Beyond Interaction: Meta-Design and Cultures of Participation

Gerhard Fischer
Center for LifeLong Learning & Design (L3D)
Department of Computer Science and Institute of Cognitive Science
University of Colorado, Boulder, CO
gerhard@colorado.edu

ABSTRACT
Most interesting, important, and pressing problems facing societies in the 21st century transcend the unaided individual human mind. They require collaborative systems to explore, frame, solve, and assess their solutions. *Cultures of participation* represent foundations for the next generation of collaborative systems by supporting all stakeholders to participate actively in personally meaningful problems. *Meta-design* supports cultures of participation by defining and creating social and technical infrastructures in which users can choose to become designers. These developments create *new discourses* in human-computer interaction (HCI), complementing and transcending current approaches centered on interaction.

This article illustrates these objectives and themes with specific examples and articulates their relevance for the OzCHI conference theme "Design, Culture and Interaction".

Author Keywords
cultures of participation, meta-design, richer ecologies of participation, new discourses in HCI

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

THE FUTURE OF HCI: LOOKING AT EXTENDED TIME FRAMES

In an article published more than 25 years ago, Newell and Card [Newell & Card, 1985] differentiated types of human-computer interaction (see Table 1) by grouping actions, memory requirements, and theories in different time frames.

Whereas early research in HCI was primarily concerned with actions of a short duration, this article analyzes and discusses HCI developments related to the domain of system development, education, and cultures. Usability objectives have a significant role to play at the right time and in the right contexts [Greenberg & Buxton, 2008], but if HCI focuses solely on usability concerns, it will miss such relevant issues as how cultures change under the influence of new media.

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CULTURES AND MEDIA

Cultures are defined in part by their media and their tools for thinking, working, learning, and collaborating. Figure 1 qualitatively illustrates some major culture changes that have taken place in the past.

There is little doubt that the major culture change was the invention of reading and writing, which transformed our societies from oral into literal societies [Ong, 1982]. One of the interesting questions to explore will be whether the change from print to digital cultures and from consumer cultures to cultures of participation [Fischer, 2011; Jenkins, 2009] will cause similar transformative changes in the years to come.

As these transformations will occur in the future, we have to ask ourselves whether they will be *desirable* (e.g., by further increasing the power of the collective human mind aided by technology) and what possible *drawbacks* there might be. Looking back to the invention of reading and writing: Socrates in his time feared that people would rely on the written word as a substitute for the knowledge they used to carry inside their heads, and they would then stop exercising their memories. By writing down ideas and arguments in books and distributing them, Socrates assumed that people would stop being directly responsible and accountable for what they would say, as had been the case merely by being physically present in oral societies. The concerns of Socrates were not wrong—but looking back at the last few millennia, our societies could not be what they are today without reading and writing.

Complementing Consumer Cultures with Cultures of Participation

In the past, the design of most media emphasized a clear distinction between producers and consumers [Benkler, 2006]. Television is the medium that most obviously exhibits this orientation; it has contributed to the degeneration of humans into *"couch potatoes"* [Fischer, 2002] 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 a mindset in students of "consumerism" rather than "ownership of problems" for the rest of their lives [Illich, 1971]. As a result, learners, workers, citizens, and software users often feel left out of decisions made by teachers, managers, policymakers, and software developers, thus denying them opportunities to take active roles.

Time		Action	Memory	Theory
(sec)	(common units)			
10^9	(decades)	Technology	Culture	Social and Organizational
10^8	(years)	System	Development	
10^7	(months)	Design	Education	
10^6	(weeks)	Task	Education	
10^5	(days)	Task	Skill	Bounded Rationality
10^4	(hours)	Task	Skill	
10^3	(ten mins)	Task	LTM	
10^2	(minutes)	Task	LTM	
10	(ten secs)	Unit task	LTM	Psychological
1	(secs)	Operator	STM	
10^{-1}	(tenths)	Cycle time	Buffers	
10^{-2}	(centisecs)	Signal	Integration	Neural and Biochemical
10^{-3}	(millisecs)	Pulse	Summation	

Table 1: Different Time Frames in HCI

Cultures of participation emphasize the "unfinished" and take into account that design problems have no stopping rule and need to remain open and fluid to accommodate ongoing change. They can complement guidelines, rules, and procedures with exceptions, negotiations, and workarounds by integrating existing accredited and expert knowledge with informal, practice-based, and situated knowledge [Suchman, 1987; Winograd & Flores, 1986].

Emergence of Cultures of Participation in Numerous Application Domains. Table 2 provides an overview of a sample of environments created by cultures of participation with unique features. These developments are no isolated phenomena: a recent study has shown that more than one-half of all teens have created media content, and roughly one-third of the teens who use the Internet have shared content they produced [Jenkins, 2009].

Characteristics of Cultures of Participation. In a culture of participation, everyone has the opportunity to be actively involved, make contributions, act as a decision maker, and share her/his creations with others. YouTube represents a simple example for illustration: with support environments to create movies, upload them into a shared environment and the use of search mechanisms, everyone with a computer and access to the Internet can create and share movies, which only a few could do just a few years ago. This does not mean that YouTube will eliminate Hollywood; it merely represents a socio-technical environment with different objectives (e.g., Hollywood is

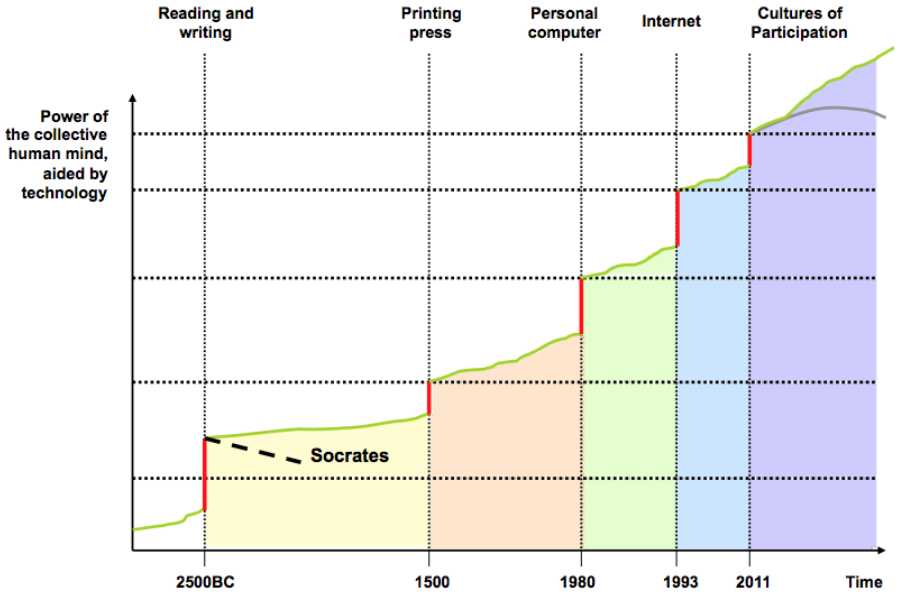

Figure 1: Major Cultures Changes Caused by New Media and New Technologies

(the scales are not linear)

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

Table 2: Environments Created by Cultures of Participation with Unique Features

not interested in producing a movie of someone's children playing at the beach that friends and grandparents in different parts of the world can watch). Cultures of participation are not just modifying past practices—they are inventing and shaping many human activities and behaviors in fundamentally new ways. They have the potential to diversify cultural expression and increase creativity [Fischer, 2005], they can lead to a more empowered conception of citizenship [Shneiderman, 2009], they change attitudes toward intellectual property [Lessig, 2008], and they create opportunities for peer-to-peer learning [Gorman & Fischer, 2009].

Problems Addressed by Cultures of Participation. The 21st century brings with it a large collection of problems and challenges: environmental degradation, energy sustainability, economic disparity, and the disappearance of local cultures in the age of globalization, to name just a few. Can "ordinary" people do more about addressing these problems than reading about them in newspapers? Is voting for a handful of candidates every few years the ultimate in public participation?

Cultures of participation offer important and interesting possibilities to cope with the major problems societies are facing today, including:

- problems of a magnitude that individuals and even large teams cannot solve (e.g., to model all buildings in the world in 3D, as addressed by Google SketchUp and 3D Warehouse, as mentioned in Table 2);
- 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, discussed later in a separate section);
- problems being poorly understood and ill-defined and therefore requiring the involvement of the owners of these problems because they cannot be delegated to others (e.g., software design problems as tackled by end-users);
- problems in modeling changing and unique worlds being dependent on open, living information repositories and modifiable tools (a fundamental aspect of all design problems).

Cultures of participation are facilitated and supported by a variety of different technological environments. Examples include the participatory Web (Web 2.0) [O'Reilly, 2006]; domain-oriented design environments [Fischer, 1994]; and tabletop computing [Arias et al., 2001])—all contributing in different ways to the aims of engaging diverse audiences, enhancing creativity, sharing information, and fostering collaboration among users acting as active contributors and designers. Cultures of participation democratize design and innovation [von Hippel, 2005] by shifting power and control toward users, supporting them to act as both designers and consumers ("prosumers") [Tapscott & Williams, 2006], and allowing systems to be evolved through use.

Understanding and Supporting the Diversity Underlying Cultures of Participation

The "average" user does not exist in cultures of participation [Nielsen, 2006]. For cultures of participation to become viable and be successful, it is critical that a sufficient number of participants take on more active and more demanding roles, such as those of contributors, collaborators, designers, and meta-designers [Porter, 2008; Preece & Shneiderman, 2009]. Research is needed to explore a richer ecology of participation that supports multiple roles, to develop tools and environments for each role, and to motivate and reward participants to migrate to more demanding roles. Table 3 illustrates different roles in the domain of energy sustainability [Dick et al., 2011].

Value and Effort as Determining Factors for Participation

Highly motivated and creative owners of problems struggle and learn tools that are useful to them in personally meaningful problems, rather than believing in the alternative of "ease-of-use," which limits them to preprogrammed features [National-Research-Council, 2003].

Participation is often determined by an individual's assessment of the complex interdependencies between *(perceived) value* and *(perceived) effort*. A consequence of establishing a richer ecology of participation is that effort and value vary greatly among the different levels of participation (see Table 3).

Value considerations are greatly influenced by allowing people to engage in personally meaningful tasks, which can persuade and motivate them to engage in serious working and learning. People are willing to spend considerable effort on things that are important to them. For example, learning to drive an automobile is not an easy task, but almost all people learn it because they associate it with a high personal value. Likewise, participating in an environment such as PatientsLikeMe (see Table 2), in which the community members exchange information and discuss experiences related to disease, provides a substantially larger value for those people who are personally affected by that disease (or for people close to them).

Some techniques to reduce the *effort* are: (1) making it easier to contribute (e.g., clicking an icon in a rating environment); (2) deriving participation information as a side-effect (e.g., Amazon's recommendation "people who bought this book also bought these books"); and (3) developing rich seeds that allow participants to edit and evolve existing information rather than creating information from scratch.

META-DESIGN: A FRAMEWORK IN SUPPORT OF CULTURES OF PARTICIPATION

Design is a fundamental aspect of many important human activities, as argued convincingly by Simon [Simon, 1996] with this statement: *"everyone designs who devises courses of action aimed at changing existing situations into preferred ones"*. Design is a generic activity with characteristic properties, such as: (1) each design problem is unique, ill-defined, and wicked [Rittel, 1984]; (2) design problems require the integration of problem framing and problem solving [Schön, 1983]; and (3) design problems have no right or wrong solutions, making satisficing a more realistic objective than optimizing [Simon, 1996].

Design Methodologies. HCI has made progress by developing and supporting different design methodologies related to the different time frames described in Table 1. In *professionally dominated design*, users have no voice and have to live with artifacts designed by others. One major initial contribution of HCI to address the limitations of professionally dominated design was *user-centered design* [Norman & Draper, 1986]. Another step forward was *participatory design* [Schuler & Namioka, 1993], which involved users more deeply in the process as co-designers by empowering them to propose and generate design alternatives themselves. Participatory design supports diverse ways of thinking, planning, and acting by making work, technologies, and social institutions more responsive to human needs. It actually *requires* social inclusion and active participation of the users. Participatory design has focused on system development at design time by bringing

	The Unaware	Aware Consumers	Collaborators	Designers	Meta-Designers
Specific roles	Unaware consumers	Users who are aware of energy; active decision makers	Assistants; teachers; learners; observers	End-user developers; visualization designers	Leaders; software architects; social community founders
Demands and activities	Use energy unconsciously as part of daily life	Are aware of energy and energy use; know the space of possibilities; make educated decisions about actions	Share data and knowledge with others; compare with and learn from others	Learn advanced languages and tools; use existing infrastructure to design new artifacts	Define tools and languages; perform seeding; create infrastructure

Table 3: Roles, Demands, and Activities for a Culture of Participation in the Energy Domain

developers and users together to envision the contexts of use. Despite the best efforts at design time, however, systems need to be evolvable to fit new needs, account for changing tasks, deal with subjects and contexts that increasingly blur professional and private life, couple with the socio-technical environment in which they are embedded, and incorporate new technologies [Henderson & Kyng, 1991].

Meta-Design Methodology. Different from these design approaches, *meta-design* [Fischer & Giaccardi, 2006] creates *open systems* that can be modified by their users and evolve through use time. It extends the traditional notion of system design beyond the original development of a system by supporting processes in which users become *co-designers* not only at design time but throughout the whole existence of the system. Whereas participatory design focuses on *"designing for use before use"*, meta-design extends the design activities by "*designing for design after design*".

A necessary, although not sufficient, condition for meta-design is that software systems include advanced features that permit users to create complex customizations and extensions [Morch, 1997]. Rather than presenting users with closed systems, meta-design provides them with opportunities, tools, and social reward structures to extend systems to fit their needs. By creating social contexts for broad participation in design activities, meta-design transcends the focus on creating only artifacts themselves. End-users, as owners of problems, bring special perspectives to collaborative design activities that are of special importance for the framing of problems. The "symmetry of ignorance" [Fischer, 2000] requires creating spaces and places that serve as boundary objects, which serve as externalizations that capture distinct domains of human knowledge and provide an opportunity for different cultures to meet..

Meta-Design's Support of Cultures of Participation. Meta-design is the design methodology most suited to support cultures of participation by addressing the following objectives:

- *Changes must seem possible:* Contributors should not be intimidated, nor 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 users may be willing to participate.
- *Changes must be technically feasible:* If a system is closed, contributors cannot make any changes; therefore, the systems must be open, and a necessary prerequisite is the need for 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 be professional (helping for one's own work), social (increased status in a community, possibilities for jobs), and personal (engaging in fun activities).
- *The environments must support people's actual tasks:* The best environments will not succeed if they are focused on activities that people do rarely or consider of marginal value.
- *Any barriers to sharing changes must be low:* Evolutionary growth is greatly accelerated in systems in which participants can share changes easily and keep track of multiple versions. If sharing is difficult, an unnecessary burden is created that participants are unwilling to overcome.

Meta-Design Modifications. Meta-design allows significant modifications when the need arises. To meet this requirement, 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;
- avoids design decisions being made in the earliest part of the design process, when the least is known about what is really needed;
- offers users (acting as designers at use time) as many alternatives as possible, avoiding irreversible commitments they cannot undo;
- needs to create design representations that are intelligible and actionable for all participants;
- acknowledges the necessity to differentiate between structurally important parts for which extensive professional experience is required and which should therefore not be easily changed (such as structure-bearing walls in buildings) and components that users should be able to modify to their needs because their personal knowledge is most relevant;
- creates technical and social conditions for broad participation in design activities by supporting "hackability" and "remixability"; and
- 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.

The Role of Meta-Designers: Meta-designers should use their own creativity to create socio-technical environments in which other people can be creative by a shift from determining the meaning, functionality, and content of a system to encouraging and supporting users to act as designers. Meta-designers must be willing to share control of how systems will be used, which content will be contained, and which functionality will be supported.

EXPLORING DIFFERENT APPLICATION DOMAINS

In addition to studying and analyzing the developments surrounding the widely known and broadly used systems lised in Table 2, we have been engaged in our own development efforts instantiating and evolving the framework for cultures of participation and meta-design. These developments include: (1) domain-oriented design environments [Fischer, 1994]; (2) the Envisionment and Discovery Collaboratory [Arias et al., 2001]; (3) the Memory Aiding Prompting System [Carmien & Fischer, 2008]; (4) the Energy Assistant [Dick et al., 2011]; (5) the SAP Community Network [Carmien & Fischer, 2008]; (6)

the CreativeIT Wiki [Dick et al., 2009]; and (7) Courses-as-Seeds [dePaula et al., 2001].

Table 4 provides an overview of these developments. One of them, the Envisionment and Discovery Collaboratory (EDC), is further described in the next section.

The Envisionment and Discovery Collaboratory

The EDC [Arias et al., 2001] is a long-term research platform that explores conceptual frameworks for social creativity and democratizes design in the context of complex design problems. It brings together participants from various backgrounds to frame and solve ill-defined, open-ended design problems. The EDC provides contextualized support for reflection-in-action [Schön, 1983] within collaborative design activities (see Figure 2).

In many cases, the knowledge to understand, frame, and solve complex design problems does not already exist [Engeström, 2001], but is constructed and evolves during the solution process—an ideal environment to study cultures of participation and meta-design. The EDC represents a socio-technical environment [Fischer & Hermann, 2011] incorporating a number of technologies, including tabletop computing, the integration of physical and computational components supporting new interaction techniques, and an open architecture supporting metadesign.

Our work with the EDC has demonstrated several of its advantages:

- More creative solutions to urban planning problems can emerge from collective interactions with the environment when heterogeneous communities of interest, rather than homogeneous communities of practice [Wenger, 1998], are involved. The EDC avoids "group think" [Janis, 1972] by supporting open representations that allow for deeper understanding, experimentation, and possibly refutation.
- Participants are more readily engaged if they perceive the design activities as personally meaningful by associating a purpose with their involvement [Brown et al., 1994]. A critical element in the EDC design is the support for participation by individuals whose valuable perspectives are related to their embedded experiences (e.g., neighborhood residents).
- Participants must be able to naturally express what they want to say [Myers et al., 2006]. The EDC employs the use of physical objects and supports parallel interaction capabilities and sketching to create inviting and natural interactions.
- Visualization of conflicting actions and decisions leads to lively discussion among participants and helps them reach consensus or explore further alternatives [Rittel, 1984]. The EDC encourages such iterations.
- The representations of decisions and their consequences can be easily shared with other users so they can reflect upon others' decisions by allowing participants to record design rationale with reasonable effort [Fischer et al., 2005]. The EDC provides opportunities for sharing and reflection.

DRAWBACKS OF CULTURES OF PARTICIPATION AND META-DESIGN

Cultures of participation and meta-design open up unique new opportunities for the design of socio-technical

System	Application Area	Objective	Focus	Status and People Involved
Domain-Oriented Design Environments	design domains (e.g., kitchen design, computer network design)	support human-problem domain interaction	putting owners of problems in charge	numerous prototypes and some commercial developments
Envisionment and Discovery Collaboratory	urban planning; emergency management	create user-modifiable versions of Simcity	table-top computing environment to support collaborative design	broad-scale use limited by lack of adequate hardware
Memory Aiding Prompting System	new media supporting people with cognitive disabilities	develop "eyeglasses for the mind"	complementing internal cognition with external support	used and evaluated with a variety of different groups
Energy Assistant	energy sustainability	support humans to change their behavior	addressing energy literacy	initial developments using smart meters
SAP Community Network	coping with high-functionality environments	supporting "if X only knew what X knows"	sharing expertise and helping each other	extensively used by more than a million participants
CreativeIT Wiki	researchers and students in creativity and IT	increase participation and sustain communities	exploring features of next-generation wikis	extensive seed but only modest participation
Courses-as-Seeds	rethinking learning and education	support students as active, self-directed learners	collaborative knowledge building and sharing	used extensively in our own teaching activities

Table 4: Overview of Our Developments and Analyses of Systems in Different Application Domains

Figure 2: The EDC Showing a Collaborative Design Session with Multiple Stakeholders

environments—but potential drawbacks should be carefully analyzed. One such drawback is that humans may be forced to cope with the burden of being active contributors in *personally irrelevant activities* (as can be the case in "do-it-yourself" societies in which companies offload work to customers by forcing customers to check out their own groceries, check themselves in at airports, etc.). In these situations, humans are empowered with modern tools to perform many tasks for 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 that professionals have acquired and maintained through the daily use of systems, as well as the broad background knowledge to do these tasks efficiently and effectively.

More experience and assessment are 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 two questions are examples of the many open issues that need to be further 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" and others might call refreshingly diverse insights) better or worse than a uniform culture (which is restricted in its coverage of unique 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?

BEYOND INTERACTION: NEW DISCOURSES FOR HCI

Cultures of participation and meta-design are not just technological developments in HCI to establish different interaction techniques; they also create *new discourses* around themes from political, economic, and social domains in human-centered computing [Fischer, 2011]. This section takes a brief look at a few of those factors.

Motivation. Human beings are diversely motivated beings. We act not only for material gain, but also 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 was articulated by Rittel [Rittel, 1984]: *"The experience of having participated in a problem makes a difference to those who are affected by the solution. People are more likely to like a solution if they have been involved in its generation; even though it might not make sense otherwise."* Cultures of participation rely on *intrinsic motivation* [Csikszentmihalyi, 1996] and they have the potential to influence it by providing contributors with the experience of joint creativity, by giving them a sense of common purpose and mutual support in achieving it, and by replacing common background or geographic proximity with a sense of well-defined purpose, shared concerns, and the successful common pursuit of these.

Control. Meta-design supports users as active contributors who can transcend the functionality and content of existing

systems. By facilitating these possibilities, *control* is distributed among all stakeholders in the design process. The importance of this distribution of control has been emphasized as important for architecture [Alexander, 1984]: *"I believe passionately in the idea that people should design buildings for themselves. In other words, not only that they should be involved in the buildings that are for them but that they should actually help design them."* Other arguments indicate that shared control will lead to more innovation [von Hippel, 2005]: *"Users that innovate can develop exactly what they want, rather than relying on manufacturers to act as their (often very imperfect) agents."*

Ownership. Our experiences gathered in the context of the design, development, and assessment of our systems (see Table 4) indicate that meta-design methodologies 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. Meta-design works best when users are part of the participatory design effort in establishing a meta-design framework, including support for intrinsic and extrinsic motivation, user toolkits for reducing the effort to make contributions, and the seeding of use communities in which individuals can share their contributions.

Social Creativity. Where do new ideas come from in meta-design environments and cultures of participation? The creativity potential is grounded in (1) incorporating user-driven innovations, (2) taking advantage of breakdowns as sources for creativity, and (3) exploiting the symmetry of ignorance and conceptual collisions [Fischer, 2000]. To increase social creativity requires (1) *diversity* (each participant should have some unique information or perspective); (2) *independence* (participants' opinions are not determined by the opinions of those around them) [Surowiecki, 2005]; (3) *decentralization* (participants are able to specialize and draw on local knowledge) [Anderson, 2006]; and (4) *aggregation* (mechanisms exist for turning individual contributions into collections, and private judgments into collective decisions). In addition, participants must be able to express themselves (which requires technical knowledge of how to contribute), must be willing to contribute (be motivated), and must be allowed to have their voices heard (not be controlled).

Quality and Trust. 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* (http://www.nature.com/) has compared the quality of articles found in the *Encyclopedia Britannica* with those on Wikipedia and has come to the conclusion that *"Wikipedia comes close to Britannica in terms of the accuracy of its science entries."* This study and the interpretation of its findings has generated a controversy, and Tapscott and Williams [Tapscott & Williams, 2006] have challenged the basic assumption that a direct comparison between the two encyclopedias is a relevant issue: *"Wikipedia isn't great because it's like the Britannica. The Britannica is great at being authoritative, edited, expensive, and monolithic. Wikipedia is great at being free, brawling, universal, and instantaneous."*

Many more open issues about quality and trust [Kittur et al., 2008] in cultures of participation remain to be investigated. For example, errors will always exist, and thus learners acquire the important skill of being critical of information rather than blindly believing in what others (specifically experts or teachers) are saying. As another example, the community at large has a greater sense of ownership and thereby is more willing to put an effort into fixing errors. The issue of ownership as a critical dimension has been explored in open source communities and has led to the observation that *"if there are enough eyeballs, all bugs are shallow"* [Raymond & Young, 2001].

CONCLUSIONS

We are moving away from a world in which a small number of people produce and most people consume toward a new culture in which everyone can actively participate in a large number of human activities. More and more people are not only using artifacts and media but also getting involved in framing and solving personally meaningful problems. The power of cultures of participation is grounded in the opportunity that the development and evolution of socio-technical environments is undertaken by a large number of users with diversified needs and skills, each making a small contribution. Beyond providing access to new technologies, a need exists to foster the skills and cultural knowledge necessary to allow participants to use the tools toward their own ends. Future research challenges for HCI centered around the themes of *culture, design,* and *interaction* are: (1) to develop a theoretical framework to support the design of socio-technical environments in which users can act as co-designers in personally meaningful problems; (2) to explore design methodologies to support the creation of evolvable seeds for open systems (rather than complete, closed systems) and contexts at design time in which participants at use time can create content; (3) to broaden the scope of human-centered design from the usability of systems to providing resources and incentives to encourage participation and sustain it; and (4) to understand the impact of cultures of participation and meta-design on such important fundamental problems as healthcare, disaster response, life-long learning and education, business innovation, and energy sustainability.

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