Using stories to overcome social obstacles in design collaborations

E. A. Domeshek[1], J. L. Kolodner[1], R. Billington[1] and C. M Zimring[2]
[1]College of Computing
[2]College of Architecture
Georgia Institute of Technology
Atlanta GA 30332-0280
USA

1. Collaboration in Design

The lone design genius, if not mythical or completely extinct, is surely on the endangered species list. Nowadays, significant design projects require teams of designers coordinating their varied expertise to arrive at effective design solutions. In more progressive circles, design teams do not work alone either. As the world adopts methods such as Concurrent Engineering (CE) and Total Quality Management (TQM), designers are being required to coordinate with customers, marketers, production experts, maintenance staff, and all the other stakeholders likely to be affected downstream by the evolving design. Common sense responses to growing complexity and past failures are crystalizing into new organizational conventions and new design procedures. These new forms reflect a growing realization that higher quality, lower cost products can be produced more quickly if potential problems are recognized earlier in the design cycle.

Despite its desirability, spatial, temporal, and social barriers often prevent effective collaboration on design projects. We are interested in studying the social obstacles to design collaborations. We believe we can build computer tools that will contribute to overcoming those obstacles. In contrast to much work in the burgeoning field of Computer Supported Cooperative Work (CSCW), we are not devising technical and procedural innovations to improve coordination of spatially and temporally distributed groups. Novel uses of computers, networks, databases, and displays can help deal with the reality that large design teams cannot

always work in the same time and place, and may not even work on the same time scale. But when we look at complex large-scale design situations, we see that even once the *physical* obstacles to collaboration are resolved, there remain *social* obstacles to turning communication and coordination into effective collaboration.

Teams are assembled, in part, so that their members can contribute a variety of strengths and abilities to the task. A design team is usually composed of individuals drawn from different specialities. They come to the project with different prior knowledge and expectations. They may be working to fulfill different agendas. They fit into different roles, and those roles partly determine how they get to influence the project. These differences multiply as more downstream stakeholders are brought into the earliest design deliberations.

Changes in design practice are beginning to make communication among various participants more frequent. We believe we can help make such communication more effective. If we can directly improve the *quality* of interactions, we may also have the desirable effect of increasing their *quantity* as well. We have, for some time, been developing computer-based design aiding tools. Now we want to extend these tools to improve communication and coordination among participants in conceptual design -- to bridge the social gaps introduced by diversity among design participants.

2. Social Obstacles to Effective Design Collaboration

We see the social obstacles to collaboration as fitting into three broad categories: structural, relational, and cultural. Our group has focused on the *cultural* differences that restrict people's ability to understand and contribute to a collaboration. We break down cultural obstacles into differences in goals, differences in abilities, differences in knowledge, and differences in conventions. The conventions we are concerned with are primarily distinctive ways of talking about or otherwise representing design issues, but may also extend to conventions for how to proceed with design, or even how to behave in a collaboration. Just as overcoming the obvious physical obstacles to collaboration still leaves all these social obstacles, so too, overcoming the structural and relational problems leaves a complex set of cultural stumbling blocks. Figure 1 sketches our taxonomy of social obstacles to effective design collaboration.

Communication is difficult when parties do not share common background and assumptions, or when they lack a common technical language and facility with external representations. We believe that failures of attempted communication are most apparent, and also most detrimental, in the early stages, during conceptual design. Early in design, the design team -- especially the extended team, including clients and users -- is not a cohesive group. Early on, members do not have much personal feel for one another, and they lack any shared group history or any common reference points. The normal terms of discussion in conceptual design only exacerbate these problems. In the absence of concrete design proposals, the participants will often talk in terms of abstractions and generalities. But what a structural engineer thinks of as a *"large"* space may be quite different than what an architect means when he says "large"; the engineer worries about spanning anything from a living room to a convention center to a river, while the architect visualizes something scaled to his image of a building design forming in his head. Similarly, a space described as *"large"* probably conjurs different images for a custodian who has to keep things clean, and the state official who has to pay for the building.

By the end of the crucial conceptual design phase, the designers must come to understand what

the clients and users really want, while the clients and users must come to understand the design implications of their desires as well as new possibilities created by innovative design. Both of these ends can be advanced by *carrying out a dialogue in the context of specific examples of related artifacts.* Illustrative examples can be quite powerful; consider, for instance, the difference between abstractions like *"we'll have a large waiting area outside the courtrooms"*, and concrete images of existing courthouse waiting areas that give an immediate feeling for what it is like to be in those spaces.

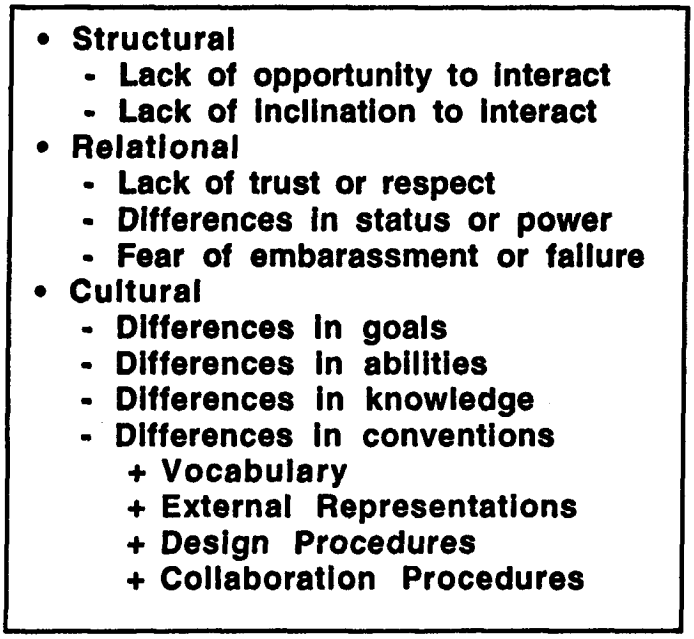

Figure 1: Taxonomy of Social Obstacles to Collaboration.

3. The Value of Concrete Communication

Our basic premise is that couching design issues in terms of concrete examples is one of the most useful things we can do to help the various design participants arrive at a common understanding of their problem and the possibilities for solutions. Examples can serve as aids to communication amongst diverse members of an extended design team. For instance, in the context of designing a county courthouse the question of what counts as a "large public waiting area" can be answered by looking at some existing county courthouses and focusing on some particular waiting areas in those buildings that have the character desired. If an architect tries to design a residence for the disabled with standard bathrooms an example telling of how the residents will suffer can make clear to her why her users object. If a client asks for a large floorplate building with private offices all around the perimeter, an example highlighting the dim cavernous interior can make clear to him why his architect objects.

These examples suggest kinds of interactions that could be supported by a design tool capable of storing and presenting evaluative stories along with documentation about existing buildings. Easy access to examples could help design participants working individually to prepare for meetings by anticipating others' reactions. Discussions during actual meetings could be more productive because the team members could easily refer to relevant details of specific examples.

Easy access to examples would make it easier to convey the reasons for particular design decisions to other team members. Appeal to examples can also serve to bolster the claims of low status team members who might otherwise be hesitant to advance their point of view.

When contrasted with design guidelines stated as abstract rules, design lessons taught in the context of particular evaluated existing designs have many advantages: examples make design lessons more vivid, and thus more memorable; examples are embedded in a context so users can make more subtle attributions of cause and effect, and thus more precisely determine when the lesson applies; well crafted presentations of examples can also teach aspects of an underlying model of the domain as they teach the higher level design lessons. When contrasted with rule-based critiquing and advising, a story-based approach to representing and teaching design lessons makes sense because many aspects of design lack a solid underlying domain model and because, accordingly, most design guidelines do not really have the force of rules.

4. Research Issues for Design Collaboration

If we expect existing artifacts to influence new designs, it is critical that we create presentations that teach clear lessons and prepare effective external representations of those design experiences. We cannot magically transport a group of users to the sites of sample buildings to experience directly the good and bad aspects of their design; even if we could get them to the sites, we could not ensure they would talk to the right stakeholders there, or that they would be told the relevant stories on cue. Using a particular existing building as an example to teach a design lesson requires crafting a presentation that makes the desired points. The same holds true for most other types of artifacts. We call such presentations *stories*. Stories, in this sense, need not be texts, or need not be soley texts. Our choice of architecture as a domain has driven us to concentrate heavily on graphical presentations, and we are interested in multimedia presentations in general.

We can take graphic presentations as representative of the sorts of problems we expect to encounter when aiming presentations at audiences with divergent backgrounds. For instance, floor plans are a good way to illustrate some aspects of building design; floor plans are developed and used by architects to facilitate their own thinking and to communicate with some of the other participants in building design. When architects looks at floor plans, certain things are particularly salient and meaningful: they instinctively note the scale, and with their extensive experience, are capable of accurately interpretting the real sizes of the spaces depicted; they can decode the distinctive fill patterns that often indicate something about the materials used for parts of the building; they can interpret schematic symbols or annotations showing construction details. When potential residents of a building looks at a floor plan, they are unlikely to see any of those things; they will simply see the relative sizes and arrangements of rooms. If the point of the story being presented (in part) by that graphic depends on any of the cues that are (initially) invisible to one set of design participants, then there is a potential problem.

We have said that various design participants may not understand each other when each speaks their own native languages, particularly when they talk in abstract and technical terms. Ideally, we will arrive at some way to characterize what kinds of gaps separate the participants' conceptions of the evolving artifact. We will not only describe the differences in their experiences and points of view, but also the similarities. We will develop some insight into which differences are really significant impediments to communication and how similarities can be exploited to compensate. If grounding discussions in concrete examples is to help avoid

misunderstandings, we will have to face the question of what kinds of concrete details make sense to different design participants, and what kinds of ways of talking about or illustrating examples will effectively communicate.

5. CBR and CBDAs

We have, for some time, been developing an example-driven approach to helping designers think through the implications of their conceptual design proposals. Now we are looking at how to apply a similar approach to supporting design collaboration. This approach to building design tools is rooted in the Artificial Intelligence paradigm known as Case-Based Reasoning (CBR). In brief, CBR is an appropriate technology on which to base computerized design aids because a significant factor in good design is *experience*, and CBR is an evolving technology aimed at capturing and retrieving useful experiences. It is a common enough observation in design research that designers in all fields make extensive use of case studies, precedents, and prior personal experience. And it is a common frustration of design practice that finding records of past experience is often annoyingly (or even prohibitively) expensive. Psychological research further suggests that people are often quite poor at picking out appropriate past experience, even when such experiences are present in their own memories. Our design tools aim to broaden the availability of experiences with design and use of artifacts.

These tools are called Case-Based Decision Aids (CBDAs). They help designers by supplying them with descriptions and evaluations of prior designs relevant to current decision making. In the context of a current problem, an old design can be taken as a suggestion, a warning, or a prod to consider particular issues. For the system to retrieve relevant examples, the user must give it some description of the current problem and any partial commitments towards a solution. In response, the system can present a view of some past design annotated with stories that teach lessons the user should know about in the current situation. The views may be graphical or textual. The stories may be only a selected subset of everything the system knows about the old design. From the initial view, which may encompass only a part of an old design, the user can access other information about that old case. From the selected stories, the user may browse to presentations of relevant design guidelines that suggest how a designer should approach a related class of problems in general. Guidelines, in turn, provide access to other stories (perhaps drawn from other designs) that serve as illustrations, counterexamples or caveats to the general rule.

The issues in designing and building CBDAs include 1) gathering stories and guidelines, 2) preparing effective presentations for a targetted user group, 3) developing a way of describing the stories so they can be found in response to a user's situation, 4) finding an acceptable way for users to express their situations, 5) providing a limited but useful set of presentations and browsing options at any time.

We have been developing CBDAs for several domains, including architecture, lesson planning and airplane design. As we have developed these tools, it has become apparent to us that they could provide a basis for correcting the communication breakdowns so common in large design efforts. We believe CBDAs can play this important role because their major effect is to illustrate the implications of constraints and proposals in concrete form -- as stories of real examples with supporting documentation, illustrations, and analysis.

Doing a good job of supporting collaboration will require further pursuit of several already

active lines of inquiry and will result in evolutionary growth in our CBDA's capabilities. We will continue to look for forms of experiential material that can be of use to a working designer, but we will also consider when such materials might be appropriate for other users. We will continue to look beyond case materials per-se to explore the effective integration of experience with generalizations, rules and principles, but we must remember that not all users have appropriate background to understand generalizations (with their technical terms and unstated limitations), or to interpret examples (with their welter of relevant and irrelevant details). We will continue to seek effective organization and presentation strategies, but we will have to consider the background, interests, and media experience of all participants.