From Reflective Practitioners to Reflective Communities

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Abstract

Over the last decade we have explored collective creativity in knowledge work primarily in the context of complex design problems. These problems require more knowledge than any single person possesses, and the knowledge relevant to a problem is usually distributed among many stakeholders. Bringing different and often controversial points of view together to create a shared understanding among these stakeholders can lead to new insights, new ideas, and new artifacts.

The challenge for the future will be not only to support reflective practitioners but also to develop new frameworks, new media, and new social environments, as well as to support *reflective communities* by overcoming the limitations of the individual human mind.

1 Introduction

The Center for LifeLong Learning and Design (L3D) at the University of Colorado in Boulder [L3D, 2005] has focused its research on *conceptual frameworks* and *system building* efforts characterized by the following global objectives:

- building systems that are not expert systems, but *systems for experts*;
- supporting reflective practitioners by *increasing the back-talk* of the design artifacts;
- putting owners of problems in charge by supporting *human problem-domain interaction*;
- creating open, evolvable systems facilitated by *meta-design* and the *seeding, evolutionary growth, reseeding process model*; and
- supporting *social creativity* among reflective design communities.

This paper focuses on *complex design problems* [Rittel & Webber, 1984; Schön, 1983; Simon, 1996] as prime examples of *knowledge work* [Drucker, 1994] [Florida, 2002] and shows that most of these problems transcend individual human minds and require social creativity [Fischer, 2000].

2 A Conceptual Framework for Design

The Nature of Design Problems. The primary challenge for designers is how to make sense of *"situations that are puzzling, troubling, and uncertain"* [Schön, 1983]. Design requires *reflective practitioners* who "listen to the back-talk" of the emerging design artifact. Simon's description of a painter provides an example of design as a conversation with the materials of the situation: "*in oil painting every new spot of pigment laid on the canvas creates some kind of pattern that provides a continuing source of new ideas to the painter. The painting process is a process of cyclical interaction between the painter and canvas in which current goals lead to new applications of paint, while the gradually changing pattern suggests new goals*" [Simon, 1996].

Integration of Problem Framing and Problem Solving. Design problems are not analyzed in one step and then enacted in the next. The process of problem framing and problem solving has to be intertwined, and therefore the role of designers cannot be restricted to solving problems but needs to include the framing of problems, as argued by [Rittel & Webber, 1984]: *"one cannot gather information meaningfully unless one has understood the problem but*

one cannot understand the problem without information about it." If one cannot begin one without the other, then the only way to proceed is with both simultaneously.

Table 1 summarizes some of the major design concepts we have pursued over the last decade in our research:

Table 1: Concepts and Objectives of Our Approach

Concept	Implications
convivial tools	allow users to invest the world with their meaning and to use tools for a purpose they have chosen [Illich, 1973]
domain-orientation	bring task to the forefront; provide time on task; support human problem-domain interaction [Fischer, 1994]
meta-design and open, evolvable systems	put owners of problems in charge; in open systems, make extension an essential part of use; create seeds and constructs for design elaboration at use time [Fischer et al., 2004a]
emergent behavior	create models that are suggestive rather than definitive [Candy & Edmonds, 2002]
collaborative work practices	support design communities [Bennis & Biederman, 1997]

3 Supporting Reflective Practitioners

Schön [Schön, 1992] ends one of his papers with the following challenge: *"The design of design assistants is an approach that has not in the past attracted the best minds in AI. Perhaps the time has come when it can and should do so."* Schön was interested in developing a *descriptive* account of design activities, illustrating and explaining what designers do, identifying the importance of human collaborations in this process, and arguing for educational changes. He did *not* design or build more powerful socio-technical environments that would empower reflective practitioners beyond the possibilities provided by pencil and paper technologies [Redmiles et al., 2004].

But design *never was and never will be independent of the media* used to support the creation of artifacts. What has been true on a global scale is that the human race has increased its intellectual capability not by increasing the size of its brain, but by the incremental creation and evolution of new tools for intellectual work to support more effective ways of distributed work and cognition [Landauer, 1988]. Socio-technical environments will empower reflective practitioners to be more effective, to avoid and overcome problems, and to learn new things as they go along. Our research has been grounded in Schön's theory and has *extended* it in the following ways:

- we have *built objects-to-think-with* in the form of demonstration prototypes (e.g., domain-oriented design environments, critiquing systems);
- we have *developed process innovations* (e.g., meta-design, and the seeding, evolutionary growth, reseeding process model);
- we have *deployed, used, and evaluated* these prototypes [Bonnardel & Sumner, 1994; Sumner et al., 1997].

Domain-Oriented Design Environments (DODEs). *DODEs* [Fischer, 1994] put owners of problems in charge by supporting human problem-domain interaction rather than just human-computer interaction. The breakdowns experienced by users of DODEs include gaps in design knowledge, lack of support for new domain elements, and new rules and guidelines that were not part of the original DODE. These breakdowns occur because design domains change over time. DODEs support design with the following tools and mechanisms:

- DODEs support the *co-evolution* of problem framing and problem solving. Partially externalizing the framing in explicit computational representations, such as specification components [Nakakoji, 1993], makes possible new ways of supporting design. If the designer's framing of a problem is interpretable by the computer, the computer can detect conflicts between the current design and the framing [Shipman, 1993];

- DODEs increase the *back-talk* of design situations with critics and they support *reflection-in-action* by making argumentation serve design [Fischer et al., 1998]; and
- DODEs support the *seeding, evolutionary growth, reseeding process model* to incrementally refine and evolve systems as living entities [Fischer et al., 2001].

Increasing the Back-Talk of Design Artifacts. The core of Schön's framework for the reflective practitioner can be summarized as follows: "*the designer acts to shape the design situation by creating or modifying design representations, and the situation "talks back" to the designer, revealing unanticipated consequences of the actions. The designer reflects on the actions and consequences by listening to the situation's back-talk, and then plans the next course of action."* Therefore design materials and the externalized representations are essential to design as a reflective conversation. Externalized representations uncover *implicit, tacit, and emergent* dimensions of design tasks that designers may not have considered. Externalizing ideas is not a matter of emptying out the mind but of actively reconstructing it, forming new associations, and expressing concepts while lessening the cognitive load required for remembering them [Bruner, 1996].

Critics. Although representations can indeed make our thoughts more accessible, it is important also to recognize the relationship between the skill and experience of designers and the "back-talk" they receive from the situation. The fact that "*buildings do not speak for themselves*" [Rittel, 1984] is a reminder that the meanings and intentions that are designed into an artifact are not always self-evident, either to the designer or to other observers. *Critiquing systems* [Fischer et al., 1998] monitor the design process and attempt to detect problematic situations. When such situations are detected, critics notify users and make further information available to help users understand the situations. Critiquing systems allow users to work in a self-directed manner and interrupt only when the users' plans, actions, or products are considered potentially problematic. The role of critics is to inform reflective practitioners and make them aware of potential problems and trade-offs; critics thus augment human intelligence rather than replace it [Norman, 1993; Terveen, 1995].

4 Reflective Communities

Supporting reflective practitioners is important, but it is not enough because complex design problems require more knowledge than any single person possesses and the knowledge relevant to a problem is usually distributed among stakeholders. Bringing different and often controversial points of view together to create a shared understanding among stakeholders can lead to new insights, new ideas, and new artifacts. The challenge for the future will be not only to develop new frameworks, new media, and new social environments to support reflective practitioners, but also to support *reflective communities* by overcoming the limitations of the individual human mind. Simon [Simon, 1996] argued that when a domain reaches a point at which the knowledge for skillful professional practice cannot be acquired in a decade, specialization increases, collaboration becomes a necessity, and practitioners make increasing use of media supporting distributed intelligence [Hollan et al., 2001; Salomon, 1993]. Design is a prime example of such a domain [Arias et al., 2000].

Reflective Communities: Coping with the Demands of Knowledge Work. The objective to educate "Renaissance Scholars" (such as Leonardo da Vinci, who was equally adept in the arts and the sciences [Shneiderman, 2002]) is not a reasonable objective for the 21st century [Buxton, 2001] — rather, the challenge is to exploit the creative potential of *"Renaissance Communities."* Numerous sources provide overwhelming evidence that the individual, disciplinary competence is limited:

- "even within disciplines, disciplinary competence is not achieved in individual minds, but as a collective achievement made possible by the overlap of narrow specialties" [Campbell, 1969] ;
- "while the Western belief in individualism romanticizes this perception of the solitary creative process, the reality is that scientific and artistic forms emerge from the joint thinking, passionate conversations, emotional connections, and shared struggles common in meaningful relationships" [John-Steiner, 2000];
- "nobody knows who the last Renaissance man really was, but sometime after Leonardo da Vinci it became impossible to learn enough about all the arts and the sciences to be an expert in more than a small fraction of them" [Csikszentmihalyi, 1996];
- "none of us is as smart as all of us" [Bennis & Biederman, 1997];

- "Linux was the first project to make a concious and successful effort to use the entire world as a talent pool" [Raymond & Young, 2001].

Fish-Scale Model. The *fish-scale model* (Figure 1) [Campbell, 1969] is a qualitative model illustrating an interesting structure of reflective communities: it tries to achieve *"collective comprehensiveness through overlapping patterns of unique narrowness."* The model depicts a competence that cannot be embodied in a single mind. The inevitably incomplete competence of an individual (sometimes referred to as *"symmetry of ignorance"* [Fischer, 2000; Rittel, 1984]) requires reflective communities in which there is the right mixture between sufficient overlap and complementary competence. The fish-scale model provides a viable path toward a new design competence, based on the integration of individual and social creativity [Fischer et al., 2005].

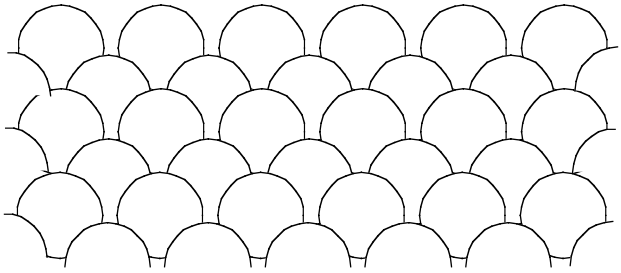

Figure 1: The Fish-Scale Model

Creating Shared Understanding. The traditional model for collaboration, the "division of labor," is inadequate to address the critical issues of social creativity. *Division of labor* [Levy & Murnane, 2004] refers to dividing knowledge work into specialized tasks within a given framework of reference; in contrast, social creativity focuses on emergent interactions and meanings. Division of labor tries to divide tasks among a group of people by functions, whereas social creativity involves people collaborating with each other by taking up tasks that fit well with their knowledge and personal interests. Figure 2 illustrates different collaboration paths in software development. The lengths of the lines in the figure relate to the difficulty of collaboration:

- *Model 1:* collaboration between a software professional (with no knowledge about the application domain) and a domain expert (with no knowledge about software) is very difficult due to the lack of a shared understanding;
- *Model 2:* the collaboration distance is reduced if a software professional acquires some domain knowledge;
- *Model 3:* similarly, the collaboration distance is reduced if a domain expert acquires some software knowledge;
- *Model 4:* the most productive collaboration occurs when each contributor has some knowledge of the other.

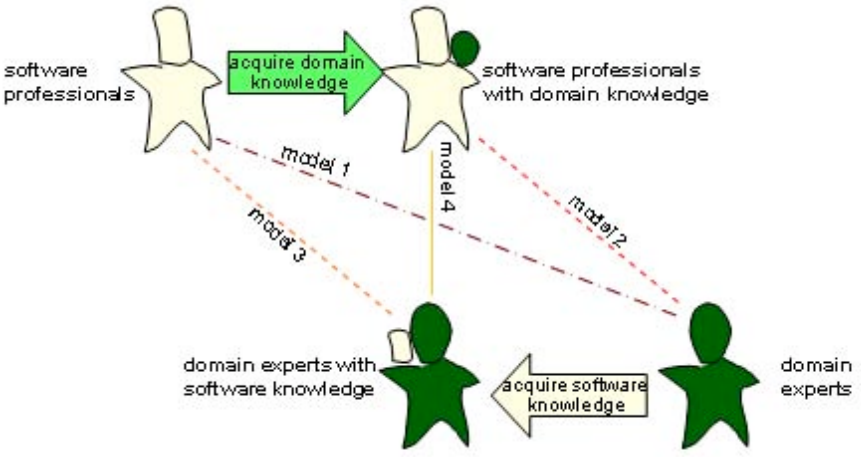

Figure 2: Collaborations Paths in Software Development

5 Supporting Reflective Communities

Domain-oriented design environments, as discussed above, have focused on supporting primarily reflective practitioners coming from specific communities of practice. Over the last few years we have tried to develop socio-technical environments to support reflective communities based on communities of interest [Fischer, 2001].

The Envisionment and Discovery Collaboratory (EDC). The EDC [Arias et al., 2000] supports reflective communities in which the participating stakeholders come from different disciplines by supporting *epistemological pluralism* [Turkle & Papert, 1991] and by providing *boundary objects* [Bowker & Star, 2000; Star, 1989; Wenger, 1998] that all stakeholders can understand and manipulate, as well as by providing underlying computational support for trying out alternative solutions, accessing information relevant to the task at hand, and capturing information and design rationale from the design process. The EDC attempts to maximize the richness of communication between stakeholders in face-to-face interaction, *mediated by both physical and computational objects*. It supports reflective communities by empowering all stakeholders to (1) engage in informed participation, (2) create shared understanding, (3) contextualize information to the task at hand, (4) create boundary objects in collaborative design activities, and (5) transcend the information given by supporting users as active contributors and not only as consumers.

Meta-Design. To bring social creativity alive, media and environments must support meta-design. *Meta-design* [Fischer et al., 2004a] characterizes objectives, techniques, and processes to allow users to act as designers and be creative. By empowering users to engage in creating knowledge rather than restricting them to the consumption of existing knowledge, meta-design supports reflective communities.

The need for meta-design is founded on the observation that design requires open systems that users can modify and evolve. Because problems cannot be completely anticipated at design time when the system is developed, users at use time will encounter mismatches between their problems and the support that a system provides. These mismatches will lead to *breakdowns* [Fischer et al., 1998] that serve as potential sources for new insights, new knowledge, and new understanding. Meta-design advocates a shift in focus from finished products or complete solutions to conditions for users to fix mismatches when they are discovered during use.

Meta-design extends the traditional notion of system design beyond the original development of a system to include an ongoing process in which stakeholders become *co-designers*—not only at design time, but throughout the whole existence of the system [Morch, 1997]. A necessary, although not sufficient, condition for users to become co-designers is that software systems include advanced features that permit users to create complex customizations and extensions. Rather than presenting users with closed systems, meta-design approaches provide them with opportunities, tools, and social reward structures to extend the system to fit their needs. Meta-design shares some important objectives with user-centered and participatory design, but it transcends these objectives in several important dimensions and it changes the processes by which systems and content are designed. Meta-design shifts control over the design process from designers to users, and it empowers users to create and contribute their own visions and objectives.

The Seeding, Evolutionary Growth, and Reseeding (SER) Process Model. The *SER* process model [Fischer et al., 2001] depicts the lifecycle of large evolving socio-technical environments as developed by reflective communities. It postulates that systems that evolve over a sustained time span must continually alternate between periods of activity and unplanned evolutions, and periods of deliberate (re)structuring and enhancement.

The SER model encourages system designers to conceptualize their activity as meta-design, thereby aiming to support users as designers and knowledge workers [Drucker, 1994] . We have explored the feasibility and usefulness of the SER model for reflective communities engaged in the development of organizational memories [Lindstaedt, 1996], course information environments [dePaula et al., 2001], and open systems approaches [Fischer et al., 2004b]. The evolution of these systems share common elements, all of which relate to sustained knowledge use and construction in support of informed participation.

6 Implications

Homogeneous versus Heterogeneous Communities. Reflective communities are social structures that enable groups of people to share knowledge and resources in support of collaborative design. Different communities grow around different types of design practices. In our work, we have identified two stereotypical kinds of design community: communities of practice (CoP) and communities of interest (CoI) [Fischer, 2001].

CoPs [Wenger, 1998] consist of practitioners who work as a community in a certain domain undertaking similar work. CoIs, which bring together stakeholders from different CoPs, are defined by their collective concern with the resolution of a particular problem. Communication within CoIs is difficult because the stakeholders, coming from different CoPs, use different languages, different conceptual knowledge systems, and sometimes even different notational systems. We believe, though, that CoIs have greater potential for creativity than CoPs because different backgrounds and different perspectives can lead to new insights [Bonifacio & Molani, 2003; Csikszentmihalyi, 1996]. A fundamental barrier for CoIs to overcome, therefore, is the challenge of creating common ground and shared understanding [Clark & Brennan, 1991] among the participants.

A New Tower of Babel: The Danger of Cultural Fragmentation. As cultures evolve, specialized knowledge will be favored over generalized knowledge [Csikszentmihalyi, 1996; Simon, 1996] (similar arguments can be made for artifacts and technologies [Basalla, 1988; Buxton, 2001]). The "solution" indicated by the fish-scale model (see Figure 1) and the collaboration model underlying reflective communities (see Figure 2) are supporting networks of specialized individuals with socio-technical environments. For reflective communities that come together as CoIs, this will not be an easy undertaking, as indicated by the work of Snow [Snow, 1993], who identified the two cultures (the science community and the arts and humanities community) and observed a deep polarization between them. As argued previously, social creativity often involves the crossing of domains, but unfortunately many of our educational institutions and work settings do little to foster effective communication across intellectual boundaries [National-Research-Council, 2003].

7 Conclusions

In the past, most computational environments have focused on the needs of individual users. Our research has evolved from empowering reflective practitioners in specific domains (e.g., with domain-oriented design environments) to creating shared understanding among reflective communities as communities of interest (e.g., with the Envisionment and Discovery Collaboratory). In this journey, we have not abandoned earlier themes—we have widened our focus.

The world has become too complex for individuals (even when they are educated and act as reflective practitioners) to have enough knowledge to tackle complex problems by themselves. A viable alternative is to create and sustain reflective communities, but this will not be an easy undertaking. Bringing people with different background knowledge and different value systems together, overcoming the biases and barriers of their separate languages, integrating different educational experiences, and eliminating the lack of reward structures will not be an easy undertaking. But there is little choice: unless we meet these challenges, we will be unable to cope with the complexities and needs of the 21st century.

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