

End-User Development and Meta-Design: Foundations for Cultures of Participation

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Abstract, The first decade of the World Wide Web predominantly enforced a clear separation between designers and consumers. New technological developments, such as the cyberinfrastructure and Web 2.0 architectures, have emerged to support a participatory Web. These developments are the foundations for a fundamental shift from a consumer culture (specialized in producing finished goods to be consumed passively) to a culture of participation (in which all people are provided with the means to participate actively in personally meaningful activities). End-user development and meta-design provide foundations for this fundamental transformation. They explore and support new approaches for the design, adoption, appropriation, adaptation, evolution, and sharing of artifacts by all participating stakeholders. They take into account that cultures of participation are not dictated by technology alone: they are the result of incremental shifts in human behavior and social organizations.

Introduction

Cultures are defined in part by their media and their tools for thinking, working, learning, and collaborating [McLuhan, 1964]. 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 [Postman, 1985] and in the worst case contributes 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” [Illich, 1971] rather than “ownership of problems” for the rest of their lives [Bruner, 1996]. As a result, learners, workers, and citizens often feel left out of decisions by teachers, managers, and policymakers, denying them opportunities to take active roles in personally meaningful and important problems.

The personal computer can produce, in principle, an incredible increase in the creative autonomy of the individual. But historically these possibilities were often of interest and accessible only to a small number of “high-tech scribes.” End-user development (EUD) is focused on the challenge of allowing users of software systems who are not primarily interested in software per se to modify, extend, evolve, and create systems that fit their needs.

What the personal computer has done for the individual, the Internet has done for groups and communities. The first decade of Internet use was dominated by broadcast models and thereby extended the existing strong separation of “designers” and “users” imposed by existing media. Meta-design is an evolving conceptual framework to exploit computational media in support of collaboration and communication (such as table-top computing and wikis) to foster cultures of participation.

End-User Development

Familiarity with software applications has become an essential requirement for professionals in a variety of complex domains: architects, doctors, electrical engineers, biochemists, statisticians, and film directors (among many others) all depend for their livelihood on the mastery of various collections of applications [Eisenberg & Fischer, 1994]. These applications, to be at all useful, must provide domain professionals

with complex, powerful functionality. In doing so, however, these systems likewise increase the cognitive cost of mastering the new capabilities and resources that they offer. Moreover, the users of these applications will notice that "*software is not soft*"—that is, that the behavior of a given application cannot be changed or meaningfully extended without substantial reprogramming.

The need for end-user development is not a luxury but a necessity: computational systems modeling some particular “world” are never complete; they must evolve over time because (1) the world changes and new requirements emerge; and (2) skilled domain professionals change their work practices over time—their understanding and use of a system will be very different after a month and certainly after several years. If systems cannot be modified to support new practices, users will be locked into existing patterns of use.

These problems were recognized early in the context of expert systems and domain-oriented environments (here we present just two examples for illustration):

- *Expert systems*: The TEIRESIAS system [Davis, 1984] was a module to support domain professionals to augment the existing knowledge base of a medical expert system; the objective of this component was to establish and support interaction at a discourse level that would allow domain professionals to articulate their knowledge without having to program in Lisp.
- *Domain-oriented environments*: The JANUS-MODIFIER system [Fischer & Girgensohn, 1990; Girgensohn, 1992] supported not just human-computer interaction but *human problem-domain interaction* to allow kitchen designers to introduce new components and new critiquing rules into design environments in support of kitchen design.

From a more theoretical perspective, end-user developments can cope with ill-defined (or wicked) problems and breakdowns:

- *Ill-defined or wicked problems* [Rittel & Webber, 1984] cannot be delegated from domain professionals to software professionals, but require the creation of externalizations that talk back to the owner of the problem [Schön, 1983].
- *Breakdowns* [Fischer, 1994] are experienced by domain professionals and not by the system developers; if domain professionals can respond to these breakdowns without relying on a “high-tech scribe,” systems will evolve in response to real needs.

Professional programmers and domain professionals define the endpoints of a continuum of computer users. The former like computers because they can program, and the latter because they get their work done. The goal of supporting domain professionals to develop and modify systems does not imply transferring the responsibility of good system design to the end-user [Burnett et al., 2004]. Normal users will in general not build tools of the quality a professional designer would (which was recognized as one of the basic limitations of second-generation design methods [Rittel, 1984]). However, if the tool does not satisfy the needs or the tastes of the end-users (who know best what these requirements are), then end-users should be able to adapt the system without requiring the assistance of developers.

A “New World” Based on Cultures of Participation

As the research community interested EUD gathers in 2009 for the *Second International Symposium on End-user Development*, an interesting question is: What has changed since the first symposium that took place in 2003 (as documented in the book *End-User Development* [Lieberman et al., 2006], which includes a chapter about the future of EUD [Klann et al., 2006])? The major innovation and transformation that emerged is the participatory web (or Web 2.0 [O’Reilly, 2006]), complementing and transcending the broadcast web (or Web 1.0), which dominated the first decade of the web.

The Web 1.0 model primarily supports web page publishing and e-commerce, whereas the Web 2.0 model is focused on collaborative design environments, social media, and social networks creating feasibility spaces for new cultures that allow people to participate rather than being confined to passive consumer roles.

This transformation represents a fundamental shift from *consumer cultures* (focused on passive consumption of finished goods produced by others) [Postman, 1985] to *cultures of participation* (in which all people are provided with the means to participate actively in personally meaningful activities) [Fischer, 2002; von Hippel, 2005]. End-user development is obviously an essential component of this

transformation, but its impact is much broader: this transformation represents a change and new opportunity for social production, for mass collaboration, for civic and political life, and for education.

The EUD research community has struggled to make its objectives and techniques known to the world, whereas the Web 2.0 world is being defined by breaking down the boundaries between producers and consumers. New broad-based developments (including open source software, Wikipedia, Second Life, YouTube, and 3D Warehouse, to name just a few) attracted a very large number of contributors. The research community interested in EUD now has an opportunity to apply its research findings to create an analytical framework to deeply understand these new developments and evolve them further.

This “new world” has established new levels of discourse, including the following:

- From the dichotomy between consumers and producers, new, middle-ground models have emerged such as
 - *prosumers* [Tapscott & Williams, 2006], who are techno-sophisticated and comfortable with the technologies with which they grew up; they have little fear of hacking, modifying, and evolving their artifacts to their own requirements. They do not wait for someone else to anticipate their needs, and they can decide what is important for them. They participate in learning and discovery and engage in experimenting, exploring, building, tinkering, framing, solving, and reflecting.
 - *professional amateurs* [Brown, 2005; Leadbeater & Miller, 2008], who are innovative, committed, and networked amateurs working to professional standards; they are a new social hybrid, and their activities are not adequately captured by the traditional dichotomous definitions of work and leisure, professional and amateur, consumption and production.
 - *social production* and *mass collaboration* [Benkler, 2006], which are based on the following facts: (a) a tiny percentage of a very large base is still a substantial number of people; (b) beyond quantitative numbers exists a great diversity of interests and passions in the Long Tail [Anderson, 2006]; and (c) while human beings often act for material rewards, they can also be motivated by social capital, reputation, connectedness, and the enjoyment derived from giving things of value away (contributing).
- An emphasis on *open systems*, which are systems focused on the “unfinished” and take into account that design problems have no stopping rule, need to remain open and fluid to accommodate ongoing change, and for which “continuous beta” becomes a desirable rather than a to-be-avoided attribute.
- The importance of *user-generated content*, in which “content” is broadly defined: creating artifacts with existing tools (e.g., writing a document with a word processor) or changing the tools (e.g., writing macros to extend the word processor as a tool). In specific environments (such as open source software), the content is subject to the additional requirement of being computationally interpretable).
- Moving from guidelines, rules, and procedures to *exceptions, negotiations, and work-arounds* to complement and integrate accredited and expert knowledge with informal, practice-based, and situated knowledge [Suchman, 1987; Orr, 1996; Winograd & Flores, 1986].
- Exploiting the Long Tail [Anderson, 2006] of knowledge distribution, allowing people from around the world to engage in topics and activities about which they feel passionate.
- Fostering and supporting richer *ecologies of participation* (see Section 4.2).
- Creating a new understanding of motivation, creativity, control, ownership, and quality (see Section 4.3).

Meta-Design

Meta-design [Fischer & Giaccardi, 2006] is focused on “design for designers.” 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 developed. At use time, users will invariably discover mismatches between their needs and the support that an existing system can provide for them.

Open systems allow significant modifications when the need arises. The successes of open source software systems and open content environments have demonstrated that, given the right conditions, design through the collaboration of many can create new kinds of systems.

Meta-design tries to reduce 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 *seeding, evolutionary growth, and reseeded (SER) model* [Fischer & Ostwald, 2002] is an emerging descriptive and prescriptive model in support of meta-design. In the past, large and complex software systems were built as complete artifacts through the large efforts of a small number of people. Instead of attempting to build complete systems, the SER model advocates building *seeds* (in participatory design activities with meta-designers and end-users) that can evolve over time through small contributions of a large number of people (being the defining characteristics of a culture of participation). It postulates that systems that evolve over a sustained time span must continually alternate between periods of planned activity and unplanned evolution and periods of deliberate (re)structuring and enhancement. A seed is something that has the potential to change and grow. In socio-technical environments, seeds need to be designed and created for the *technical* as well as the *social* component of the environment.

4.1 The Ubiquity of Meta-Design

Meta-design transcends end-user development by studying and supporting cultures of participation not only in the area of software artifacts, but also in every domain of information and cultural production. Meta-design explores different purposes associated with the artifacts under development, ranging from reliability and efficiency to reaching a deeper understanding of problems and developing more creative and innovative solutions.

In our research, we have explored meta-design [Fischer & Giaccardi, 2006] in the following areas:

- *design of computational artifacts* [Lieberman et al., 2006], with an emphasis on customization, personalization, tailorability, end-user modifiability, design for diversity, and design for a “universe of one” [Carmien & Fischer, 2008];
- *architectural design* [Brand, 1995], with an emphasis on underdesign and support for an “unself-conscious culture of design” [Alexander, 1964];
- *new models of teaching and learning* [Brown, 2005; Rogoff et al., 1998], with an emphasis on challenging the assumption that information must move from teachers and other credentialed producers to passive learners and consumers [Illich, 1971], such as learning communities, teachers as meta-designers, and courses-as-seeds [dePaula et al., 2001];
- *open source* [Raymond & Young, 2001], with an emphasis on open source as a success model of decentralized, collaborative, evolutionary development [Scharff, 2002]; and
- *interactive art* [Giaccardi, 2004], with an emphasis on collaboration and co-creation facilitated by putting the tools rather than the object of design in the hands of users.

In our currently active research, we are further deepening our understanding of meta-design and cultures of participation with the following projects:

- *3D WAREHOUSE*, an environment in which people from around the world can share 3D models created with SketchUp, and how these models can be referenced and displayed in Google Earth;
- *SAP DEVELOPER NETWORK*, an example of a successful socio-technical environment consisting of more than one million registered users forming a highly active online community; and
- *CREATIVEIT*, a wiki-based environment fostering and supporting the evolving scientific community participating in the NSF Program on “Creativity and IT.”

4.2 Richer Ecologies of Participation

The traditional notions of developer and user are unable to reflect the fact that many socio-technical environments nowadays are developed with the participation of many people with varied interests and capabilities. Cultures of participation require contributors with diverse background knowledge who need to provide support and value different ways of participating. Many collaborative design environments serve *only as content management* systems: participants contribute and share their *own* interests and abilities, and additional activities such as critiquing, rating, tagging, deliberating, extending, improving, and negotiating do not take place and are not adequately supported; their value is therefore not sufficiently recognized.

Early studies [Gantt & Nardi, 1992] already identified that EUD is more successful if supported by collaborative work practices rather than focusing on individuals. Gantt and Nardi observed the emergence of “gardeners” (also known as “power users” and “local developers”), who are technically interested and sophisticated enough to perform system modifications that are needed by a community of users but that other end-users are not able or inclined to perform.

A detailed analysis of open-source software systems [Ye & Fischer, 2007] revealed a variety of different roles: (1) *passive users* (using the system); (2) *readers* (trying to understand how the system works by reading the source code); (3) *bug reporters* (discovering and reporting bugs); (4) *bug fixers* (fixing bugs); (5) *peripheral developers* (occasionally contributing new functionality or features); (6) *active developers* (regularly contributing new features and fixing bugs); and (7) *project leader(s)* (initiating the project and being responsible for its vision and overall direction).

In the SketchUp/3D Warehouse/Google Earth environments, a similar role distribution can be observed: contributors create new models with SketchUp, raters and taggers evaluate and describe these models, and curators organize models in collections and create narratives.

To be more specific about the role of *meta-designers*: what do they do? They use their own creativity to create socio-technical environments in which other people can be creative. The main activity of meta-designers shifts from determining the meaning, functionality, and content of a system to encouraging and supporting users to engage in these activities. 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. They do so with a focus on *underdesign* (1) by creating contexts and content creation tools rather than content; (2) by creating technical and social conditions for broad participation in design activities; and (3) by supporting “hackability” and “remixability.”

4.3 Motivation, Control, Ownership, Creativity, and Quality

As argued before, understanding and fostering cultures of participation with meta-design requires paying attention to factors from political, economical, and social domains. 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 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 EUD 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.”* Meta-design relies on intrinsic motivation for participation and it has the potential to influence this 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 [Anderson, 2006; Fischer, 2001].

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 indicate that meta-design methodologies are less successful when users are brought into the process late (thereby denying them ownership) than when users are “misused” to fix problems and to address weaknesses of systems that the developers did not fix themselves. Meta-design does work 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 [Dawe, 2007].

Social Creativity. Where do new ideas come from in meta-design environments and cultures of participation? The creativity potential is grounded in (1) user-driven innovations, (2) taking advantage of breakdowns as sources for creativity, and (3) exploiting the symmetry of ignorance and conceptual collisions. To increase social creativity requires: (1) *diversity* (each participants 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 (requiring EUD competencies), must be willing to contribute (motivation), and must be allowed to have their voices heard (control).

Quality. 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 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.*”

There are many more open issues to be investigated about quality and trust [Kittur et al., 2008] in cultures of participation, including: (1) errors will always exist, resulting in learners acquiring the important skill of always being critical of information rather than blindly believing in what others (specifically experts or teachers) are saying; and (2) ownership may be a critical dimension: the community at large has a greater sense of ownership and thereby is more willing to put an effort into fixing errors. This last issue 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].

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 drawback can be illustrated with “do-it-yourself” societies. Through 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 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 (e.g., companies offloading work to customers).

Substantially more experience and assessment is required to determine whether 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). Such a determination will depend on creating a deeper understanding of these trade-offs [Carr, 2008; Lanier, 2006].

Implications and Conclusions

For a couple of decades the rise of digital media has been providing new powers for the *individual*. The world's networks are now providing enormous unexplored opportunities for *groups and communities*.

Providing all citizens with the means to become co-creators of new ideas, knowledge, and products in personally meaningful activities presents one of the most exciting innovations and transformations, with profound implications in the years to come.

This paper has described numerous reasons why EUD environments (for customizing, tailoring, and evolving systems) are highly desirable. Despite the fact that some EUD environments and their supporting research have been around for years and some success models exist [Lieberman et al., 2006], there is evidence that the impact of academic research efforts in this area has been limited.

We do know, however, that digital media are powerful catalysts of cultural change. The challenge for the EUD research community is not only understanding, supporting, and participating in existing cultures, but also shaping, transforming, and fostering new cultures. Humans all over the world have the opportunity today not only to be exposed to cultures of consumerism [Postman, 1985], but to become active contributors in cultures of participation. Without an analytic model and a demystification of media to deeply understand and explain new emerging phenomena and environments, however, we will only be able to treat them as curiosities or transient fads [Benkler, 2006]. The potential impact of cultures of participation supported by meta-design is substantial: they erode monopolistic positions held by professions, educational institutions, and experts, and they increase the diversity of perspectives on the way the world is and the way it could be. They require new metaphors, new levels of discourse, and new environments to think, reflect, and support working, learning, and collaboration for alternative and more democratic futures.

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