed SCN using our theoretical framework, compared it with open source communities, and interpreted a variety of data in order to understand the context- and application-specific nature of the collaborations underlying cultures of participation in this specific context [12].

be designed and created for the technical as well as the social component of the environment. The SER model postulates that systems that evolve over a sustained time span must continually alternate between periods of planned activity (the seeding phase), unplanned evolution (the evolutionary growth phase), and periods of deliberate (re)structuring and enhancement (the reseeding phase).

In cultures of participation, not every participant must contribute, but all participants must have opportunities to contribute when they want to. For cultures of participation to become viable and be successful, it is critical that a sufficient number of participants take on the more active and more demanding roles. To encourage and support migration paths toward more demanding roles, mechanisms are needed that lead to more involvement and motivation, and that facilitate the acquisition of the additional knowledge required by the more demanding and involved roles. These mechanisms will include objectives such as:

- "low threshold and high ceiling," allowing new participants to contribute as early as possible, and at the same time supporting experienced participants with a broad functionality for their more complex tasks
- scaffolding mechanisms to support migration paths
- special interaction mechanisms for different levels of participation (e.g., contributors, curators, and meta-designers)
- support for different levels of participation with regard to the time and effort that an individual must invest
- rewards and incentives needed to reduce the funnel effect [10] from one level to the next.

Exploring Different Application Domains

To assess the viability and applicability of the concepts and components of the theoretical framework described in the previous section, we have explored cultures of participation in numerous domains, including the following:

- open source software, with an emphasis on open source as a success model of decentralized, collaborative, evolutionary development
- architectural design and urban planning, with an emphasis on underdesign and allowing and supporting all participants (as illustrated by the EDC, a tabletop computing environment supporting stakeholders from diverse backgrounds in face-to-face meetings)
- design of computational artifacts, with an emphasis on customization, personalization, tailorability, end-user modifiability, and design for diversity (as illustrated by the Memory Aiding Prompting System (MAPS), supporting people with cognitive disabilities and their caregivers)
- new models of teaching and learning, with an emphasis on learning communities, teachers as meta-designers, and courses-as-seeds (these approaches challenge the assumption that information must move from teachers and other credentialed producers to passive learners and consumers)

These developments will be described in the sidebar "Collaborative Efforts in Large-Scale Projects."

Open Source Software. Open source software is one of the earliest success models of cultures of participation. Some of the slogans developed in these communities served as indicators of the opportunities associated with cultures of participation: "if there are enough

eyeballs, all bugs are shallow," indicates the public scrutiny of collaborative developed artifacts can lead to a high reliability and trustworthiness, and "do not send a bug report, send a bug fix," indicates the desirable migration from the role of bug reporter to bug fixer.

In software design, many of the challenges mentioned earlier were clearly recognized, including the need for open and evolvable systems (perpetual beta) based on fluctuating, conflicting requirements, which will lead over time to mismatches between an evolving world and the software system that models this world—as well as the need for supporting communication and coordination in a richer ecology of participants who have different interests, skills, and background knowledge.

A recent interview with a geoscientist at the University of Colorado, Boulder highlights the importance of these challenges. He uses a couple of domain-specific software systems to analyze his research data, but none of the existing systems can provide complete solutions to his problems as his research unfolds and his understanding of the problem, data, and results proceeds.

"I spend on average an hour every day developing software for myself to analyze the data I collected because there is not any available software. Even if there is a software developer sitting next to me, it would not be of much help, because my needs vary as my research progresses and I cannot clearly explain what I want to do at any moment. Even if the software developer can manage to write a program for me, I will not know if he or she has done it right without looking at the code…So I spent three months to gain enough programming knowledge to get by. Software development has now become an essential task of my research, but I do not consider myself a software developer and I don't know many other things about software development."

Clearly, he is not a professional software engineer and does not intend to become one, but he is definitely acting as a participant.

The Envisionment and Discovery Collaboratory (EDC). The EDC is a long-term research platform that explores conceptual frameworks for democratizing design in the context of framing and resolving complex urban planning by bringing together participants from various backgrounds in face-to-face meetings [7]. The knowledge to understand, frame, and solve such problems does not already exist but is constructed and evolves during the solution process. The EDC (representing a sociotechnical environment) incorporates a number of innovative technologies, including tabletop computing, the integration of physical and computational components supporting new interaction techniques, and an open architecture, and has proven to be an ideal environment in which to study and support meta-design and social creativity by making all voices heard.

During the past decade, our research with the EDC to foster and support cultures of participation within collaborative design activities led to the following observations:

- Each urban-planning problem is unique: It has to take into consideration the geography, culture, and population of specific locations.
- More creative solutions to problems can emerge from the collective interactions with the environment by heterogeneous communities (such as communities of interest, which are more diverse than communities of practice).
- Boundary objects are needed to establish common ground and establish shared understanding for communities of interest.
- Participants must be able to naturally express what they want to say.
- Interaction mechanisms must have a low threshold for easy participation and a high ceiling for expressing sophisticated ideas.
- Participants are more readily engaged if they perceive the design activities as personally meaningful by associating a purpose with their involvement.

The further investigation of the above has been thwarted by obstacles that rest with the difficulties of democratizing the design of the EDC by providing more control to the participants [5]. Currently, EDC developers have to customize the system at the source-code level to reflect the specific characteristics of the city and its urban-planning problem. As urban planning deals with ill-defined problems, the domain- and context-specific knowledge is sticky, tacit, and difficult to transfer from local urban planners to the EDC developers. The EDC supports problem-solving activities by bringing individuals who share a common problem (the representatives of the Boulder City Council and the Regents of the University of Colorado) together in face-to-face meetings and promoting social reflection-in-action. Problems are discussed and explored by providing participants with a shared construction space in which they interact with computationally enhanced physical objects that are used to represent the situation. Computer-generated information is projected back onto the tabletop construction area, creating an augmented reality environment.

This construction in the tabletop environment is coupled with information displayed on a vertical electronic whiteboard relevant to the problem currently being discussed. A key aspect of the EDC that makes it a critical and unique component (and sets it apart from other environments, such as the Google 3-D modeling environment) is the emphasis on the collaborative construction of artifacts, rather than on the sharing of individually constructed items.

Coping with "Universes of One": Design for Diversity. Individuals with disabilities are often unable to live independently due to their inability to perform activities of daily living, such as cooking, housework, or shopping. But with socio-technical environments to extend their abilities, and thereby their independence, these individuals can lead lives less dependent on others.

Our research to support and empower people with cognitive disabilities explored cultures of participation by supporting mobile-device customization, personalization, and configuration by caregivers and effective use by clients [10]. People with cognitive disabilities represent a "universe of one" problem: A solution for one person will rarely work for another. Understanding and addressing unexpected and great variations in skills and needs, particularly with respect to creating task support, requires an intimate knowledge of the client that only caregivers can provide. Currently, a substantial portion of all assistive technology is abandoned after initial purchase and use—the very population that could most benefit from technology is paying for expensive devices that end up in the back of closets after a short time.

A unique challenge of cultures of participation in the domain of cognitive disabilities is that the clients themselves cannot act as designers. However, the caregivers, who have the most intimate knowledge of the client, need to become the designers. The scripts needed to effectively support users are specific for particular tasks, creating the requirement that the people who know about the clients and the tasks (i.e., the local caregivers, rather than a technologist far removed from the action) must be able to develop scripts.

Caregivers generally have no specific professional technology training, nor are they interested in becoming computer programmers. This creates the need for design environments with extensive meta-design support to allow caregivers to create, store, and share scripts. The Memory Aiding Prompting System (MAPS) allows caregivers to create complex multimodal prompting sequences that enables sound, pictures, and video to be assembled by using a film-strip-based scripting metaphor [11].

The design of MAPS involved three different groups of participants; assistive technology professionals and special education teachers; parents of clients; and, professional caregivers. By designing the MAPS environment to enable script redesign and reuse, caregivers were able to create an environment that matched the unique needs of an individual with cognitive disabilities. MAPS represents an example of democratizing design by supporting meta-design, embedding new technologies into sociotechnical environments, and helping people with cognitive disabilities and their caregivers have more interesting and more rewarding lives.

Rethinking Learning and Education. The current mind-set about learning, teaching, and education is dominated by a view in which a supposedly all-knowing teacher explicitly tells or shows unknowing, passive learners something they presumably know nothing about. A critical challenge is to reformulate and reconceptualize this impoverished and misleading conception.

A culture-of-participation perspective for learning and education is focused not on delivering predigested information to individuals, but on providing opportunities and resources for learners to engage in authentic activities, participate in social debates and discussions, create shared understanding among diverse stakeholders, and frame and solve personally meaningful problems. It is grounded in the fundamental belief that all humans have interest and knowledge in one or more niche domains and are eager to actively contribute in these contexts.

Over the past decade, we have reconceptualized and reinvented our teaching activities and grounded them in sociotechnical environments in which communities of mutual learners act simultaneously as learners and as active contributors (based on the assumption that being a teacher or a learner is not an attribute of a person but an attribute of a context). Peer-to-peer learning is supported, and teachers act as "guides on the side" rather than as "sages on the stage," and courses are considered seeds rather than finished products [2].

Implications and Impact

As illustrated in Figure 1, the new opportunities and the drawbacks of cultures of participation need to be carefully assessed. These

assessments should be based on measurements; however, new ways to measure developments are needed—especially as new discourses are established to understand, foster, and support cultures of participation.

Drawbacks of Cultures of Participation. Cultures of participation open up unique new opportunities for mass collaboration and social production, but they are not without drawbacks. One such drawback is that humans may be forced to cope with the burden of being active contributors in personally irrelevant activities. This can be illustrated by do-it-yourself societies. With modern tools, humans are empowered to perform many tasks themselves that were done previously by skilled domain workers serving as agents and intermediaries. Although this shift provides power, freedom, and control to customers, it also has forced people to act as contributors in contexts for which they lack the experience (which professionals have acquired and maintained through the daily use of systems) and the broad background knowledge to do these tasks efficiently and effectively (e.g., companies offloading work to customers).

More experience and assessment is required to determine the design trade-offs for specific contexts and application domains in which the advantages of cultures of participation (such as extensive coverage of information, creation of large numbers of artifacts, creative chaos by making all voices heard, reduced authority of expert opinions, and shared experience of social creativity) will outweigh the disadvantages (accumulation of irrelevant information, wasting human resources in large information spaces, and lack of coherent voices). The following research questions need to be explored:

- Under which conditions is a fragmented culture (with numerous idiosyncratic voices representing what some might characterize as a modern version of the Tower of Babel) better or worse than a uniform culture (which is restricted in its coverage of the uniqueness of local identities and experience)?
- If all people can contribute, how do we assess the quality and reliability of the resulting artifacts? How can curator networks effectively increase the quality and reliability?
- What is the role of trust, empathy, altruism, and reciprocity in such an environment, and how will these factors affect cultures of participation?

Measurement. Some aspects determining cultures of participation can be easily measured—e.g., how well a site lives up to certain usability and sociability factors [9], how people located a site, and how often they visit it—and tools for obtaining these measurements exist (such as Google Analytics). But other aspects are much more difficult to assess and measure. In our collaborative work analyzing the SAP Community Network (SCN) (see sidebar) as a culture of participation, we have created and investigated the following parameters [12]:

- *Responsiveness.* How responsive are communities to the needs of its members?
- *Engagement intensity.* How timely is the peer support?
- *Role distribution:* How wide is the participation of users and in what kind of roles do they participate?
- *Reward system.* What is the impact of explicit reward (point) systems on community behavior?

Establishing New Discourses: Motivation, Control, Ownership, Autonomy, and Quality. Cultures of participation are establishing new discourses. Human beings are diversely motivated beings. We act not only for material gain, but for psychological well-being, for social integration and connectedness, for social capital, for recognition, and for improving our standing in a reputation economy. The motivation for going the extra step to engage in cultures of participation is based on the overwhelming evidence of the IKEA effect [13]: People are more likely to like a solution if they have been involved in its generation, even though it might not make sense otherwise. Creating something personal (such as hand-knitted sweaters and socks and home-cooked meals) even of moderate quality has a different kind of appeal than consuming something of possibly higher quality made by others—even something of very high quality.

Cultures of participation rely on intrinsic motivation for participation by providing contributors with the sense and experience of joint creativity, by giving them a sense of common purpose and mutual support in achieving it, and, in many situations, by replacing common background or geographic proximity with a sense of well-defined purpose, shared concerns, and the successful common pursuit of these.

Cultures of participation support users as active contributors who can transcend the functionality and content of existing systems. Through the facilitation of these possibilities, control is distributed among all stakeholders in the design process. There is evidence that shared control will

DESIGN GUIDE	RATIONALE
Support human-problem interaction	By advancing human-computer interaction to human problem-domain interaction with meta-design environments, owners of problems are put in charge and social creativity is supported.
Underdesign for emergent behavior	Instead of providing fixed content, rules, and processes, create seeds for open, living information repositories and contexts in which participants can create content, cope with exceptions, design workarounds, and engage in negotiations .
Support different engagement levels	Honor the fact that users have different capabilities, different interests, and different knowledge; support migration paths to more demanding roles.
Reward and recognize contributions	Transcend the sole reliance on economic incentives by supporting social capital, reputation economies, and gift cultures.
Co-evolution of artifacts and user community	Support the mutual cross-pollination between the evolution of communities and the resources for system developments.

Design guidelines supporting cultures of participation.

lead to more innovation: "Users that innovate can develop exactly what they want, rather than relying on manufacturers to act as their (often very imperfect) agents" [5]. (A similar argument surfaced in the interview with the geoscientist described earlier.) Cultures of participation erode monopoly positions held by professions, educational institutions, experts, and high-tech scribes [2].

Our experiences gathered in the context of the design, development, and assessment of our systems indicate that cultures of participation are less successful when users are brought into the process late (thereby denying them ownership) and when they are "misused" to fix problems and to address weaknesses of systems that the developers did not fix themselves.

Many teachers will tell their students that they will not accept research findings and argumentation based on articles from Wikipedia. This exclusion is usually based on considerations such as: "How are we to know that the content produced by widely dispersed and qualified individuals is not of substandard quality?" The online journal *Nature* has compared the quality of articles found in the *Encyclopedia Britannica* with Wikipedia and has come to the conclusion that "Wikipedia comes close to Britannica in terms of the accuracy of its science entries" [14]. There are many more open issues to be investigated about quality and trust in cultures of participation. Errors will always exist, resulting in learners acquiring the important skill of always being critical of information rather than blindly believing what others (specifically experts or teachers) are saying. Ownership is also a critical dimension—the community at large has a greater sense of ownership and is thereby more willing to put an effort into fixing errors.

Technology alone does not determine social structure, nor does it change human behavior; rather, it creates feasibility spaces for new social practices [1] and can persuade and motivate changes at the individual, group, and community levels. Human-centered technologies can change people's lives by making it easier for people to do things, by allowing people to explore cause-and-effect relationships, and by providing value that cannot be accounted for in monetary terms [13].

Research in behavioral psychology has shown that providing feedback, goal setting, and tailored information are useful in motivating people to change their behaviors [13]. Our studies provide evidence that we become engaged when we can decide and that we value what we make [6]. All people want to be in some situations a consumer (in personally irrelevant activities) and in others an active contributor (in personally meaningful activities). Being a consumer or active contributor is not an attribute of a person, but of a context. Cultures of participation empower humans to be active contributors in personally meaningful activities.

Conclusion

Cultures of participation, which include technological changes in human-centered computing, pursue a much broader and more fundamental agenda: participation is invited, supported, encouraged, and valued rather than prohibited; control, creative contributions, and innovations are decentralized and extended from design time to use time; new relationships between the individual and society are established; artifacts are

CHALLENGES FOR FUTURE RESEARCH

Identify the social abilities, technical skills, and cultural competencies that people need in cultures of participation.
Extend the theoretical framework to support the design of sociotechnical environments in which users can act as co-designers in personally meaningful problems.
Analyze the different processes and trade-offs underlying cultures of participation (e.g., creating seeds for open, living artifacts) and consumer cultures (e.g., create complete systems).
Broaden the scope of human-centered design from the usability of systems to providing resources, incentives, information to encourage participation and sustain it and allow users to reflect upon changing their behavior.
Create a deeper understanding of how cultures of participation harness important social benefits related to national priorities, such as energy sustainability, lifelong learning, education, and healthcare.
Differentiate domains in which cultures of participation will flourish and be successful from the ones that are not suitable by exploring the drawbacks associated with cultures of participation.

developed as open, evolvable seeds rather than finished products; and the focus of education is shifted from teaching to learning.

While social computing is potentially the most important new driving force behind cultures of participation (illustrated with the examples in Table 1), the framework also strives to increase social creativity, put domain professionals in charge of exploring ill-defined problems, and make owners of problems independent of high-tech scribes.

The major role for new media and new technologies from a culture-of-participation perspective is not to deliver predigested information and non-changeable artifacts and tools to individuals, but rather to provide the opportunity and resources for engaging them in authentic activities, for participating in social debates and discussions, for creating shared understanding among diverse stakeholders, and for framing and solving personally meaningful problems.

Acknowledgements

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How Prototyping Practices Affect Design Results

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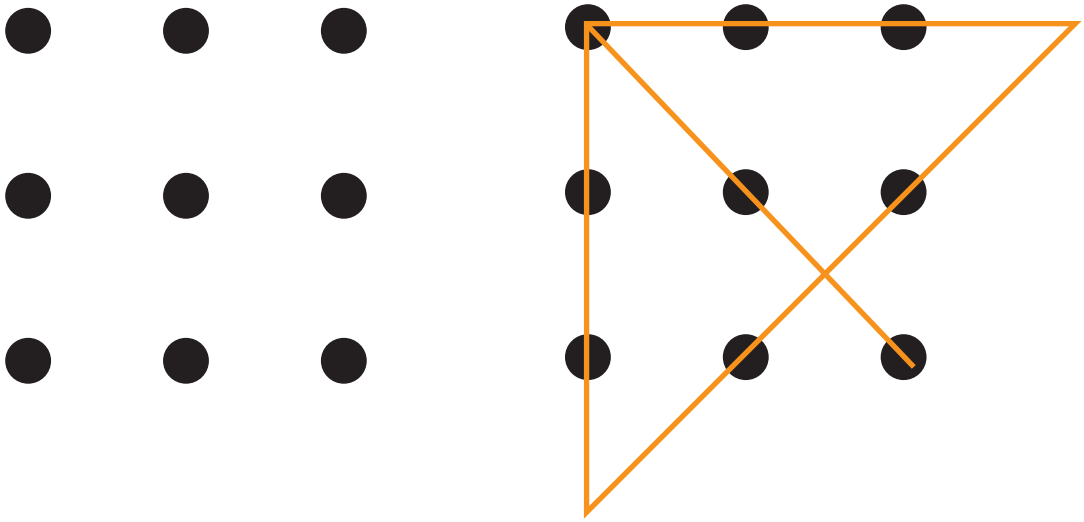
Iterate rapidly. Explore broadly. Gather feedback from multiple sources. Don't conflate ego with object. These pearls of wisdom state principles and values with which few designers disagree. Behind these mantras lie decades of human science research that can enrich our understanding of design. For the past few years, my Stanford colleagues and I have studied how and when design practices affect results. Our experiments begin to clarify why these designerly rules of thumb matter and where breakdowns can occur. By examining the cognition of comparison and the social psychology of sunk-cost reasoning, practitioners and educators can more fully realize the value of creating multiple alternatives throughout a design process.

There's a story about a ceramics teacher who divides his class into two groups. He tells one group they will be graded on quantity: Produce as many ceramics as possible. He tells the other half to focus on quality. He would base their grade on one good ceramic. It was reported "while the quantity group was busily churning out piles of work—and learning from their mistakes—the quality group had sat theorizing about perfection" [1]. Iterative deliberate practice led to better results. While some people resonate with this story, others point out that production schedules often discourage iteration in favor of realization. As Michael Schrage says, "It is hard to persuade companies that one more iteration costs less than a flawed product" [2]. It raises an empirical question about design practices: Is iterative prototyping valuable when time is highly constrained?

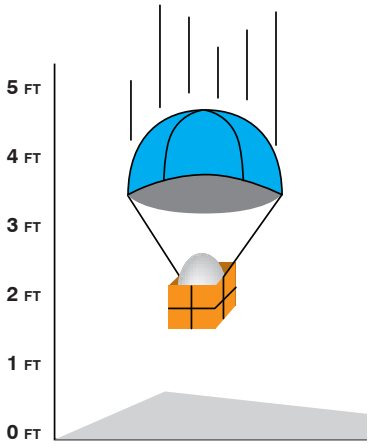
In 2005 Stanford opened the Hasso Plattner Institute of Design, also known as the d.school, to begin teaching a creative problem-solving process known as "design thinking." Imagine the ultimate cross-disciplinary studio space, full of configurable furniture, sketches, electronics, and ongoing student projects. On the wall, a sign reads "Believe in Process" (see Figure 1). This commitment to a particular strategy rests largely on faith. The goal for our research—sponsored by the Hasso Plattner design-thinking research program—has been to study the principles behind practices and to articulate how and why process affects creative results.

But how can we experiment on design practices? Scientists have

▸ Figure 1. Signs of faith adorn the walls of Stanford's d.school.



▸ Figure 2. The nine-dot problem—the origin of "outside the box."



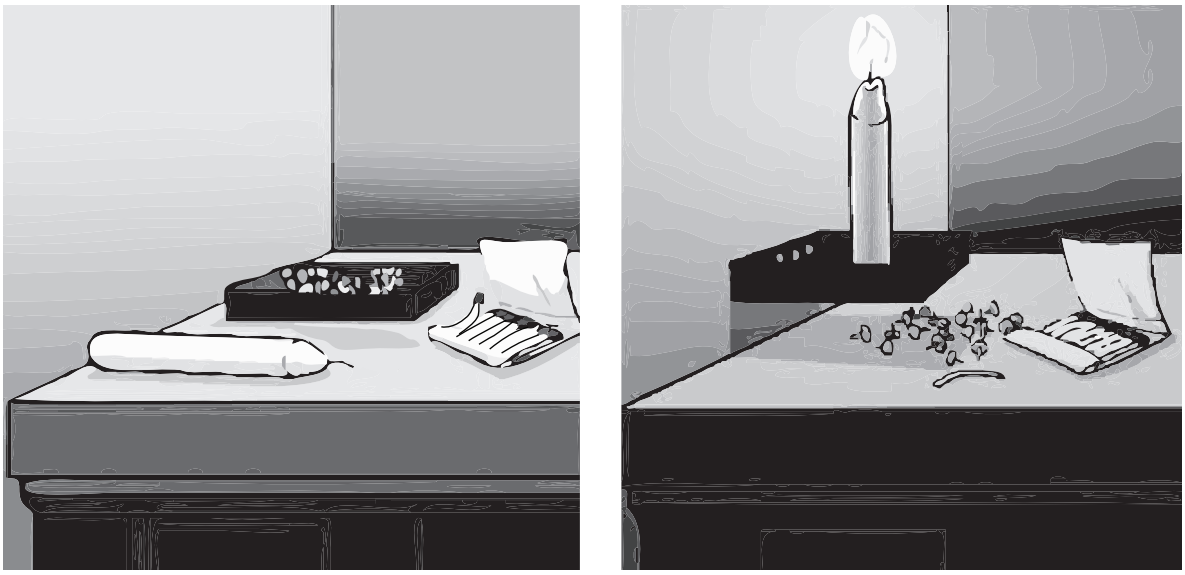
▸ Figure 3. Using the egg-drop problem to study design process.

long been interested in creativity. One classic creative insight experiment asks participants to connect nine dots with four straight lines without lifting the pen (see Figure 2a). The oft-missed insight is that lines must extend "outside the box" (see Figure 2b). As a proxy for creativity, scientists measure how long it takes people to solve the problem [3]. Other researchers ask people to invent alternative uses for objects. For example, a brick can be a paperweight, a boat anchor, a blunt weapon, and so on. As a creativity measure, scientists count up the number of valid and unique ideas. In Finke, Ward, and Smith's experiments on creative cognition, they ask people to sketch "creatures from another planet" [4]. Experts can then judge each idea on various criteria.

These approaches all contributed to an understanding of creativity. However, as my colleagues and I reflected on design and how practices affect the real world, we realized we needed a different Petri dish. Unlike the nine-dot problem, we wanted to give participants a problem in which outcomes cannot be defined by success/failure/right/wrong, but by what concept best fits the design context. More important, we wanted to measure creative impact using more objective criteria. How could we objectively contrast creative solutions? We found inspiration for our Petri dish in a classic middle-school activity: We had people design and construct vessels from raw materials to protect a raw egg's plummet (see Figure 3).

We tested the ceramics teacher's hypothesis about rapid iteration. Half of the 28 participants were encouraged to rapidly iterate; the other half focused on perfecting one design. As a dependent measure, we dropped the vessels from one foot up, then two feet, and so on, until the egg eventually cracked. Everyone came up with a different idea, with varying degrees of success. Our results showed quantitatively that—even under tight time constraints, when people have the tendency to focus on realization—rapid iteration led to better results [5].

What really surprised us was, independent of condition, participants tended to pick one idea and stick with it. The time constraints certainly contributed to participants' limited exploration, but people felt they had fully explored the concepts. Many talked about how "they could not see any other alternatives for the materials." Participants exhibited a psychological effect known as functional fixation, first studied by Karl Duncker back in the 1940s [6]. He did a series of experiments where



▸ Figure 4. Duncker's candle problem.

he presented a candle, a book of matches, and a box of tacks (see Figure 4). He told participants to affix the candle to the wall so that the wax did not drip down. The hidden insight is that the box of tacks can be used to support the candle. People often exhibit functional fixation in viewing the box's primary function as a container for tacks. It turns out that if the exact same materials are provided, but the tacks are left outside the box on the table, people are much more likely to solve the puzzle.

Could iteration, in some cases, increase fixation around a particular design? Prototypes elicit feedback, whether it's from the physical world, through simulations, or from colleagues and potential users. Feedback often frames subsequent actions around the existing solution; it provides a road map for how to improve designs but doesn't explicitly encourage exploration. We wondered if we could combat this fixation through a simple change in process.

Instead of just iterating solutions to a problem, what if people created and tested different designs in parallel? To answer this empirical question, we recruited people to participate in a design task where the solutions are creatively diverse and objectively measurable. This time, instead of egg-drop vessels, participants designed Web advertisements. Participants all created ads for the same client, *Ambidextrous*, a student-run magazine at Stanford. Online advertising presents an unprecedented opportunity to study the creative process. People of all skill levels can design simple Web graphics, and then the ads can be placed online to gather a host of performance metrics, such as click-through rates.

Study participants created an equal number of ad designs in the same time frame, but the process differed across conditions. Serial participants received a descriptive expert critique directly after each prototype. Parallel participants created multiple prototypes before receiving any feedback (see Figure 5).

The study found a parallel prototyping approach led participants to create better ad designs [7]. Web users clicked more parallel ads per appearance than serial ads. Not only did parallel ads generate more visitors to the *Ambidextrous* website, but those visitors also spent more time on the client site; the parallel ads did better at reaching the target audience. Moreover, independent expert raters—both ad professionals and the magazine editors—judged the parallel ads to be better than serial ads.

Why did a parallel approach lead to better results? One reason has to do with our fundamental human ability to draw contrasts. Dedre Gentner and colleagues' many experiments on comparison show people are much more likely to transfer a principle to a new context when explicitly prompted to draw contrasts between cases [8]. People do a better job of capturing knowledge when they compare. So perhaps viewing and thinking about two ads side-by-side helped people to understand and apply graphic design principles to subsequent designs.

Our study also revealed parallel participants created more diverse ad designs. Using a crowdsourcing platform, we asked independent judges to rate the similarity within participants' set of designs. The judges deemed serial ads to be very similar and the parallel ads, more diverse. The timing of feedback affected how broadly people generated ideas. By simply waiting for a critique, parallel participants had time to explore.

Moreover, more than half of the serial participants reacted negatively to the expert critique; none of the parallel participants felt this way. One serial participant complained, "[The expert is] telling me I am completely doing something wrong here…there was a period where the emotional response overwhelmed any positive logical impact that this ended up having." The critiques were not any more negative for serial participants, but they were perceived that way. Parallel participants showed several ideas at once, so they were less invested in any particular idea. By spreading investments, parallel participants were more open to diverse feedback.

The "parallel process" led to a number of learning and motivational benefits for individuals, but we wondered how such strategies could affect design interactions in groups. Many designers live by the principle "never go to a client meeting without a prototype." However, the presence of a concrete prototype may (for better or worse) focus the discussion on refining that idea rather than thinking more broadly. Moreover, people tend to polish prototypes to look good in front of colleagues. What kinds of dynamics occur when group members share multiple concepts as opposed to sharing only their best idea? We hypothesize that sharing multiple designs leads to better results because people will be more open to adopting and merging new ideas.

We recruited pairs of participants to work together on an ad-design task. Participants worked individually to create either multiple designs or a single design. Then they shared their design(s) with a partner and critiqued each other's ideas. Each person created a final ad design, which we launched in a Web ad campaign. The results show when participants create and share multiple prototypes—rather than devoting their time to polishing one concept—they produce better results [9]. Moreover, participants who shared multiple designs borrowed more specific features and provided higher reports of group rapport. By a number of indicators, the collaboration was more productive.

Iteration helps designers integrate feedback into their designs but may have some limitations. With only one idea on the table, designers may take feedback and use it to concentrate on improving design without considering other options. Creating multiple alternatives and getting feedback on them in parallel encourages designers to enumerate more diverse solutions, helps reduce fixation, discourages emotional investment in any one idea, and gives group members license to be more candid and critical of their own and others' ideas.

What do the results mean for the interaction design community? While parallel strategies may be common practice for seasoned designers, the rationale behind these practices often eludes people. Empirical evidence may help persuade disbelievers to adopt a culture of prototyping. More important, understanding the cognitive and social underpinnings of prototyping practices can challenge designers and non-designers alike to reflect on why and how their actions affect results. What follows are practical implications for how practitioners and educators can structure creative group work.

The "enlightened trial and error" of prototyping offers a way to explore the opportunities and constraints of new design contexts. As the egg-drop experiment illustrates, iteration helps people discover unknown variables and their interrelationships. This notion of "design as discovery" is particularly important when addressing wicked problems. Often, trying solutions helps uncover the right problems to solve. Iterative prototyping initiates a conversation with the space of design possibilities.

Perhaps overlooked is how *parallel* design provides value throughout a process, not just in early stages. In many domains, sketches can be produced quickly, but creating complete designs is costly and time consuming. When creating multiple comprehensive designs is impractical, designers can still prototype and share alternatives to subproblems. In Web design, for example, it may be infeasible to produce three very different functional sites, but invaluable to create and test strategically selected elements.

Indeed, many organizations practice alternative generation beyond the early brainstorming stages. When IDEO redesigned the shopping cart in the infamous *Nightline* report, they created four physical mockups around different user needs [10]. By putting multiple functional prototypes in front of customers, they could gather

the kind of comparative feedback needed to make effective design decisions.

Multiple alternatives help refine a design. When Dan Siroker served as director of analytics for the Obama campaign's website, data played a central role [11]. With millions of visitors arriving each day, they could easily evaluate different combinations of image media, color, and button phrasing and measure the impact on sign-up rates and donations. The results often surprised the campaign staff. For example, while many members of the team assumed Obama's stirring videos would lead to improvements, the data told a different story. Page versions with images rather than videos helped the campaign collect the most email addresses.

Further, our results provide an opportunity to reassess the dynamics of client interactions. Clients may not want to hire a design firm that presents several half-baked ideas. However, finely polishing a concept in anticipation of a big client presentation can lead to fixation and overinvestment. David Kelley, founder of the design firm IDEO, claims that part of his company's mission is to "train" clients about their approach. Effective design practice is not a straight march to a particular solution, but a process of trying out alternatives and tolerating shifts in direction.

Educators may look for ways to improve project-based design courses by teaching parallel practices. Scott Klemmer and his teaching assistants have largely revamped the curriculum for Stanford's course on HCI design around generating alternatives (See cs147.stanford.edu). In the first assignment, students brainstorm at least 20 ideas for how to redesign the "waiting in line" experience. In week three, students create storyboards for two points of view. In week eight, teams create multiple redesigns of functional prototypes and then gather data on these alternatives. When students form teams, they each bring multiple project ideas to help avoid imposing preconceived notions of their project's focus.

Parallel design is a strategy for coping with unpredictability. It's about avoiding commitment and signaling to others that the process could go in a number of directions. By enabling comparison, parallel design helps problem solvers reason about the implications of possible futures. While the variance of design alternatives necessarily narrows as deadlines approach, the parallel mind-set provides designers rational and emotional support throughout a design process.

In terms of research methods, our approach opportunistically leverages the modern Web. Using banner ad design and data analytics, we bring a fresh perspective to questions about human creativity, motivation, and teamwork. Our future experiments will examine how novices transition to experts, how reflective techniques affect fixation, how value-centered strategies reflect stakeholder perspectives, and how the dynamics of feedback affect client relations.

Design excellence goes beyond learning to sketch and prototype. It's not only a craft skill but also a way of thinking. How can the community harness the most value from these practices? With a deeper understanding of why prototyping practices matter, perhaps new pearls of wisdom emerge. Engage in conversation with the design space. Create prototypes that examine big unknowns. Discover problems in addition to solutions. Focus on interpreting and integrating feedback. Keep multiple possibilities in play as long as possible.

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Using 3-D Projection to Bring a Statue to Life

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In the dungeons of Kronborg, a nearly 400-year-old Renaissance castle known from Shakespeare's *Hamlet*, there is a statue of Holger the Dane. Holger the Dane is a mythical figure who, according to one myth, will awaken and defend the country when an enemy from beyond the borders threatens the kingdom of Denmark. Annually, more than 90,000 people visit the castle, and while most of them visit the dungeons, they usually visit the statue only briefly.

How does a Danish myth relate to HCI? Well thanks to 3-D technology, we have been able to bring Holger the Dane "to life." In order to create an engaging experience that communicates some of the many legends about Holger the Dane, most of which are unknown to the public, we looked to 3-D projection. Three-dimensional projection on physical objects is a particular kind of spatially augmented reality (AR), which augments a physical object by projecting digital content directly onto it, rather than by using a device such as a mobile phone or a head-mounted display. During the past two decades, several research teams have been investigating 3-D projection on physical objects from a technical perspective [1, 2, 3]; in contrast, our interest is in using the technology to support engaged communication.

Beyond such explorations of 3-D projection, which primarily focus on the technical aspects of the technology, the most prominent examples of 3-D projection are, arguably, the works of Pablo Valbuena. His series of installations, entitled *Augmented Sculptures*, has been displayed at Ars Electronica and has attracted many online visitors to Youtube [4]. Valbuena's installations are typically composed of camera-tracked, angular, and clear-cut geometric shapes in conjunction with 3-D technology, which is used to create the illusion of light sources moving across elements of the faces of the installations. Also, there is a growing number of installations that employ 3-D projection to mimic the third dimension on a 2-D surface. 555 *Kubik* is one example of such an installation [5]. Projected onto the facade of Hamburg's Kunsthalle, the instal-

This article is based on a CHI 2011 paper by P. Dalsgaard and K. Halskov entitled "3-D Projection on Physical Objects: Design Insights from Five Real-Life Cases."

Operating in the digital 3-D world also enables the designer to virtually project on specific elements of a physical model, and thus pick out particular areas to augment.

lation employs visuals that create a sense of depth in various ways: The tiles appear to move in and out of the facade, the interior of the building is revealed in perspective, and so forth. AntiVJ's installation, *Enghien* [6], employs similar forms of expression but takes further steps to both underline and break down the illusion. Projected onto a building facade, the installation first mimics moving light sources to emphasize the 3-D effect; then, it starts copying and apparently moving the physical architectural features, such as windows and balconies; finally, it deconstructs and eventually explodes these features of the building.

These installations are either developed to explore technological potential or for artistic reasons. The artistically oriented installations primarily explore new means of expression and may be defined as staged events for audiences. In relation to these, the Holger the Dane installation may be characterized as more functionally oriented in the sense that the installation has been developed to support communication. In addition to this installation, our research team has developed a series of other installations that employ 3-D projection on physical objects, including an augmented rune stone exhibit at a cultural heritage museum, a contribution to the Venice Architecture Biennale on urban planning, and a design tool that was used in the development of the Danish pavilion at the 2010 Expo in Shanghai. These installations, along with Holger the Dane, are explored in more detail elsewhere [7].

Holger the Dane

When visitors approach the statue, "embers" behind the feet of Holger the Dane glow more brightly, and a sequence of narrative segments recounts his life (a video of the installation can be viewed online [8]). According to legend, six fairies gave special power to Holger the Dane, one of which appears in front of the statue. It flies around, while its shadow is cast on the sculpture, and fairy dust illuminates parts of the sculpture, imbuing Holger with his powers. The many legends about Holger the Dane—he was held captive by King Charlemagne, became an outlaw, and fought Burmand the giant—are conveyed in the narrative segments through visually abstract references. For instance, the fight with Burmand is conveyed by a shadow slowly covering the statue, to illustrate Burmand's approach. Next, sounds illustrate the fight between the two; then another fairy arrives, giving Holger the Dane additional strength and enabling him to split the shadow. Blood appears to splash his shield and one of the statue's feet. Finally, in the last sequence, Holger the Dane appears to have fallen asleep, suggested by the upper part of his body slowly moving with the rhythm of his breathing. The statue is a very popular photographic subject, and when a photographic flash is detected, the visual style of the projection changes.

Design Potential

In our research, we studied the Holger the Dane installation, and the related installations mentioned in the introduction [7], in order to explore the design potential of 3-D projection on physical objects. As a result of this work, we wish to highlight two areas we find particularly promising for designers venturing into the domain of 3-D projection.

Fusing digital and physical objects. Generally speaking, the use of 3-D projection in spatial AR provides designers with the opportunity to employ a wide range of visual effects and illusions. In addition to new means of expression, designers may also make use of standard visual effects that are parts of existing 3-D software, for instance 3-D Studio Max.

In the case of Holger the Dane, the first step of the process was to enlist a scanning company to assist us in creating a digital model, which was subsequently used to create a 3-D print in a scale of 1:4. This enabled us to carry out a number of experiments and tests of the installation in real life, without traveling to Kronborg Castle and disturbing the exhibition before the launch of the installation. The creation of a 3-D model that matched the statue and its surroundings was the first step in fusing digital and physical objects, and the scale model allowed us to explore some of the 3-D effects that may be used to strengthen this fusion.

One of the standard effects in 3-D modeling is the use of shadows to support visual depth. In the installation, the fairies that grant Holger his powers are modeled as 3-D objects and cast shadows on the 3-D model of the statue. When project-

ing the fairies and their shadows onto the physical statue, we create the illusion that the fairies are flying in front of the statue. In other sequences, we use shadows cast on the statue by objects that are not visible. For instance, the approaching giant is visualized by a shadow cast on the statue, and when Holger the Dane is imprisoned, shadows of prison bars are cast on the statue.

Another common technique with which we have successfully worked is the use of various particle systems, which can simulate fire, for example. Such particle systems may be placed in front of a model; they create quite realistic effects, for instance, in terms of reflections on the complex geometry of the physical object itself. The fire behind the leg of Holger the Dane was made using this strategy. Moreover, we used a particle system to visualize the fairies' dust.

A third technique, which also uses 3-D software, is incorporating various filters normally confined to the digital 3-D world to create visual effects on the physical model. For instance, we used the twirl filter to create the illusion that Holger the Dane was sleeping, as indicated by having the upper part of his body appearing to slowly move to the rhythm of his breathing.

Transforming the perception of space and materials. In addition to using various means to fuse digital and physical objects, one of the aspects we found to have the greatest impact on audiences is the use of 3-D projection to transform the perception of space and materials. The Holger the Dane installation offers a good example of how visual effects that emphasize and transform physical properties may be combined with the emphasis or transformation of semantic properties. The public perceives the statue as "rock solid"—both literally, being cut from stone, and in terms of representing a firm and unyielding mythological warrior. In the installation, we emphasized this general perception by initially projecting an image of the statue onto the statue. The result is an increased contrast that emphasizes the physical properties and makes the figure appear even more solid. However, at a later point in the unfolding narrative, we employ the aforementioned twirl filter on the projected image, which makes the statue appear to move and twist ever so slightly. This illusion plays into the viewer's perception of the physical structure, as well as the permanence of the mythological figure now coming to life.

Operating in the digital 3-D world also enables the designer to virtually project on specific elements of a physical model, and thus pick out particular areas to augment. In the case of Holger the Dane, the fire is confined to a glow behind his legs, and blood appears to splash the shield and one of the statue's feet. Such effects may serve to further play on the perceived materiality of the physical object.

Viewer Reactions

The installation has been in operation at Kronborg Castle since October 2010, and an initial study, supplemented by visitor interviews, indicates that many visitors find the installation fascinating and novel. The positive effect of this is that many visitors now make a longer stop at the statue, and the visuals prompt them to learn more about the myths concerning Holger the Dane. However, on the basis of our observations and interviews, it is also clear that the novelty of the installation causes some issues that must be addressed in future versions of the installation or in similar projects.

First of all, the installation truly stands out in comparison with the rest of the site with regards to the high-tech appearance of the installation in contrast to the ancient dungeons in which it is placed. Second, many visitors join a guided tour, and while the tour guides are usually the center of attention and chief narrators for most of the tour, when the tour reaches the statue, the installation takes center stage. This leads to a clash in narrative styles, and the tour guides are not yet comfortable in handling this situation. Third, many visitors in fact know little about the myths of Holger the Dane, save for the one that tells that he will rise when the nation is under threat. For this reason, some of the visuals can be confusing. As stated by one interviewee: "The visuals are very impressive, but what is up with the fairies?" These three issues all highlight the need for the installation to be more closely integrated into the context and practices of the castle as a cultural heritage attraction.

Visitors' spontaneous exclamations—for instance, "Now he's locked up!" when bars are projected onto the statue—indicate that some of the visual effects make sense to them. In particular, the effect of splashing blood and the sleeping sequence evoke visitor reactions. However, only a portion of visitors view the entire sequence of narrative events; one reason for this is that the sequence runs in a loop. If you enter in the middle of the sequence, visitors will miss some of the initial narrative fragments that build up to subsequent events; furthermore, many visitors leave when the sequence is finished and do not stay to view the initial parts that

they missed. Also, few notice the effect of flash photography.

Our interviews reveal that visitors are split when it comes to evaluating the overall concept and visual style: Some find the installation a bit too "Disney World" and point out the clash between the ancient dungeons and the modern, tech-heavy installation, whereas others appreciate the mood and atmosphere created by the installation and also point out that the installation could be a powerful way of creating interest in the younger generations about the legend of Holger the Dane. The manager of Kronborg Castle and the cultural heritage communications manager were initially in favor of a more direct retelling of the myths but were ultimately captivated by the atmosphere of the relatively abstract final installation.

Conclusion

In contrast to conventional AR, such as what is found in mobile devices, spatial AR using 3-D projection presents interaction designers with unique opportunities and challenges. The most prominent advantage of using 3-D projection on physical objects is, arguably, that it offers viewers an experience of immediacy and physical presence. This is different from what may be achieved with traditional AR, which uses a screen as the media layer. Three-dimensional projection removes the screen as media layer and presents the virtual layer directly on top of the physical object or environment. This enables an experience of presence that is qualitatively different from screen-mediated AR.

In some settings, such as museums and exhibitions, this is a particularly promising strategy. For instance, many museums place an emphasis on presenting visitors with authentic objects, such as the original Holger the Dane statue, but also wish to communicate further information related to the object. Traditionally, this has been accomplished by presenting audiences with a separate channel of communication, such as accompanying leaflets, descriptions on signs near the objects, audio guides, and so on. When properly employed, 3-D projection keeps the emphasis on the object itself, while adding layers of information. In another project, we worked with projection—though not 3-D projection—on a Danish rune stone, as part of an exploration of fusing projection and object, in an engaging approach to communicating information at a cultural heritage museum [1].

However, 3-D projection on physical objects is a complex process that presents the designer with a number of challenges. First, the process of developing a precise 3-D model of the physical environment may be complicated, particularly when dealing with complex structures, such as the Holger the Dane statue. Second, content must be custom-developed for the specific environment; although standard effects from 3-D software may be employed, other types of content must be carefully aligned with the physical environment. Third, successful implementation of 3-D projection requires a high degree of control over the physical location in which the technology is employed. The projectors must be calibrated very precisely, the lighting conditions have to fall within specific parameters, and the physical environment must not be altered. This set of challenges is most likely the reason that related examples of spatial AR are set up in controlled environments, either in laboratory settings or designated exhibition areas. Fourth, spatial AR installa-

tions must be integrated into the context, not just with regards to the physical space, but certainly also with regards to the established practices of the site.

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Experimental Design: Does External Validity Trump Internal Validity?

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Like many who submit manuscripts to the CHI conference each year, I look forward to reading the reviewers' reflections on my submissions. This year my coauthors and I were asked to justify the validity of our highly controlled research; similar requests have been made of our recent submissions to journals. In these experiments, we went to great lengths to ensure a high degree of internal validity. Our research goal was to establish a cause-and-effect relationship between what we were manipulating and what we were measuring. The only way to establish cause-and-effect relationships is by using designs with high internal validity.

It is not uncommon for researchers to be asked to reframe their highly controlled experimental designs in applied terms—people want to know the real-world application of the work. However, based on recent feedback from review committees, it has been suggested studies high in internal validity are of little value to CHI participants. To illustrate this point, let's explore one of my students' CHI reviews. The associate chair provided an excellent summary regarding the "issue" of design's high internal validity: "The reviewers agree that this idea has merit and could be a useful tool for HCI designers, but raised some concerns about validity of the results (this issue was also discussed by the authors)." One reviewer stated, "…The nature of the experiment was not particularly ecologically valid…" Another reviewer wrote, "The authors are aware of this shortcoming and point out that 'the situations presented in the experiment were relatively minimal and artificial.' I contend that the situations were minimal and artificial enough that it is not possible to draw conclusions… [this variable] should be tested in a more realistic task in order to evaluate viability."

What follows is a typical rebuttal I might offer:

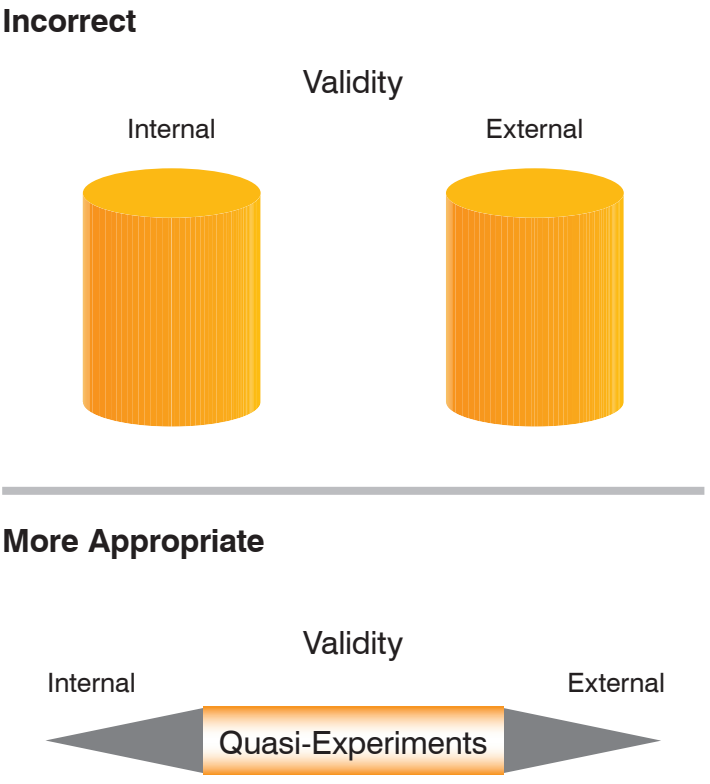
This experiment does indeed lack a high amount of external ecological validity (which we hung a lantern on), but this design comes with the benefit of having a high amount of internal validity. Our goal was to understand the cognitive operations typically involved with the interaction types, not to investigate its use in a particular setting. For instance, we did not set out to only understand "X" interaction type within the context of "Y." However, we do hope that future research will test the external validity of the claims presented in this manuscript.

Describing Internal and External Validity

Let's take a moment to define internal and external validity in their purest forms. In an experiment with high internal validity, a variable of interest (i.e., independent variable) is manipulated to determine its effect on something being measured (i.e., dependent measure). The advantage of using a design with high internal validity is its ability to control for confounding variables. In other words, it allows researchers to be confident that the variable being manipulated is causing the change seen within the dependent measure. In contrast, a study with high external validity might be conducted in a more natural setting, for instance, studying user interactions with a piece of equipment in the specific situation in which that equipment is typically used. Studies with high external validity are beneficial because they allow one to observe many variables

interacting with one another; these interactions are purposely minimized in studies with high internal validity. The primary drawback is the presence of co-varying variables precludes the researcher from establishing cause-and-effect relationships. Most research falls somewhere between these two extremes of validity; those are referred to as quasi-experiments.

We suspect that some have the incorrect mental model of experimental validity. They believe validity is dichotomous, consisting of two independent categories—a study can have internal validity or external validity—and therefore, for instance, a study with internal validity cannot have external validity. Conversely, it is the case that any particular study's validity fails on a continuum between the two extremes. With this more appropriate mental model, it becomes clear that identification of a study as having "pure" internal or external validity is difficult (See Figure 1). Most HCI studies would be considered quasi-experimental. That is, some independent variables are manipulated by the researcher, allowing for cause-and-effect conclusions (e.g., simulator training: yes or no), while other experimental variables of interest are not manipulated (e.g., age, working memory capacity of participants). When variables of interest are not manipulated, cause-and-effect conclusions cannot be drawn because other variables may co-vary with those variables of interest. For example, participants' working memory capacity, although it may be of interest, cannot be manipulated. Working memory capacity may co-vary with a number of variables, including intelligence, experience with the task/material, and attention; therefore, one cannot say that differences in working memory alone result in differential task performance.



► Figure 1 displays two mental models of internal and external validity. The top model is incorrect, as each type of validity is categorically separate. The bottom model is more appropriate, as the continuous bar reflects the continuum between the two extreme states of validity. The thickness of the bar represents hypothetical prevalence of design types used in interaction design studies–quasi-experiments are most common, while experiments with more internal or external validity are less common.

Associating Validity with Basic and Applied Research

I have suggested studies with high internal validity do have a place in the HCI literature, but there is a second conceptual issue that reviewers may take issue with. They may have incorrectly equated internal validity with basic research and external validity with applied research, as is often done. The difference between basic and applied research lies not in experimental validity; rather, the difference lies in their intended purpose [2]. Basic research is most often preformed without an immediate practical purpose. Many who execute basic research hope it will someday have a direct and practical benefit but primarily hope to further scientific understanding of a particular topic by discovering and describing the principles that govern a particular phenomenon. On the other hand, applied research is performed with the intent of providing a solution for a specific, practical problem. In

It is not uncommon for researchers to be asked to reframe their highly controlled experimental designs in applied terms—people want to know the real-world application of the work.

a mature research program, like that directed by Paul Fitts, basic and applied research are used to inform each other. In addition, it is important to note either basic or applied research can have a high degree of internal or external validity. An example of applied research with high internal validity would be searching for a cure for cancer within a laboratory environment. An example of basic research with high external validity would be performing a case study of a newly discovered animal's behavior within its natural environment. These two examples highlight research that clearly violates the incorrect conceptualization that internal validity is found only in basic research and external validity is found only in applied research. It could be the case that the reviewers had this incorrect conceptualization. Of course, it is also possible that there is a correct understanding of experimental validity but that some reviewers simply do not value basic research.

Why Our Future Depends on Basic Research

Let me share a fictional scenario to illustrate the importance of basic research. I believe it especially rings true for the field of HCI, as we never know what future technologies will come to fruition. Imagine that a researcher studies the game of croquet—a lawn game that involves whacking balls through hoops. This researcher manipulates the velocity of the balls, lawn conditions (e.g., slope, type of grass), ball placement (e.g., angle, distance), and ball mass. He measures where the whacked ball stops, how long it took to stop, and one ball's displacement of the other balls in play. Through his experimental work, he hopes to be able to predict where a ball will stop under a variety of conditions. Other academics on campus mock the research, saying it has no real value. Further, administrators pressure him to quit his current work and explore more funding-attractive research. The research simply does not provide a solution to a currently recognized problem. However, after many years (and the rise and fall of many popular problem sets), the world suddenly fears that a giant asteroid, crossing through the asteroid belt between Mars and Jupiter, may hit the Earth, resulting in Armageddon. Now the professor's croquet-game research is relevant! Based on his previous research, he is able to predict where the asteroid would strike and what force would be required to alter its course. This scenario illustrates the potential of basic research for the rapid resolution of unforeseen, practical problems.

Conclusion

My goal here is simply to remind researchers that with any design decision—experimental design or interaction design—there is a trade-off between benefits and costs. We strongly believe the field of HCI benefits from the acceptance and support of research falling near the internally valid end of the validity spectrum (bottom panel of Figure 1). Again, this type of experimental validity produces knowledge about the cause-and-effect relationship between variables and measurements of interest. However, in using this design, we accept that it does come at the cost of not being able to apply our findings to specific instances of interaction with absolute confidence.

It is vital for the future development of the field of interaction design that authors recognize the trade-offs associated with their experimental design decisions. Remember, "any measure device is valid if it does what it is intended to do" [1]. We ought to be transparent about our research validity goals and seek quality research, whether it is high in internal or external validity or somewhere between.

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Public policy increasingly plays a role in influencing the work that we do as HCI researchers, interaction designers, and practitioners. "Public policy" is a broad term that includes both government policy and policy within non-governmental organizations, such as standards bodies. The Interacting with Public Policy forum focuses on topics at the intersection of human-computer interaction and public policy.

Jonathan Lazar, Editor

Are HCI Researchers an Endangered Species in Brazil?

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Recently, Brazilian researchers have been receiving mixed signals regarding the recognition of human-computer interaction (HCI) as a relevant area of study in Brazil. On the one hand, HCI was granted considerable prestige when the Brazilian Computer Society launched its Five Grand Challenges for the decade in 2006. One of them was the "universal and participatory access of Brazilian citizens to knowledge and services," a challenge that cannot be faced without seriously involving HCI research in its many forms. Four years ago, the establishment of such a challenge attracted the attention of several graduate students, who saw an opportunity to make substantial contributions to the Brazilian people and society with their research. It brought about an exciting and prolific moment for HCI in Brazil. On the other hand, in less than three years, these feelings have changed.

HCI in Brazil—a Bit of History

The HCI research community in Brazil has steadily grown in the past decade. The first Brazilian HCI conference was held in 1998 (IHC 1998), with 15 papers on the program. Up until 2002, we held annual conferences, gathering between 100 and 150 participants every year and bringing renowned international speakers, mainly from North America and Europe. In 2001, at the Latin American Development Consortium at CHI, we decided to join our efforts with other HCI researchers in Latin America to create a series of regional HCI conferences. In 2003, the first Latin-American Conference on HCI, CLIHC 2003, was held in Rio de Janeiro, gathering 250 participants from all over the world. Between 2004 and 2008, we held the Brazilian HCI conference every other year, alternating it with CLIHC, which was held twice in Brazil and twice in Mexico. In 2010 our national HCI conference included 32 papers in three different categories (long papers, short papers, industrial reports), in addition to demos and posters. The community decided to hold annual conferences from 2011 onwards and to have next year's edition co-located with CLIHC, the Latin American conference, in Pernambuco, Brazil. Also, in 2007 we held the IFIP INTERACT conference in Rio de Janeiro, which brought even more attention and prestige to the area. We found 2006 and 2007 were good years for motivating HCI research in Brazil.

How Graduate Programs Are Currently Evaluated in Brazil

Every graduate program in Brazil, from any research area, is evaluated every three years by a governmental agency called CAPES (http://www.capes.gov.br). Its main goals are to ensure high-quality university programs at both undergraduate and graduate levels. In the most recent evaluation, 40 percent of performance was judged on how many high-ranking publications faculty and students produced for the graduate program. But one major issue was how the publications were ranked. CAPES issued its own rank of "qualified" publications for each of the 40-plus areas in which graduate programs were grouped, in a classification system named Qualis (http://qualis.capes.gov.br/webqualis/).

When CAPES was devising the classification criteria, there was a very strong reluctance to include both computer science journals and conference proceedings in Qualis. At first, CAPES was adamant about considering only journal publica-

tions in their ranking. After much discussion, the Computer Science Commission and CAPES have reached a compromise to create an objective measure of the quality of conference publications—a formula based on citation indices.

Although the ranking for computer science included both journals and conference proceedings, the formula CAPES has come up with makes no distinction between the idiosyncrasies of different research areas. Younger research areas, emerging lines of research, innovative research topics, and localized research to address regional issues get consistently low values in the adopted evaluation. As such, HCI research is unfortunately among the areas that were most strongly affected by the current evaluation.

In the past, the citation indices were considered, of course, but the Brazilian research community could argue for the quality or relevance of a conference to the country, and then have the ranking adjusted accordingly. Whereas then we had room for some qualitative assessment of our publications, now our research community is restricted to the global indices that do not reflect the regional issues that must be addressed by Brazilian researchers.

HCI Evaluation and Graduate Programs in Brazil

In the most recent Qualis ranking established by CAPES in late 2009, only 1.6 percent of the top 25 percent of computer science publications were specifically devoted to HCI. Even globally recognized conferences, such as ACM CHI and IFIP INTERACT, were *not* among the chosen. This has had a very negative impact on young researchers looking for an academic career in HCI. Compared with colleagues doing research in artificial intelligence, software engineering, or information retrieval, their chances of having "starred" publications on their CV has become considerably smaller. Thus, in competing for a faculty position in Brazilian universities, HCI researchers are not as likely to impress graduate program directors as candidates specializing in areas with higher-ranking and more abundant publication opportunities.

According to the CAPES website, there are currently 43 accredited computer science programs in Brazil. Upon further review of each program's website, 12 of them include HCI in their research areas or topics. Unfortunately, eight out of the 12 include HCI as part of another research area, such as software engineering, computer graphics, and so on. Only four of them characterize it as a standalone research area.

From 2004 to 2008, there was a high increase (a little more than 50 percent) in the number of computer science–related graduate programs, growing from 28 to 43 accredited programs. Among the 15 recently accredited programs, three indicate HCI as a research area on their websites. As emerging programs, they are even more affected by the lack of prestige. Academic programs may not only hesitate in hiring HCI researchers, who have a low potential of producing "high quality" publications as understood by CAPES, but may even come to prune the "problematic" research areas if the next CAPES evaluation raises a red flag.

The Impact of the Current Evaluation Criteria

The negative effects of the current Brazilian ranking for CS publications have already transcended individual academic careers. The 12-year national conference series on HCI, which has been greatly successful in consolidating a community of productive and creative HCI researchers, features in the second tier of the official evaluation ranking. Therefore, the conference is no longer a priority when Brazilian researchers wish to publish their research. This is especially disturbing when we stop and think about our object of study.

Among all multidisciplinary subareas of computer science, HCI is probably the most sensitive to the cultural context in which research is done. The "user experience," which we all want to understand, improve, and diversify, cannot be dissociated from the user's social and cultural background. Therefore, doing research in HCI requires that researchers themselves have a deep understanding of the particular sociocultural context in which the object of their investigation is placed. Hence, national HCI conferences have a great value for HCI research communities anywhere in the world, because they congregate people who have an insider's perspective on the issues that affect the way technology is perceived and used in a particular country or region. The interplay between an insider's and an outsider's research perspective is an absolute requirement for quality research in any culturally sensitive area. So, the disqualification of the Brazilian HCI conference series by official academic evaluation criteria may have a devastating effect, not only on individual professional careers but also on ICT development in this country as a whole. We must change this situation quickly.

The overall goal of research in

HCI is to improve the quality of interaction between people and digital technologies, with special emphasis on the opportunities for increasing the social value of those technologies. In emerging economies like Brazil, good HCI solutions can contribute to leveraging social change by helping low-income populations with little education use ICT products and services to transform their lives. Thus, the Grand Challenge launched for the Brazilian HCI community in 2006 still stands. All HCI researchers, especially in countries like Brazil, have an acute awareness of their social responsibility, which imposes a particular research agenda, research pace, and even research method that is not necessarily the same as in other countries with different socioeconomic profiles and challenges.

Our government's goal to motivate Brazilian researchers to play an increasingly relevant role in the international scientific community is of course highly commendable. However, to use impact factors and citation indices of publications as the most important measure of the quality of research is a serious threat to the very mission of socially responsible researchers. It places the country's own priorities for social development in second place compared with the global scientific interests that guide editorial policies of international publishers. Although the international scientific community is increasingly sensitive to social issues, the number of citations that a particular article receives should not be the prime instrument for promoting and evaluating high-quality, socially relevant scientific research. Many of us recognize the quality of various country-specific publications and learn something from them, but precisely because they talk about a socioeconomic reality that is not the same as ours, we may not have a reason to cite them when reporting the results of our own research. Not all countries have equivalent problems, goals, concerns, values, and priorities. Therefore, HCI solutions in one place may not necessarily work in another. The problems themselves are likely to be considerably different.

Because HCI research in Brazil is mainly carried out in universities, Brazilian HCI faculty have been left with only a fraction of opportunities to show that they can perform well academically. It is highly probable that HCI researchers are indeed an endangered species in this country. This new reality is contradictory even within the country. The Ministry for Science and Technology, for instance, has fully embraced the Grand Challenges of the Brazilian Computer Society and has been creating many funding opportunities for socially inclusive ICT projects. The question is: Who is going to engage in these projects? Without academic prestige, undergraduate and graduate students are likely to develop little or no interest in HCI. Many already believe that a quick training session on design and evaluation techniques is enough to develop good interfaces with a desirable level of usability and accessibility. However, as every HCI researcher knows, it is not that simple.

We must be able to promote and sustain the constant development of local scientific communities capable of producing knowledge and innovation that is in line with each country's or region's context. We must also be able to find efficient and effective mechanisms for assessing the quality of our own research, keeping in mind that gaining international visibility and appreciation is necessary but not more important than fulfilling the social role of research in this country. Should we forget this, our research would be exclusively aligned with global research interests and might help address social demands and opportunities that are not necessarily among the priorities of Brazilian citizens.

As we said, the cultural determination of HCI research is not a Latin American idiosyncrasy. All HCI research carries the trace of cultural values of those who do it and those who benefit from it. International scientific exchange is the premier means to increase the awareness of such cultural determination and share different perspectives on problems and solutions. We believe encouraging the development of strong national HCI communities will unfailingly benefit the global community as a whole. So, we invite our colleagues from other countries to join our efforts in bringing together data and testimonies on the importance of HCI as a strategic research area that respects their countries' characteristics, needs, and culture.

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Timelines provides perspectives on HCI history, glancing back at a road that sometimes took unexpected branches and turns. History is not a dry list of events; it is about points of view and differing interpretations.

Jonathan Grudin, Editor

The DigiBarn Computer Museum: A Personal Passion for Personal Computing

Bruce Damer
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In 1993 ACM sponsored HCI researchers on a vist to Eastern and Central Europe. I met Bruce Damer in Prague, where he held a professorship in computer science despite not having a Ph.D. Bruce quickly impressed me as one of the most brilliantly creative people I'd ever met, a visionary who builds things. Like other visionaries, he may optimistically assume that everyone will work at his pace; some visions materialize slowly. Here, he describes a vision a quarter century in the making that has become an impressive reality. —Jonathan Grudin

The DigiBarn Computer Museum project started inauspiciously enough in 1987, when I found myself at a yard sale in the San Fernando Valley, transfixed by a beautiful object. There before me was a Comptometer, an early mechanical adding/multiplying calculator in a handsome brass case, for a mere $15. At home I polished it up and noticed a steel placard engraved with a series of patent dates, starting with '87. I realized this was, of course, 1887—sitting before me was a 100-year-old desktop computer (or, rather, a calculator).

Back in 1981, when I was a freshman in college, I became transfixed by an image of the Xerox Star 8010 desktop interface presented on a magazine cover. From that moment on I was convinced that there was a future in computing. By 1990 I began to ask myself two questions: What was the source of the invention of the personal computer and the GUI, and how could I acquire and document the artifacts and stories of this most impactful of inventions on our everyday existence?

The Birth of a Computer Museum (with a difference)

The idea for a fully fledged museum was finally born in a 90-year-old barn on a farm, which I purchased in 1998, amid the halcyon redwood forests of the Santa Cruz Mountains. Home to my initial collection, the museum fast grew with donations from friends in the area and nearby Silicon Valley. My vision was encapsulated in the phrase "A Memory Palace for Nerds." It would be a living workshop where long-silent vintage systems would come alive, prompting visitors familiar with them to give us a download of key stories and historical facts from their own long-dormant memories. The museum and website would focus on the birth of personal computing, the GUI, and the networked lifestyle in which we are all now enveloped.

Open houses were created to attract visitors; eventually, the collection began to attract quite a following of both famous and not-so-well-known industry people; most of the audio and video of their visits were recorded for the website. I later initiated annual birthday event gatherings, including speakers and machine restorations, for key anniversaries in computing history that would otherwise have gone unnoticed. Spontaneously emerging from this project was an exciting new practice of "deep digital archaeology," wherein an unusual artifact, worked on by an extended community over years, could unravel an entire aspect of the history of computing that would otherwise have stayed buried (see the sidebar on Norm Cox's icon designs).

The Collection

The DigiBarn began life in homage to those who invented and popularized personal computing using a GUI, but fast expanded to encompass all aspects of personal computing through the ages. The collection now contains century-old hand-cranked mechanical comptometers, slide rules, electronic calculators, a 1960s personal workstation progenitor called the

LINC (see sidebar), home-brewed hobbyist specials from the 1970s, early prototypes of Apple and other commercial microcomputers, a full line of widely used home/business PCs and game consoles, and, more recently, Web appliances, tablets, and cell phones. The collection even includes two Cray Supercomputers (a Cray-1 and Cray-2 prototype), thrown in for good measure (and useful seating).

Encouraged by Computer History Museum founder Gordon Bell, I placed a major focus on the cyber-museum with a sprawling, mostly hand-built website at www.DigiBarn.com. The site contains hundreds of thousands of photos, personal stories, schematics, advertisements, manuals, books, T-shirts, audio, movies, and full reconstructions of both machines and personal biographies. As notable contributors to the art are passing from the scene (such as the initiator of the Macintosh project, Jef Raskin), the site now features memorial pages. Legal firms are now using the DigiBarn in their efforts to fight patent infringement lawsuits. The Creative Commons organization used the DigiBarn site as a test case in the launch of their new licenses in 2002 and the collection was part of a brief about orphaned works for the U.S. Copyright Office.

Key Moments in Digital Historical Decoding

In the nearly 10 years since the DigiBarn has been fully up and operating, several thousand people have taken the trek over windy mountain roads to get the personal tour. Many arrive bearing gifts—artifacts that are sometimes placed directly into the living timeline, growing the museum in an organic fashion. All bring stories, which add to the weave of the history. Millions of visitors to the cyber-museum have added much more. Boxes of unique contributions continue to flow in, as do copious volumes of online digital donations. The site has developed a heavily cross-linked nature, inspired by James Burke's "Connections" TV series, which promotes the idea that major inventions are all driven by people, machines, and companies all related in a non-linear, densely interwoven fashion.

Perhaps some of the most poignant moments came through memorable quotations from visitors to the museum or those who were interviewed in the field. I am paraphrasing some of the more historically significant utterances here for you to form your own connections.

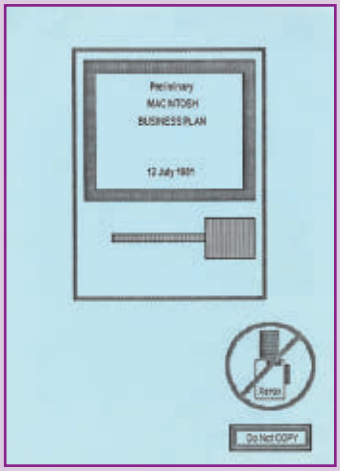
- Steve Wozniak: "I just designed a computer I would want to own myself."
- Daniel Kottke: "I went to work in Steve Jobs' garage assembling Apple 1s in June 1976, but it took Woz a while to explain to me how computers actually worked."
- Johanna Hoffman: "Back in 1981 I would sneak into Xerox PARC at night, write and draw the Macintosh business plan on a friend's Alto computer, print multiple copies on the laser printer in the basement, and leave for the morning meetings with Steve Jobs at Apple before PARC people arrived for work."
- Bill Pentz: "In 1972 at Cal State Sacramento, we created the first microcomputer in the world that had an operating system, a color terminal, a hard disk, and other devices, and then Gary Kildall and many others like Paul Allen stole our implementation."
- Gordon Bell: "I tried to convince DEC of the value of small computers."
- Bob Taylor: "The LINC is the machine on which I first learned about computers, before I went to DARPA where I started the ARPANET project."
- Wes Clark: "We took John Lily's LINC away from him around 1965 because, for one thing, he had it too close to the dolphin tank."
- Bob Frankston: "The spread-

Deep Digital Archeology at the DigiBarn

An example of "deep digital archeology" is the contribution of artist Norm Cox's first design for a "you've got mail" icon and the end products produced for the Xerox Star 8010 workstation, launched in 1981. Many of the icon metaphors and styles prevalent today trace their lineage to this work, as the Star was widely emulated as GUIs propagated in the 1980s.

It turns out that Cox had no idea about the properties of the medium for which he was asked to design icons, reporting that "the people from Xerox asked me to design a picture symbolizing that you had just received mail, so I drew an envelope rushing through a door. I later understood that this had to be created within a little square of black and white pixels."

The DigiBarn Collection: Documents and Hardware



A large collection of early microcomputer- and computer-culture documents are housed in the collection and featured on the website. Presented here is the cover of the Preliminary Macintosh Business Plan of July 12, 1981, which laid out Apple's 1980s strategy for introducing the Lisa and Macintosh computers. Displaying a high degree of irony, this document was created by an Apple employee working at night on an Alto computer at Xerox PARC.

Other documents include:

- Ted Nelson's Computer Lib, an early large-format book on the culture of computer users;
- The first issues of the People's Computer newsletters;
- A large set of Homebrew Computer Club newsletters;
- The original invitation to the West Coast Computer Faire of 1977;
- Apple co-founder Steve Wozniak's handwritten notes and schematics for the several early Apple computers and peripherals; and
- A large set of Xerox PARC "blue and white" research reports, as well as complete documentation on Xerox's workstations.

The DigiBarn also features a number of hardware artifacts, which were in their own way "firsts." In 2007, DigiBarn celebrated the 45th anniversary of the paradigm-shifting 1962 LINC computer, considered by many to be the first true personal workstation.

Some other groundbreaking hardware on display:

- The SacState 8008, which is quite possibly the first complete computer built around a microprocessor, is the 1972 Cal State Sacramento system based on the Intel 8008;
- The 1962 LINC, considered by many to be the first personal computer or workstation;
- The Cray Q2, prototype unit for the Cray 2 Supercomputer and the first supercomputer to be connected to the Internet;
- Altair-assembled kit #47, possible the oldest "pristine" new-in-the-box microcomputer;
- The IMSAI computer that Rob Barnaby used to write WordStar, the first widely used personal computer software package; and
- Jef Raskin's hand-built joystick for the Apple II, which he developed for Steve Wozniak to test the game port of the computer during development.

sheet was the greatest tool for lying ever invented."

- Rob Barnaby: "When I was writing WordStar I mapped out dozens of keyboards from different micros and found one common set of keystrokes that I could use—that way my program would be usable on all these machines."
- Ted Nelson: "Xerox PARC is where it all went wrong."

The Future of the DigiBarn Project

The DigiBarn is greatly in need of a financial sponsorship, both for upgrading the physical structure and for its cyber-presence. This year a new roof was put on the barn building, but the entire interior needs to be sealed from the weather to avoid the annual pack-up of the exhibits to dry rooms. The website also needs to be automated with modern tools, and the vast collection of documents should be selectively scanned. I am hoping that a foundation or a university museum-studies program could "adopt" the DigiBarn and that grants could be obtained to support students and complete the renovations—and that we can continue to interview people, capturing critical oral histories before it is too late. In the very long term, I will look for a new home for the materials at an institution that is comitted to the goal of developing deep understanding of the birth of personal computing, which I believe is the most important invention affecting life in the 21st century.

I invite collaboration of any sort, from donation of funds, to physical and virtual artifacts, to stories, volunteer assistance, and the pursuit of professional historical projects. Another important project might be the writing of a book that weaves together the threads of computing history that are uniquely available through this collection.

Please feel free to visit the cyber-collection at www.DigiBarn.com and to contact Bruce to arrange a visit to the physical collection.

The rest of Bruce's life and work can be visited at http://www.damer.com.

ABOUT THE AUTHOR

In the 1980s Bruce Damer built some of the first GUIs on PCs with Elixir and Xerox; in the 1990s he created innovative avatar virtual worlds; in the 2000s he designed missions for NASA using 3D visualization; and today, he researches the origins of life with the EvoGrid project.

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Models help bridge the gap between observing and making—especially when systems are involved (as in designing for interaction, service, and evolution). This forum introduces new models, links them to existing models, and describes their history and why they matter.

Hugh Dubberly, Editor

Conversational Alignment

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People invent and revise their conversation midsentence. People assume they understand enough to converse and then simply jump in; all the while they monitor and correct when things appear to go astray from the purposes at hand. This article explores how this adaptive regime works, and how it meshes with less adaptive regimes of machines and systems.

A Tale of Two Stories

A colleague told us a story of two friends discussing euthanasia. At least, that was what one thought they were discussing. The other heard the discussion as being about "youth in Asia." Remarkably, the conversation went on for more than five minutes before the misalignment was detected.

The "Who's on first?" comedy routine by Abbott and Costello is based on a similar misalignment. Those master comedians make the audience a knowing third party to the difficulties.

The usual accounts of such conversations would have it that this is an exceptional case, and usually speakers are well aligned. These accounts hold that good (or even perfect) alignment is necessary for conversation.

We explore an alternative perspective: These stories of misaligned conversations are not different in kind from more typical, apparently well-aligned conversations. Rather, we hold that all interactions are necessarily misaligned to some degree, and the mechanisms that make conversation "good" are not those that bring speakers into perfect alignment, but rather those that maintain a degree of alignment appropriate for the situation. The work of being a good conversant is to produce alignment that is just good enough for the purposes at hand.

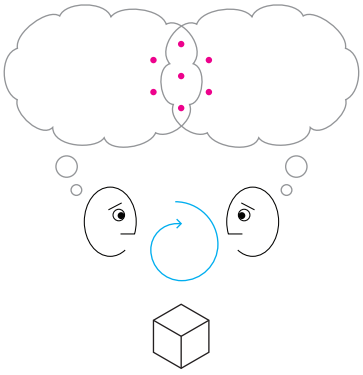
Getting Started

If you were starting a conversation with a Martian, you might reasonably be uncertain about what you could assume concerning the Martian's view of the impending conversation—its views on interactional moves, language, subject matter, even what a conversation is. You would have difficulty knowing where to start.

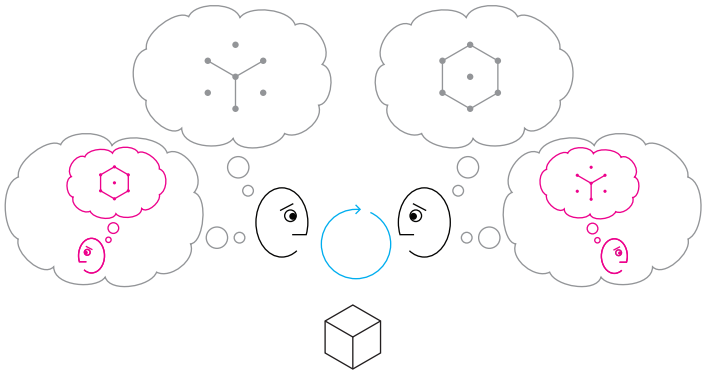
In contrast, when you meet a colleague in the hallway, you usually get started with little difficulty. You assume they will speak, using the same language you used yesterday when you two last spoke; that a friendly greeting is a good starting subject matter; and that the conversation will be composed of both of you taking turns, sometimes overlapping, with an end in the not too distant future.

We argue that the starting situations with your colleague and with the Martian are different only in degree, not in kind. In each case, both of you make a set of assumptions about the situation. And then one or other (or both!) of you will simply make some interactional move. The Martian might wave its ears; your friend might say, "Did you have a good weekend?" And as a result of that first move of plunging in, you immediately have all sorts of information that you can use as evidence for or against the assumptions you made about the conversation. Yes, the conversation appears to be talking (rather than ear waving, or crying, or hugging, or…); yes, it appears to be in English (although no doubt you may have on occasion started a conversation with "Bonjour!" to a friend who you know also speaks French); yes, it appears to be starting with social niceties; and yes, we seem to be embarking on a hallway conversation.

There is nothing determined about any of this. The world we live in emerges as we live it, and we have to take it as it comes, and make of it what we can. So you have to start with assumptions, engage in conversation on the basis of those guesses, and subsequently adjust



▸ We describe conversation *as if* we are creating a shared mental model...



▸ But 'sharing' is shorthand for a more complex process in which we form a mental model of our interlocutor's mental model of the topic at hand,...

your assumptions as you produce evidence from the engagement.

And at the same time, your partner in this game is doing exactly the same thing: starting with assumptions, engaging, and using your conversational moves as evidence for adjusting those assumptions.

Adequate Alignment

As the conversation continues, both of you make conversational moves and monitor each other to see if you make sense out of each other's moves. In the normal (normative) case, the moves provide evidence that supports, extends, or incrementally changes the assumptions with which you started.

At the same time, both of you are monitoring each other to see whether you are being "understood"—whether the other person appears to be making enough sense out of what you said. You cannot read their mind. However, their responses are evidence of whatever sense they made of your move.

In a similar vein, when you are listening, in order to provide information for your conversational partner's use, you may signal that you are making sense of their moves: Maybe you make eye contact, give a nod or a smile, even engage in an overlapping completion of their sentence.

We achieve continued conversation by maintaining mutual assurance that each of us can make enough sense of each other's moves.

Trouble

However, sometimes making sense is not so easy. In the "Who's on first?" routine, the evidence of trouble is immediate and profound. In the "euthanasia" scenario, trouble took surprisingly long to emerge.

Confronted with trouble, the next conversational move may address not whatever is under discussion, but rather the difficulty in interacting. This may take the form of "What are you talking about?" or a furrowed brow, or a conversational turn about the trouble: "When you say 'euthanasia,' are you talking about assisted dying?"

Conversation analysts refer to such shifts in subject matter from the matter at hand to the conversation itself as "breakdowns." A breakdown in this sense is a response to a feeling that our interaction is not working well enough, and that the conversation should be interrupted and refocused on the conversation itself. When a hammer handle breaks, fixing the roof stops, and fixing the hammer begins. We shift focus to converse about the conversation and "repair" the breakdown.

Once a repair has been concluded, the conversation can pick up where it left off, but now possibly with improved alignment—a better grip on the mechanics of conversing, the meaning of the terms, even the purpose of the discussion.

Levels

In conversation we always work on multiple levels: We monitor the comfort, interest, and comprehension of our partners; adjust our approach; maybe switch topics, etc. Explicit repair of breakdowns is an unusually clear case of switching primary attention to a different level.

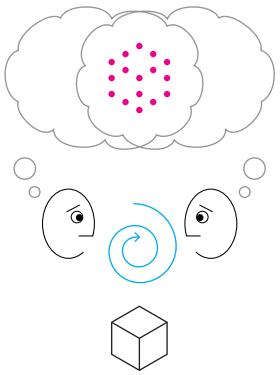
In most situations we shift our emphasis between these levels so easily that we are hardly aware they exist and so we may find it difficult to make our multilevel negotiations explicit.

Sense Making

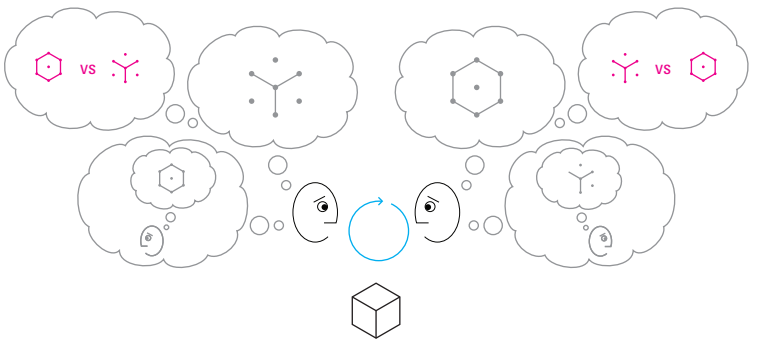
We are all very good at making sense of situations, fitting things into the context and moving along. The sense we have made may later turn out to be flawed, but we are really troubled only if we can't make our understanding work well enough for the purposes at hand.

Sometimes we find that new activity is confirming evidence: We can make sense of it without any change to our assumptions or understanding. It fits right into the sense we have made of the world.

Alternatively, we may have to change our assumptions in order to make sense of a move. We might think the sky is blue, and our



▸ ...*as if* our mental models are converging.



▸ ...and compare it to our own model in order to confirm sufficient agreement on relevant areas to continue the conversation.

conversational partner might say, "Looks like rain." On observation, low clouds in the west are indeed there, so we adjust our blue sky to have low western clouds, and we adjust our assumptions about our partner to reflect that they see the world that way too.

When something doesn't fit, we tend to look for the smallest (and often most local) changes in our view that will have things make sense. After which, we may opt to move on. But we also often retain a concurrent view of how well we are doing in making sense of things, how much work we had to do, how happy we were with the result, and whether there are loose ends—simply, is the conversation working?

Because it is expensive to drastically reset our assumptions, we are inclined to delay doing so until we are reasonably sure about being unsure. Therefore, the suspicion of misalignment often develops over a number of interactional moves, finally reaching the point where we feel the effort of realignment is worthwhile.

This process of working within common assumptions, noting anomalies, seeking the smallest changes that can get us back on a track that seems to make sense, and sometimes reluctantly accepting the need for a more radical overhaul of our conceptual framework exactly fits the pattern Thomas Kuhn first described in *The Structure of Scientific Revolutions*—though on a much smaller scale. Each partner has their own tacit, informal theory of the conversational ground, and the interaction proceeds by growing and/or challenging the partners' theories. In our design conversations, our local renegotiation of meanings often ripples out to shift our design goals, directions, and fantasies, and in the most fruitful cases may pave the way to revolutions.

Repair

When we shift focus to improve alignment, we are working to repair the breakdown:

A; "*Bonjour*!" (start shift)

B; "Oh, *parlez-vous français?*" (start repair)

A; "No, but I grew up in Toronto and struggled with French for five years in high school."

B; "Oh, I see. (end repair) OK. (end shift) *Bonjour* to you too."

And, of course, shifts and repairs are themselves conversation. You and your conversational partner have to deal with them in exactly the same way as any other conversation—including the ones in which you encountered a breakdown. You have to use the same conversational mechanisms and practices. In tough cases, when implicit coordination breaks down, you have to hope your partner recognizes that you are shifting focus and talking about the talk, not about the weather. You have to make assumptions, monitor, adjust, and continue. You have to work to stay adequately aligned through this sub-conversation and to get back to the interrupted one.

Uncertainty

In talking about the conversation, you are using the same assume-act-monitor-adjust style of communicating as in any other conversation. And you get only circumstantial evidence that you are understanding what sense your partner is making of the whole thing.

When you work on terminology and meaning and philosophical frameworks, you may infer a lot about the alignment of your respective views. However, you cannot ever know for sure what sense your partner is making, nor how closely aligned that sense is to the sense you are making.

Aligned Enough

Fortunately, you don't need to know your partner's sense of the conversation precisely or certainly. You need only enough evidence to stay confident that your alignment can meet the needs of the conversation. Small talk about having a nice day will probably not require exploration of a partner's sense of the terms of meteorology. But discussion of a hurricane might.

INFORMATION THEORY

The work that defined information theory is Claude Shannon, A mathematical theory of communication, *Bell System Technical Journal 27* (1948), 379–423, 623–656. Since then, of course, it has become the foundation of entire disciplines.

COGNITIVE LINGUISTICS

Deirdre Wilson and Dan Sperber, Relevance theory, in *The Handbook of Pragmatics*, L.R. Horn and G. Ward (eds.), Wiley-Blackwell, Oxford, UK, 2004, 607–632; http://www.dan.sperber.fr/?p=93/.

EVOLUTIONARY LINGUISTICS

Luc Steels, Grounding symbols through evolutionary language games, in *Simulating the Evolution of Language*, A. Cangelosi and D. Parisi (eds.), Springer, New York, 2001.

GAME THEORY

Computational approximation of multi-agent game equilibria, such as Yoav Shoham and Kevin Leyton-Brown. *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*, Cambridge University Press, Cambridge, UK, 2009; http://www.masfoundations.org/download.html./

H. Peyton Y*oung, Individual Strategy and Social Structure: An Evolutionary Theory of Institutions*, Princeton University Press, Princeton, NJ, 1998. Analyzes convergence on consensus using game theory.

BREAKDOWNS

Analysis of breakdowns in interaction has many roots, including work by Heidegger, Garfinkle, Schegloff, Bodker, and others. For a review of "trouble and repair" in this context, see B. Jordan and A. Henderson, Interaction analysis: Foundations and practice, *The Journal of the Learning Sciences 4*, 1 (1995), 39-103.

SCIENTIFIC REVOLUTIONS

Kuhn's work catalyzed an entire field devoted to these issues. His original statement of the pattern was Thomas S. Kuhn, *The Structure of Scientific Revolutions,* University of Chicago Press, Chicago, 1962.

ADAPTIVE COMMUNICATIONS

This area is under very active development. The first comprehensive treatment was Peter D. Grünwald, *The Minimum Description Length Principle,* MIT Press, Cambridge, MA, 2007. However, research has progressed significantly beyond Grünwald's account.

Your understanding of the purpose of the conversation will tell you how much alignment is needed and how hard you need to work at achieving it. And of course your partner will have their own view of the conversational purpose and their willingness to invest in achieving alignment. Their view may be different. How different? Recursively, the answer is: however much each of you find sufficient for the purposes at hand.

Stability

As the conversation continues, confidence in sufficient alignment can build and be reinforced by the success of the preceding talk: The same term continues to be used in ways that continue to make the same sense; conversational moves do not lead to incompatible responses, and any breakdowns are easy to repair. Overall, a feeling of stable convergence can develop.

We may think of this as a "fixed point" of the conversational negotiational activity, in the mathematical sense that the ongoing conversation keeps converging on the same underlying understanding while continuing to add layers and details to that understanding.

Further, stability can accumulate. Each discussion means the assumptions for starting the next discussion can be better, convergence can be faster, and so forth. This is sometimes referred to as "having good bandwidth" with someone. Indeed, if our communication channel is fixed—for example, face-to-face conversation—we get greater effective bandwidth. Conversely, if we just want to convey a specific point, we can do it with less bandwidth. This metric has been partially formalized in some three-level accounts of adaptive communication.

As the background becomes stable, we are increasingly tempted to treat it as if it were frozen forever. This can make it difficult for us to "challenge the brief," to question and revise the context of our own designs. Great designs typically involve unfreezing and renegotiation of the background.

Codes and Negotiations

Fixed points in conversation remind us of classical information theory, which starts from the premise that communication always depends on a fixed "code" that defines the possible messages and the encoding of those messages in the channel. Information theory was inspired by the experience of building a national telephone network and has subsequently become the standard basis for designing machine-machine interactions.

In our view, this is an optimized case of collapsed negotiation-based conversation, with completely stable fixed points of conversational meaning. This raises two questions for us: Where did the codes come from, and how can codes change?

Where did the code come from? Information theory is concerned with optimizing communication efficiency in a static environment. As mentioned earlier, in conversations based on stable understandings, fixed points—the codes—can be frozen and sedimented.

How can codes change? In code-based communication there is no place for negotiation of the codes, so system-builders must negotiate outside the code itself to respond to misalignment. Such negotiation mechanisms need to be included in a full account of how codes work in the real world. That is where our "larger" perspective is required.

Consider HTML. A given version of HTML may be viewed as a classi-

cal information theoretic code, but in practice HTML is defined by an ecology of roughly compatible codes being generated and accepted by multiple (buggy) software packages, and furthermore constantly being renegotiated at higher levels by developers, standards bodies, and so forth. We have to consider multiple levels to understand the evolution or even the current status of HTML.

While our view is unusual in most parts of computer science, powerful conceptual tools are available to support it. It has been explored in different forms in cognitive linguistics and has been formally analyzed in various ways using game theory.

So both perspectives are necessary; they complete each other. Negotiated systems can gain efficiency from stability when it has emerged, and code-based systems need negotiation, so that they can be responsive to a diverse and changing world.

Change

Because conversation does not depend on preestablished agreements, and the mechanisms of monitoring and repair help us handle a partner's conversational moves that we can't understand, this conversational practice is also suitable for dealing with a changing world.

If a partner changes their mind about something—and that change is relevant to a discussion—the mechanisms for conversation have the capacity for detecting the mismatch from the conversational moves, shifting focus, negotiating adequate realignment, and resuming.

Agreement

We often say we "reach agreement" with others on some matter. We talk as if there is a view that we then all share (a "common ground"). In contrast, our view is that the idea of "reaching a shared view" is a linguistic gloss, shorthand for something much more complex and powerful. Agreement is not a single ground. Rather, it is a commitment to continue to work together to maintain coherence.

We would say the parties to an agreement interact with each other until they each can construct senses for themselves and for each other that are aligned enough, so they anticipate their subsequent individual actions will be coherent enough to achieve their goals.

A common failing of meetings is that participants engage in "collaborative misalignment"—working hard to get language that all can agree to but avoiding testing whether the inevitably disparate senses carried away will lead to collectively coherent action. Another failing is that on later encountering a world that was unanticipated during the meeting, individual action is based on personal understanding alone rather than on the personally aggregated sense of the disparate understandings of all.

Coherence, Responsiveness, and Scale

Finally, we see this perspective as strongly supporting the need for systems to both be responsive to many particular viewpoints and also to achieve coherence in activity, and to do so even as scale increases.

Consider scaling the achievement of conversational alignment over many people doing many things. Meanings, purposes, and negotiations are local, but because of overlapping alignments, they begin to cohere into a commonality that we think of as the meaning of language—again, at risk of reverting to the one level code perspective. We believe it is important to stay aware that this sense of commonality is a gloss for a vast dynamic network of local exchange and negotiation of meaning. Our systems must support both the efficient use of commonality and the renegotiation of meaning when the commonality is inadequate to the needs of participants.

Design

Unlike communications systems, people interact with each other without first agreeing on communication protocols. This is possible because they start and continue to act on the assumption that they understand enough to communicate—and then they interact. All the while they monitor and correct when things appear not to be working well enough for the purposes at hand.

As designers, conversations are at the center of our practice. Now we must challenge ourselves to design systems that accept and support users' conversations. Machines cannot yet negotiate alignment, but they can and should help their users carry on conversations, recognize breakdowns, and negotiate meanings to meet the needs of a heterogeneous and changing world.

ABOUT THE AUTHORS

Austin Henderson's 45-year career in HCI includes research, design, architecture, product development, and consulting at Lincoln Laboratory, BBN, Xerox (PARC and EuroPARC), Fitch, Apple, and Pitney Bowes. He focuses on technology in conversations in a rich and changing world.

Jed Harris started out exploring cultural anthropology, linguistics, philosophy of science, and artificial intelligence research, and then spent 40 years in research and development at SRI, Stanford, Xerox PARC, Data General, Intel, and Apple. He's now happily meshing technology with the human sciences.

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Making Time

"One morning, as Gregor Samsa was waking up from anxious dreams, he discovered that in his bed he had been transformed into a monstrous verminous bug."

Thus begins one of my favorite novels, *The Metamorphosis*, by Franz Kafka. What is most remarkable about Gregor's awakening, in which he discovers that he has metamorphosed into a dung beetle, is that, in the minutes that follow, his greatest concern is that he has missed his train.

Like Gregor, time and schedules have been on my mind of late. Why? Well, first, I overslept the other day. My phone is my alarm clock. Sadly, my phone had died quietly during the night. Ergo, no alarm to awaken me. Although I did not wake up a dung beetle, I was nevertheless disoriented. Second, about a week ago, I missed a meeting. Well, strictly speaking, I didn't miss it, because I didn't know I was supposed attend it. All I can surmise is that there had been a breakdown in the complicated network of services, applications, devices, and people that constitute the sociotechnical practice of time management called "calendaring." The meeting was clearly listed on my colleague's calendar, but not on mine.

So, given my recent horological mishaps, I have been ruminating on the concept of time and its management through calendars and alerts.

Calendars reckon past and/or future time. The primary purpose of the calendar is to orient our bodies and minds—and those of others—in time and space. In contrast to the fluidity of experienced time, calendars create boundaries between activities. They prescribe the amount of time we should spend on something: 30 minutes with Jane talking about her project, an hour for the budget meeting, an hour giving a lecture on HTML-5, 30 minutes on a mandated management course...and of course, finally, a day of rest.

To be effective social coordinators, calendars require that we share an idea of how time is structured and named—if we are going to meet for dinner at 8PM, we should share an idea of exactly when 8PM is. We should also share a sense of how time breaks down quantitatively. My minute and yours should both be 60 seconds. However, as we all know, clock time and experienced time can be quite disjointed. Clock time passes at the same rate quantitatively for you as it does for me, but qualitatively/phenomenologically the hours may be rushing by for me, while you feel stuck in slow-motion, like you are swimming in treacle. Boredom, disengagement, and impatience expand the experience of elapsed time while engagement, focus, and immersion compress it. Per the old adage, a watched pot never boils.

Calendars don't just keep individuals synchronized. Calendars, as scholars like sociologist Emile Durkheim tell us, are central to societal order. Calendars are the sentinels of "appropriate" behavior. Minutes and days and hours often have activities associated with them—indications of when we *should* work, rest, pray, and play. Different social values are placed on different hours of the day and on days of the week; in many calendars, Saturdays and Sundays have less space, reflecting social norms that separate workdays from (non-work) weekend days. Routine, calendared time is central to creating a sense of belonging. In a 2006 article, Tim Edensor argues structured time in the form of everyday rhythms—which he breaks down into institutionalized schedules, habitual routines, collective synchronicities, and serialized time spaces—are how a sense of national identity and belonging is sustained. One can see this play out in my neighborhood, home to many different immigrant cultures. What is considered an appropriate time for dinner differs by several hours: between 6PM and 7PM for some, between 9PM and 10PM for others.

I suspect most of us take for granted the idea that we have a shared concept of time. However, the carving up of time into seconds, minutes, hours, days, months, and years is a convention. The familiar structure of the predominant Western calendar—the Gregorian calendar introduced in 1582—differs from classical calendars like the Mayan, Aztec, and Inca, and the more recent Julian calendar [1]. Notably, Russia and Greece converted to the Gregorian calendar

from the Julian calendar only in the 20th century. Further, it has not always been the case that someone in Bangalore could so easily work out what time it is for me in San Francisco. It was only in the 1880s that a uniform time was imposed in Britain; until then, time there varied according to location. Local time stood in contrast to "London time" (such as Greenwich Mean Time or GMT); Oxford was five minutes behind London, while Plymouth was 20 minutes behind London [2].

In his book *The Culture of Time and Space 1880-1918*, Stephen Kern writes of the railroads in the U.S.: "Around 1870 if a traveler from Washington to San Francisco set his watch in every town he passed through, he would set it over 200 times." The railroads instituted uniform time on November 18, 1883. In 1884 Greenwich was established to be the zero meridian, with 24 time zones one hour apart. Countries signed up to this structuring of time one by one: Japan in 1888, Belgium and Holland in 1892, and Germany, Austria-Hungary, and Italy in 1893.

At the International Conference on Time in 1912, the telegraph was proposed to be the method of maintaining accurate time signals and transmitting them around the world. This process was inaugurated on July 1, 1913, at 10AM. Astronomical readings were sent to the Eiffel Tower from where they were relayed to eight stations spaced over the globe. Global time was born, the death knell rang for the quaint custom of local time. We can thus trace our globally shared personal and corporate calendars back to the railroads and their push for the rationalization of time. It's quite fitting, therefore, that missing the train and, as a result, being late for work is foremost in Gregor's mind when he wakes up.

Calendars have ecclesiastical origins; the Book of Hours structured time into routines for work and worship for monks in the Benedictine order. However, in sharp contrast to the quiet, stable regularity of the liturgical life, my calendar is a chaotic beast in constant need of maintenance and management. Meetings pop on and off like jumping beans as the hoping-to-be-assembled try to find a time that works for all concerned. Vigilance is required lest one is triply booked, and priorities are always being calculated: *Is this meeting more important than that one, but if so-and-so is there, then that is a good opportunity to get things moving forward…. Oh no, now they're not going to be there after all and yet I'm committed to going, how do I shift this around…* and on and on.

The root of the problem lies in the multiples—multiple calendars and multiple people on one calendar. For the first point, I have too many calendars, and the effective synchronization of my calendars is not a solved problem. Ghost (long departed/deleted) meetings haunt the calendar on my computer, while my mobile phone presents a suspiciously clean blank slate. Sometimes there is little correlation between the two, despite their notionally being jacked in to the same server. For the second point, shared calendars (such a good idea in principle) are a gargantuan, rogue elephant. Herein lie clashes in culture, herein lie power relationships, and herein lie a network of complex dependencies. Routine issues arise for me in the following forms: blank space on the calendar, the curse of durational rigidity, the clash between sociotemporal and biotemporal time, and the problem of travel time. Let's briefly review each of these.

"Idle" time. People routinely look at my calendar to determine when I am free to meet; they plop meetings on my calendar based on what they see as "free'" time. This is based on a fallacious assumption—that if nothing is recorded there, then I am free. It's a misreading of my practice of calendar use: Booked times on my calendar are not simply islands of color in a collaborative paint-by-numbers schematic where the blanks are inviting others to fill them.

Of course, idle time is anathema to the shared calendar in a culture where to be not actively *doing* could possibly be interpreted as shirking. In my view, days of back-to-back meetings means there is too little time for creative thought or for reflection. Research indicates that times when one is doing the least—for example, when meditating—are often the most creative [3]. The jammed calendar, continual context-switching, and mad dashes from one location to another are emotionally draining, mania inducing, and counter to creativity.

So I sometimes put "meetings" onto my calendar to simply block out some thinking time. I feel sheepish about this. I am reminded of a friend of mine, who, when we were teenagers, used to write things like "peas and carrots for tea" in her journal. Recording peas and carrots was not because of some dietary obsession; they stood in as code for "held hands and kissed," a recording of her encounters with her boyfriend. The code was invented lest her mother should read her journal and be mortified by her teenage explorations. So it is that I transform thinking, writing, and reading into "Strategy" and "Planning," appropriate behaviors

for a corporate context. Durkheim and followers are correct: How one manages one's time is an issue of morality and social accountability, not just temporal coordination. It's a tricky business.

Durational rigidity. For the operationally minded, a meeting that is scheduled for an hour must last an hour, even when nothing is being achieved. On the other side of that, sometimes one can just be warming up, just getting to the crux of a problem and the hour is up. The meeting ends, truncating the creative process.

Travel time. Another problem, and one in which a simple technical solution would help, is travel time between locations. When one works in several different office buildings that are miles apart, it takes time to get from one to the other. It would be useful if I could hook my calendar up to these locations and have travel time automatically calculated and reflected. So if a meeting were dropped onto my calendar, travel time would automatically be blocked in—in fact, I could imagine a lot of background calculating that could be done by hooking my calendar up to location and to my social services and applications [4].

Biotemporal time. Working across time zones can be really hard. The cheerful calendar flattens time, sees all times as equal. Calendars are simply tabulated time in a grid; they do not reflect lived time. Odd times for calls can sneak in there, creating social and personal dilemmas: *I want to be a good citizen, but I know I am going to be less than my best at that time.* Sociotemporal time (as in, when it is appropriate to be working and when not) clashes here with biotemporal time. Being on a conference call when your body and your entire environment tell you that you should be sleeping is simply difficult. Time may be global, but my body is not.

None of my observations is earth-shatteringly novel. There has been a wealth of research in the HCI community, stretching back to the early 1980s, on calendaring—in collocated and in distributed work goups, in the home, in leisure groups, within families, between families, on paper, on personal computers, using mobiles, using location services—but there's still plenty we can do in the world of sociotechnical design to rethink the calendar.

"We shape our dwellings and afterward our dwellings shape us," said Winston Churchill in 1943. We could apply this observation to time; we shaped the calendar and now the calendar shapes us, dictating how we (should) live. True to Louis Sullivan's adage, form follows function. The digital calendar wears its assumptions and its intellectual heritage on its sleeve: computer science, psychology, information architecture, and the ethical structure of the approved-of day. Perhaps we need a new tack.

In Branko Lukic's and Barry Katz's 2011 text, *Nonobject*, they explore product designs that sit at the interstices of philosophy and technology. They step back from simplistic notions of form and function to shake up how we think about products, to question what is "normal" or taken for granted, and to question the values that are embedded within the typical form of everyday artifacts. In a section entitled "Overclocked," they take on clocks and watches, our timekeepers. Katz writes, "As our measuring devices grow ever more accurate, we find ourselves perpetually 'overclocked,' to use a term familiar to every computer hacker who has racheted up a component to run at a higher clock speed than it was intended for in order to coax higher performance out of a system. We do the same to ourselves." A number of designs are presented: the Tick-Tock Inner Clock that taps against the skin to let someone feel the passage of time and the Clock Book, where time is laid out on pages we can turn—when we want to. Lukic's watches and clocks invite us to rethink how we conceptualize, represent, and manage time.

Let's do the same thing with calendars. Let's take a step back. Let's follow Lukic and take our lead from Architectura Da Carta, the Italian tradition of articulating and illustrating the unlikely, the unbuilt, and the unbuildable. Let's use art, philosophy, and technological creativity to envision a better aesthetic experience, to blast the calendar apart and rebuild it; let's be better about enabling the plurality of private and public times that humans live in parallel; let's automate the calculation of time in motion between location(s); let's build in time for creativity and reflection as social and moral imperatives; let's make a calendar that adapts your schedule when it realizes you have woken up having metamorphosed into a sentient dung beetle.

ENDOTES

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SIGCHI: The State of the Society

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ACM's Special Interest Group on Computer-Human Interaction (SIGCHI) elects its executive committee (EC) every three years (currently: Elizabeth Churchill, Loren Terveen, Gary Olson, John Thomas, Paula Kotzé, Fred Sampson, and myself). The EC is rounded out by the editors-in-chief of *interactions* Magazine (Ron Wakkary and Erik Stolterman), the past president (Julie Jacko), the chair of the Publications Board (Dan Olsen), and ACM HQ staff members (Fran Spinola and Ashley Cozzi).

Most of the readers of *interactions* are members of SIGCHI, so it makes sense to keep you posted on what your EC is doing. I intend to make this happen on a regular basis. The most visible products of SIGCHI are conferences, publications, and the website. In fact, *interactions* is one of those products; the overlap of authors and readers with SIGCHI is strong thanks to a close relationship between the EICs and SIGCHI.

The conferences, both CHI and the specialized ones, require many resources from the EC. To that end, we appoint a vice president for conferences (currently Scooter Morris) and an adjunct chair for specialized conferences (Philippe Palanque). Scooter works with a site-selection group to identify locations for the future CHI conferences, and Philippe works with his group to support sponsored and in-cooperation conferences (annually, there are more than 20 of these, most of which are in long-term relationship with SIGCHI). And there is a conference-management committee that develops policies and tools for long-term support of our conferences through the reviewing process, publication of proceedings, budget development, and advertising. This committee also tracks trends and uses feedback from SIGCHI members to improve conferences over time.

SIGCHI is an international society, and we are working to become more so. A vice president for chapters (Tuomo Kujala), a representative (John Karat) to the International Federation for Information Processing (IFIP), and an adjunct chair for the developing world (Zhengjie Liu) all help to assist our overseas efforts. Tuomo is supporting our large group of local chapters across the globe, and Zhengjie and John are currently focusing on Southeast Asia, for which we held a workshop at the end of March to gather information on the coordination, support, and development of the local HCI community and related activities. At this workshop we met with key members of local groups from 14 countries and explored structural collaboration. And, of course, we have plans for other parts of the globe as well.

Investing in students is crucial to our future. Again, we found a volunteer to take up the post of adjunct chair for education (Jenny Preece). Working with Elizabeth Churchill (vice president), Jenny is starting a program to improve our understanding of HCI education worldwide. The aims of this program are to learn from the diverse programs that exist and to support improvement and development wherever needed. We also support students, not only with low membership fees and special chapters, but also with highly reduced conference fees, student volunteer programs, and the student-design and student-research competitions at CHI.

SIGCHI maintains a set of awards that are presented annually at the CHI conference (see http://www.sigchi.org/about/awards). In addition, the SIGCHI Awards Committee has begun to nominate leading members of the HCI field for appropriate ACM awards. These efforts already have borne fruit: For example, Gregory Abowd was the recipient of the 2009 ACM Lawler Humanitarian Award and a number of members of the HCI field have been named ACM Fellows.

About 2,000 readers of interactions *will be at CHI this year in Vancouver (chi2011.org, May 7–12), where you'll have an opportunity to participate in our Town Hall Meeting. In the meantime, we welcome your feedback and are open to proposals for activities or initiatives.*

— Gerrit C. van der Veer,
President, ACM SIGCHI

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Human-Centered Interaction Design Lab (HCIDL), KAIST, Department of Industrial Design

http://hcidl.kaist.ac.kr

How do you describe your lab to visitors? The Human-Centered Interaction Design Lab (HCIDL) is a leading Korean institution that focuses on planning and developing human-centered interactions using in-depth research to tackle physical, cognitive, emotional, and socio-cultural aspects of the human being. The lab is embedded in the Department of Industrial Design at KAIST, one of the most prestigious design schools in Korea and among the top 30 design programs worldwide, as selected by *BusinessWeek*.

What is a unique feature of your lab? Our lab has substantially contributed to the development of design research and design knowledge in Korea. The laboratory's activities began with the implementation of simple usability testing aimed at minor improvements and moved on to innovation in the design of a comprehensive user experience. Thus, our core competences have focused on design planning, human-centered interaction design, designing with mass-collaboration, emotional design, experience design, service design, and cross-cultural comparative studies that reflect the user's socio-cultural characteristics.

Since its foundation, our lab has focused on user studies that enable designers to access and apply a user's latent needs to design, while maintaining a structured design process. We have developed diverse design tools and customized software solutions—such as remote usability testing, mouse tracking, and wearable cameras—that have been integral to our user studies. These simple prototypical tools have led to various original methods, such as "Wish Prototyping," and "Pocket Stories," which helped us understand users in deeper ways.

Our laboratory is equipped with state-of-the-art facilities, including a usability testing room, gaze analyzers, and a portable ethnographic tool kit for user observations. Current research includes the exploration of new techniques that complement or go beyond conventional user-centered design.

How many people are in the lab, and what is the mix of backgrounds and roles? At present, our laboratory is made up of six full-time Ph.D. candidates and two master's degree students. In addition, there are five part-time Ph.D. candidates, who are active university professors. Most of our lab members have a background in industrial design. Some also have experience in other domains such as industrial engineering, graphic design, or architecture. Those different specialties have proven to be helpful during theoretical

Recent Projects

Analyzing the Relationship of Content Use and Communication Activity to inform the User Experience Design of ICT Devices (Research Partner: Samsung Electronics)

ICT devices enable the access of large amount of contents and utilize various ways of communication with other devices. The goal of this project was to develop models of communication activities and user interactions with digital contents that would result in UI guidelines for the design of ICT devices. This research helped to understand how users deal with contents, communicate with other users, and how both activities relate to each other.

Unified User Experience of Home Appliances (Research Partner: LG Electronics)

Companies have made recent attempts to unify user experiences of products to pursue consistent brand identities in a large scale; in turn our laboratory has explored the essential user experiences of LG Electronics home appliances and conducted a six month longitudinal user research with a group of housekeepers. As a result, we have delivered a theoretical model of brand experience and a practical design guideline for home appliances, through which we enabled in-house designers to uphold the identity of LG products and unify their product experiences. Not only graphic and product designers, but also interaction designers can reference this guideline.

User Manipulation of Deformable Displays as Input Devices (Research Partner: Korean Government)

This study aimed at understanding deformation-based user gestures by observing users interacting with artificial deformable displays with various levels of flexibility. We collected user-defined gestures that would help with the design and implementation of deformation-based interfaces, without considering current technical limitations. We found when a display material gives more freedom from deformation, the level of consensus of gestures among the users as well as the intuitiveness and preferences were all enhanced. This study offers implications for deformation-based interaction, which will be helpful for both designers and engineers who are trying to set the direction for future interface and technology development. *(Published in CHI 2010 Proceedings)*

inquiries and practical project works, as they widen the scope of research. Our laboratory is especially proud of its cultural diversity represented through our Korean, German, Canadian, and Chinese colleagues. This cultural blend reflects our research activities, since the understanding of various cultures is essential to our studies. Our international profile is rounded out by visiting scholars from France, the Netherlands, Germany, as well as Japan, Malaysia, and India, who frequent our lab to exchange knowledge.

Professor Kun-Pyo Lee, our lab director, serves various positions including secretary general for the International Association of Societies of Design Research, fellow of the Design Research Society, and an editorial board member for *Design Studies* and the *International Journal of Design*. Currently, he is also the executive vice president of LG Electronics where he is responsible for all of the company's design around the world. He brings design methods and thinking from the academic area to the real world.

Briefly describe a day in the life of your lab. A working day in our lab usually starts with an informal meeting at 9AM. We have a joint breakfast, in which we share important lab matters and plans for research. After this meeting, we proceed with collaborative industry projects that involve working with companies such as LG Electronics, Samsung Electronics, or Volkswagen. We usually dedicate our time to these projects until late afternoon. Team work is emphasized in every phase of the design research process by ensuring that all members are assigned to productive roles. Moreover, we seek a close relationship with our industry partners, who regularly join us during work meetings. Although lab-based team efforts, as such, account for most of our activities, we also strive to balance our schedule to find time for individual work that focuses on personal thesis research. Thus, in the afternoon and evening, students have the possibility to discuss their studies with their colleagues and professor to get valuable feedback.

What is one feature of your lab you could not do without? Stickiness. Social gatherings and familiy-like organizational structures ensure the strong bond among lab colleagues. Ph.D. candidates are assigned to advise the master's students.

What is one feature of your lab that you want and don't have? A feature we strive for would be a robust and explicit knowledge-base that extends across the 20 years of our practical research. As we are one of the leading laboratories in Korea, which conduct user experience research, we have developed many methods and tools for understanding users. Yet, many of those only exist in the form of the lab members' episodic knowledge. Lack of time makes it difficult to explicate, organize, and merge that knowledge. Currently we are developing the "HCIDL Wiki" website, a "Wikipedia" for UX research. We also have plans to publish books making it possible to share our full knowledge with other researchers.

How would you describe the interaction in your lab? The interaction among our lab members is essentially determined by the given physical space. Our laboratory consists of two rooms: one is a large shared space that is much more flexible and open, and therefore ideal for group interactions and meetings; the other room provides more secluded spaces for personal in-depth research and allows for privacy.

The large shared space ensures vivid interactions among the students by accommodating breakfast meetings and casual gatherings, where we share research plans as well as official lab seminars to present and critique research progresses. Moreover, due to its open atmosphere, the large room also serves as a forum for students from other laboratories and departments as they frequently visit HCIDL to share opinions and insights. Since our department of industrial design belongs to the engineering school at KAIST, we often collaborate with other engineering laboratories. Currently we are conducting a project for designing and developing organic user interfaces with the department of computer science and electrical engineering. In this project, we develop user-defined gesture sets for a new interface prototype that the other labs have created.

On the other hand, the smaller private spaces allow students to "get things done efficiently" by allowing them to focus on defined tasks and individual styles of problem-solving, and to "dive deep into a problem" by offering them a comfortable space of their own to think without disturbances.

In addition to the physical space, all lab members interact with each other in the virtual space of the Internet. Currently, our laboratory utilizes smart phones for real-time communication through social-networking services. This significantly contributes to the interaction between lab members inside and outside of the lab.

Finally, in terms of interaction between doctoral and master course students, we have a mentoring system, in which each doctoral student is assigned to advise and guide a master's student regarding her/his thesis research. Mentors support the students not only in their research but in everyday lab life.

What is the one thing you see as the most important about what you do here? Among many other types of research, the development and the testing of tools and methods is one of our key areas. Ultimately, we aim to humanize interaction design methodologies. We strive for innovation of user research methods by focusing on more natural ways to interact and communicate with devices, exploring how users in the design process may contribute with their creativity, and modeling a theoretical background for the communication between users and designers.

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May 2011:

Design Action, Leadership, and the Future (Brisbane, Australia)

Conference date:
July 22-24

Expressions of interest due:
May 6

Contact: m.conron@griffith.edu.au

CHI 2011: The ACM CHI Conference on Human Factors in Computing Systems (Vancouver)

Conference date:
May 7-12

http://www.chi2011.org/

ISMAR 2011: The 10th IEEE International Symposium on Mixed and Augmented Reality (Basel, Switzerland)

Abstracts due:
May 11

Conference date:
October 26-29

http://www.ismar11.org/

4T: Design, Technology and Experience (Izmir, Turkey)

Conference date:
May 12-13

http://ekotam.ieu.edu.tr/4t/index.php/

DESIRE '11: Creativity and Innovation in Design (Eindhoven, the Netherlands)

Long and short papers due:
May 17

Conference date:
October 19-21

www.desire11.id.tue.nl/

Workshop 07 CHCI&ID: International Workshop on Collaboration, Human-Centered Issues and Interactivity Design as part of CTS 2011 (Philadelphia, PA)

Conference date:
May 23-27

http://cts2011.cisedu.info/2-conference/workshops/workshop-07--thumi/

HCIL's 28th Annual Human-Computer Interaction Lab Symposium

Conference date:
May 25-26

http://www.cs.umd.edu/hcil/soh/

June 2011:

Imagining Imagination (London)

Conference date:
June 10-11, 2011

Contact: michael.schwab@rca.ac.uk

EICS 2011: ACM SIGCHI Symposium on Engineering Interactive Computing Systems (Pisa, Italy)

Conference date:
June 13-16

http://eics-conference.org/2011/

DPPI '11: The Fifth Conference on Designing Pleasurable Products and Interfaces (Milan)

Conference date:
June 22-25

http://www.dppi11.polimi.it/

Ethnographic Fiction and Speculative Design Workshop as part of C&T 2011 (Brisbane, Australia)

Workshop date:
June 30

http://www.designculturelab.org/ethnographic-fiction-speculative-design-workshop-cfp/

July 2011:

HCI 2011: Health, Wealth and Happiness (Newcastle Upon Tyne, UK)

Conference date:
July 4-8

http://www.hci2011.co.uk/

PLM11: The Eight International Conference on Product Lifecycle Management (Eindhoven, the Netherlands)

Conference date:
July 11-13

http://www.plm-conference.org/

WMSCI 2011: The 15th World Multi-Conference on Systemics, Cybernetics, and Informatics (Orlando, FLA)

Conference date:
July 19-22

http://www.iiis2011.org/wmsci/

August 2011:

ICOHTEC 2011: The International Committee for the History of Technology's 38th Symposium (Glasgow, UK)

Conference date:
August 2-7

http://www.icohtec.org/annual-meeting-current.html

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IHI 2011 – CALL FOR PAPERS

2nd ACM SIGHIT International Health Informatics Symposium

November 9-11, 2011 Miami, Florida

http://sites.google.com/site/web2011ihi/
(mirror: http://www.comp.hkbu.edu.hk/ihi2011/)

IHI 2011 is the main conference of the newly formed ACM Special Interest Group on Health Informatics (SIGHIT). It is ACM's premier community forum concerned with the application of computer science principles, information science principles, information technology, and communication technology to address problems in healthcare, public health, and everyday wellness. The conference highlights the most novel technical contributions in computing-oriented health informatics and the related social and ethical implications.

IHI 2011 serves as a venue for the discussion of technical contributions highlighting end-to-end applications, systems, and technologies, even if available only in prototype form. We strongly encourage authors to submit their original contributions describing their algorithmic contributions, methodological contributions, and well-founded conjectures based on an application-oriented context.

Contributions in the realm of social and behavioral issues might include empirical studies of health-related information use and needs, socio-technical studies on the implementation and use of health information technology, studies on health informatics in the context of community impact and implications, studies on public policies on leveraging health informatics infrastructure, among others.

Specific topics of interest for this conference cover various facets of health informatics research, including but not limited to the following:

- Information technologies for healthcare delivery and management
- Health data acquisition, management, and visualization
- Healthcare knowledge management and decision support
- Healthcare modeling and simulation
- Data analytics, data mining, and machine learning
- Health information system engineering
- Health information systems
- Healthcare communication networks and environments
- Interactions with health information technologies

IMPORTANT DATES

May 23, 2011	Abstract submission
May 30, 2011	Paper/demo/panel proposal/tutorial proposal submission
August 1, 2011	Paper/demo/panel proposal/tutorial proposal acceptance notification
August 8, 2011	Non-refereed extended abstract submission
August 15, 2011	Non-refereed extended abstract acceptance notification

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Fei Wang, IBM Almaden Research Center
Qiang Shawn Cheng, Southern Illinois University Carbondale
Pierangelo Veltri, University Magna Graecia of Catanzaro, Italy

The UX Factor

"Even when customers love your product the way it is, user experience researchers are always thinking about what's next."

–Frances Karandy, *Bentley, MBA, MSHFID, Lead User Experience Researcher, eBay, Inc.*

With her background in design and her interest in business, Frances Karandy considered Bentley's MSHFID program ideal preparation for the emerging field of user experience design. Here she answers questions about her role as a user experience researcher and the program that launched her career.

Why is the "user experience" so important to today's e-commerce companies? Online commerce is mainstream and becoming increasingly competitive. Hundreds of thousands of e-commerce transactions and communication exchanges take place every day online. We need to constantly adapt to changing customer needs—the competition is only a click away.

Where in the product development cycle does user experience research come into play? Ideally, right from the start. User experience research can inform everything from strategic marketing and positioning to product design and development. Helping teams build better products and services requires a deep understanding and anticipation of customer needs—that's the role of research.

Why did you choose Bentley? I was interested in consumer behavior and how businesses could become more profitable by designing products and services that customers love to use. Bentley's integration of business and information design was exactly what I was looking for. The Bentley Design and Usability Center puts you right into the professional lab environment, you have access to all the marketing tools and resources used by today's companies, and you're taught by some of the pioneers in the field.

Bottom line: a good career move? From the case study methods and internships to the usability facilities and external client projects, I felt well prepared to hit the ground running at some of the top companies in Silicon Valley.

To learn more about the MSHFID or to register for our online information session, visit graduate.bentley.edu/ms/hfid or contact Program Director Dr. Bill Gribbons at 781.891.2926.

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