# SUPPORTING CRITICAL DESIGN DIALOG

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by

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**SUPPORTING CRITICAL DESIGN DIALOG**

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# SUMMARY

The goal of this research was to understand how to support critical design dialog among peers and experts in different learning environments. Critical design dialog (CDD) is a pedagogical technique in which students, educators, and others discuss students' design projects to help them improve their projects and learn from their activities. Research in other fields such as education, cognitive science, and design learning provide a rationale for why critical design dialog can be useful in helping students learn from their design activities. However, little research has been done to guide educators in creating a learning environment that uses CDD, especially one that differs from the traditional design studio in important ways. This research has been aimed at helping educators navigate this process.

Two class settings are used to investigate what CDD looks like in practice and what is needed to support it. In the first setting, an educator uses a series of CDD activities (pin-ups and jury reviews) in an otherwise traditionally organized class on human-computer interaction (HCI) in a computer science department. The second setting is a traditional design studio in a school of architecture. In addition to using the common forms of CDD, the educator uses a collaborative website (CoWeb) to conduct a mid-term jury review. This setting therefore provides two opportunities to study CDD, first as it usually occurs in the studio with the participants interacting in person, and second as it is transformed to use an online environment.

Results show that there are four important tasks that need to be supported by a learning environment that uses CDD. They are: 1) clear communication of the design idea, 2) a balance of diversity and commonality in student projects, 3) publicness of the dialog, and 4) the role of the educator in mediating and guiding the dialog. The importance of each of these is discussed and suggestions on how to support them are made. Additionally, the special advantages and challenges in using technology to support CDD are discussed.

# CHAPTER I

# INTRODUCTION

Interest in teaching and learning through design is increasing. In some cases, disciplines are beginning to acknowledge design skills as an important part of professional practice (e.g. engineering [Dixon, 1991b], [Mistree & Muster, 1988] and human-computer interaction [Strong, et al., 1994], [Winograd, 1990]). In other cases, educators are using design as a way to contextualize and motivate learning in other domains (e.g. mathematics [Harel, 1991], [Shaffer, 1998a] and science [Kolodner, et al., 1998]). Regardless of the reason, helping students to learn *to* and *through* design requires creating a learning environment that addresses the needs of students as they work on design projects.

This research explores a technique called *critical design dialog* in which students, educators, and others discuss students' design projects to help them improve their projects and learn from their activities. Research in other fields such as education, cognitive science, and design learning provide a rationale for why critical design dialog can be useful in helping students learn from their design activities. This research instead focuses on how this technique can be put into practice. In traditional design disciplines, such as architecture, critical design dialog is commonplace within the design studio—a learning environment quite different from those found in other disciplines. This research takes the position, however, that critical design dialog can be a useful technique in a variety of learning environments, not just those that closely resemble the design studio. Therefore, the goal of this research is:

*to understand how to support critical design dialog among peers and experts in different learning environments*.

The rest of this chapter is organized as follows. The next section, “What is Critical Design Dialog?”, defines critical design dialog more clearly by contrasting it to other kinds of learning discussions and considering the meanings of *critical* and *dialog*. Following that, “Why use Critical Design Dialog?” discusses why critical design dialog is an appropriate technique for design learning. It explains why design learning creates certain needs for students and shows how critical design dialog can meet those needs. It also previews the theoretical support for this technique, which is discussed more fully in Chapter II. “How to use Critical Design Dialog” discusses the use of critical design dialog in practice. It introduces the design studio and how it can serve as a model for other kinds of learning environments. It also points out that educators still face a significant task in putting this model into practice, especially when the learning environment is very different from the design studio. The “Approach” section introduces the two class settings used in these studies, why they were chosen, and how they are used to address the research goal. Following that, “Research Goal and Questions” restates the research goal and presents the particular questions addressed in this research. It also explains the goal more clearly, defining what a *learning environment* is and what it means for a learning environment to *support* critical design dialog. Finally, the “Contributions” section summarizes the contributions of this work and the "Overview" section outlines the rest of the dissertation.

## **What is Critical Design Dialog?**

Critical design dialog (CDD) is a pedagogical technique that aims to help students learn from their design activities through discussion. As with other kinds of classroom discussions, the basic goal of CDD is to help students learn. However, it has several characteristics that distinguish it from other kinds of learning discussions. During CDD, participants are critiquing, interpreting, and asking questions about each other's work. Unlike end-of-term presentations, the discussion is aimed at influencing the project as it progresses, rather than simply evaluating it when completed. CDD is often conducted in a whole-class setting, so that students can learn from each others' design efforts and feedback. Table 1-1 lists some of the characteristics of CDD and contrasts them with other kinds of learning discussions.

The term *critical* is used here in the sense of *criticism* or *critique*, to emphasize the intellectual nature of the dialog. Often these terms are associated with making judgements about the object of critique—frequently, negative judgments. But intellectual criticism is actually much broader, involving not only evaluation, but interpretation and description as well [Attoe, 1978]. The familiar form of criticism, a judgment based on standards, is only one kind of criticism (normative). Other forms of criticism have different goals—for example, to advocate a particular way of understanding something (persuasive or

**TABLE 1-1 Contrasting CDD with other kinds of learning discussions**

| CDD characteristic | Contrast |
|---|---|
| exchanging ideas and opinions between students and others (teachers, experts, critics) | answering questions asked by the teacher (e.g. recitation) |
| grounded in students' design projects and activities | grounded in materials created by others (e.g. interpretive discussion of a poem, text, or historical event) |
| considering new and contrasting points of view | seeking consensus (e.g. discussion among project team members) |
| reporting what was done, current status, and future plans to enable further discussion and feedback | reporting what was done for evaluative purposes (e.g. typical end-of-term presentation) |
| critiquing, interpreting, making judgements based on different criteria | demonstrating recall of facts and arguments developed by others (e.g. recitation) |
| publicness, emphasis on learning from what others are doing and saying | privateness, emphasis on learning from the teacher (e.g. written comments on a project report, individual discussions with the teacher) |
| students, teachers and others as sources of knowledge | teacher and textbook as sources of knowledge |

interpretive criticism). The term *critical* in CDD refers to criticism in the broadest sense, including all of its forms and concerns.

This dissertation will use the terms *dialog* and *discussion* interchangeably. Some researchers make distinctions between the terms dialog, discussion, discourse, conversation, etc. For example, [Jenlink & Carr, 1996] distinguishes between several kinds of conversations, including discussion (where people advocate for their own positions) and dialog (where people construct shared concepts by considering multiple perspectives). [Cox, et al, 1999] draw a distinction between dialog (between a student and a tutor) and discourse (a spoken explanation) in an educational setting. These differences are interesting but are more fine-grained than is needed for this research. [Bowers &

Flinders, 1990] considers the difference between educational dialog and ordinary dialog, for example, one between two friends. They note that an ordinary dialog is open, informal, and locally-managed. There is no rigid turn-taking, and anyone can respond or change topics at will. Although CDD might not have the degree of openness and informality of ordinary dialog, it still represents a shift in this direction from typical classroom interaction. The terms *dialog* and *discussion* are used in this dissertation in their everyday sense—an open exchange of ideas and opinions among a group of people.

## Why use Critical Design Dialog?

CDD is a particularly appropriate technique for design learning because of the nature of design problems and the nature of the design process. These create unique learning needs for students and at the same time, unique opportunities to learn from each other. Goel and Pirolli [Goel & Pirolli, 1992] identify twelve features that characterize design problems across different domains. For example, design problems are generally large and have many parts that interrelate in complex ways. As a result, most aspects of the problem are unclear at the start, and the problem can only be defined and understood as it is being solved. But for any given problem there are many possible solutions, and although there may be many constraints, they do not uniquely define a solution. Often the solution must be evaluated using a simulation because the “real” thing is very expensive or time-consuming to build. Not all design problems will exhibit all of these features, but the more a problem does, the more prototypical it is.

Goel and Pirolli and others have also identified characteristics of the design process. For example, designers pass through different phases while working on a design problem including problem framing, preliminary design, refinement, and detailed design [Goel & Pirolli, 1992], [Atman & Turns, 1999]. Progress through these phases is not linear but iterative, meaning that they may be revisited multiple times before a solution is reached. Within these phases, designers engage in activities such as gathering information, generating alternatives, evaluating solutions, monitoring their progress, creating models, and reacting to their unfolding solution. The design process is not a formula to follow, but a set of strategies and techniques that designers call upon as they address the challenges of a particular design problem.

These characteristics of design problems and design processes make teaching and learning through design challenging. Since design problems by definition have neither systematic solutions nor "correct" answers, educators cannot lay out in advance exactly how students should proceed or what information will be relevant to the design. Instead, design problems require a more reactive and flexible approach by educators. Students need guidance throughout the design process, which means that educators need ways to monitor students' progress and to provide that guidance at critical points. Another challenge in teaching design is that the design process is difficult to understand outside the context of practice. As [Schön, 1987] notes, beginning students often find descriptions of design vague and ambiguous, even when the educator thinks he/she is being clear and specific. Students therefore need feedback which is grounded in their own work but is also connected to more general ideas about design and the domain in which they are working.

Educators are often in a unique position to provide that kind of feedback because of their familiarity with both the students' work and the domain. Finally, students can have trouble making judgements about their own designs because many design goals are qualitative and subjective. An important skill in designing is learning to recognize and judge these various qualities [Schön, 1987]. Students develop this skill, at least in part, by modeling more skilled designers and therefore need opportunities to observe educators in this role.

Critical design dialog provides opportunities to meet all of the needs of students identified above: educators can monitor students' work and provide timely feedback; they can ground that feedback in the students' work, using it to illustrate more general concepts; and they can model design thinking by providing this feedback in a public setting. In addition, CDD provides students with a chance to take a step back from their design projects, to reflect on what they have been doing, and to decide what to do next. It requires them to articulate their design and rationale clearly, so that others can understand what they are doing and why. By hearing what others are doing and the problems they are having, students can gauge their own progress and make adjustments if needed. Finally, because design projects and solutions can vary so widely, students can gain a broader exposure to design issues by sharing their experiences with one another.

There is a wide range of theoretical support for the use of dialog in learning, especially when learning from complex activities such as design. From a purely cognitive stance, case-based reasoning theorizes that students must *reflect* on their experiences in order to learn from them [Kolodner, 1997], [Kolodner & Guzdial, 2000]. That is, they must actively organize and express what they have learned. In this view, an effective dialog is a form of reflection during which students make sense of their experiences and connect new knowledge to their existing knowledge.

Other theories focus on how dialog links the external and internal worlds. In cognitive apprenticeship, dialog makes educators' thinking available to students so that it can be imitated, questioned, and eventually internalized by students [Collins, Brown, & Newman, 1989]. It also makes students' thinking available to educators, so that appropriate guidance can be provided. In addition, dialog can help students become aware of their own understanding and learning process. Vygotsky's theories about the relationship between language and thought state this case even more strongly, proposing that all of the "higher [psychological] functions originate as actual relations between human individuals" and eventually become internalized [Vygotsky, 1978]. Dialog, in his view, is a central part of the social activity that is the basis for all learning.

Still other theories highlight the incremental and situational aspects of dialog. Rochelle's theory of convergent conceptual change shows how dialog allows for the incremental development and refinement of ideas over time [Roschelle, 1996]. This theory draws upon other research which showed that during dialog, participants build, monitor, and repair shared knowledge [Sacks, Schegloff, & Jefferson, 1974]. Similarly, cognitive apprenticeship and other theories describe dialog as *coaching* when it is between participants of unequal skill, usually an educator and a student. The key feature of coaching is that it occurs in the moment, reacting to what a student has said or done and invoking a further reaction from the student. It is highly interactive and immediately relevant to what the student is trying to achieve.

Finally, other theories understand dialog as an important form of participation in a community. Lave and Wenger emphasize the fundamentally social nature of learning and view it as a process of increasing participation in a community of practice [Lave & Wenger, 1991]. Part of participating in a community, therefore, is using its terminology and ways of speaking and communicating. Brown and Campione's "Community of Learners" [Brown & Campione, 1994] and Scardamalia and Bereiter's "Knowledge-Building Communities" [Scardamalia & Bereiter, 1996] also emphasize the relationship between community and learning. For all of these theories, dialog is not considered in terms of how it affects the individual, but rather how it sustains and builds the community. Learning is then an integral part of participating in the community, not a special task for students to undertake.

The number and diversity of theories about how students learn through dialog suggests that dialogs play a variety of roles in learning. These theories along with other research from education, learning sciences, and design education are discussed further in Chapter II along with their implications for this research.

## How to use Critical Design Dialog

Even with an understanding of what CDD is and why it is an important activity for design learning, the educator still faces the challenge of creating a learning environment that uses it successfully. One strategy would be to emulate another learning environment that already uses CDD, such as the design studio.

## An Example: The Design Studio

In design-oriented disciplines, CDD often occurs within a tradition called the design studio. The design studio is a central component of the curriculum and epitomizes the philosophy of "learning by doing". Specifically, it is based on the idea that learning to design requires *doing* design, and in many cases the doing must precede the learning [Schön, 1987]. Doing is not a demonstration of what has been learned; it is the mechanism through which learning occurs. In general, the studio is organized around a design problem given by the educator. Over a period of weeks, the educator works with students individually to develop and guide their solutions [Cuff, 1994]. The specific activities of the studio that use CDD include desk crits (individual conversations between a student and educator about the progress of a design), pin-up sessions (whole-class activities in which students present and discuss their work), and jury reviews (formal presentations of students' projects to invited experts). Students and educators often spend long hours in the studio (10+ hours per week). During this time, students move fluidly between quiet individual work, work-related discussions, desk crits, socializing, and other activities. Studios vary widely in the details of their purpose and organization, but they do share these common features which distinguish them from other learning environments.

Several researchers have studied how the design studio works as a learning environment. Schön has written extensively on the design studio and how it can serve as a model for many forms of professional education [Schön, 1987]. He sees the architecture studio as a prototype of the *reflective practicum*–a situation designed for learning where students develop expertise and artistry in their discipline. Schön identifies the three main features of a reflective practicum as: 1) learning by doing, 2) coaching rather than teaching, and 3) a dialog of reciprocal *reflection-in-action* between coach and student.

Reflection-in-action is Schön's characterization of the design process. He describes it as a series of moments in which the designer performing a routine action encounters a "surprise" which causes him/her to reflect on what is happening and reinterpret the situation. The designer then performs an "on-the-spot experiment" to allow the action to continue. The experiment may be successful or may lead to new surprises requiring further reflection-in-action. Studio dialog is described as reciprocal reflection-in-action because both the student and coach respond to surprises in each other's actions as they work together. Through demonstrating/imitating and telling/listening, coaches and students work toward a convergence of meaning, reflecting-in-action both on the design itself and on their own efforts to learn and coach design.

Schön's analysis focuses on one kind of dialog found in the studio—the desk crit, where instructors work individually with each student. But is this the only important kind of dialog in the studio? Is it possible to have a reflective practicum without this level of one-on-one interaction? How and what do students learn through other forms of studio dialog?

Shaffer also discusses modeling other learning environments after the design studio [Shaffer, 1998b]. He identifies three levels at which the studio can be interpreted when adapting it to new situations: surface structure, pedagogy, and substance. The surface structure of the studio includes aspects such as class size, spatial organization, and the number of hours spent by educators and students. Pedagogy refers to the particular activities of the studio (desk crits, pin-ups, jury reviews) and the nature of these activities (providing coaching, scaffolding, generative feedback). Finally, the substance of the studio has to do with the nature of design problems, the underlying educational goals of the studio, and the basic beliefs about knowledge and learning that it embodies. All of these levels are interconnected and build upon one another to make the studio work as a learning environment.

Shaffer cautions against taking a "piecemeal" approach where elements of the studio are adopted without considering how they relate to the studio as a whole. But how much of the studio must be adopted? Can some studio activities be successful in a non-studio environment? Schön's and Shaffer's analyses provide important insights about learning in the design studio, but they still leave many questions unanswered about how these insights can be applied to other learning environments, particularly those that differ from the typical design studio.

## Creating a Learning Environment for CDD

The design studio provides one example of a learning environment that uses CDD, but this research takes the position that CDD can be useful in a variety of situations where students are learning through design projects. Other learning environments differ in important ways from the typical studio environment. For example, they may have larger class sizes and less contact time between educators and students. Courses may have additional learning objectives that do not relate to the design project or design might be a less significant part of the curriculum. Educators may also have to take into account that students, critics, and they themselves might be inexperienced with CDD. However, these environments need not be thought of as impoverished imitations of the design studio—they are complete learning environments in their own right.

For an educator who wants to use CDD there is an endless list of choices to be made: What kinds of projects to use? When and how often to have CDD sessions? What form these sessions should take? Who should participate? What roles should participants play? What are reasonable expectations from using CDD? Educators are, in fact, facing their own complex design problem. As with any design problem, there is no single best solution; each educator must find his/her own solution that works within the constraints they face. This research is aimed at helping educators and others who create learning environments navigate this process.

## Approach

Research in other fields such as education, cognitive science, and design learning provide a rationale for why CDD can be useful in helping students learn from their design activities. The research presented here considers how it can actually be made to work, which involves understanding two things in more detail: what CDD looks like in practice and what is needed to support it.

Two class settings are used to investigate these issues. In the first, an educator uses a series of CDD activities (pin-ups and jury reviews) in an otherwise traditionally organized class on human-computer interaction (HCI) in a computer science department. The educator draws on the traditions of design education but reinvents the activities for this new setting. In many ways, this situation represents what many educators will face when introducing CDD into their classes—an existing class structure that is not set up to support CDD and participants who are not familiar with it. This setting provides an example of what CDD can look like in this kind of environment and demonstrates some of its potentials for helping students learn.

The second setting is a traditional design studio in a school of architecture. In addition to using the common forms of CDD (pin-ups, jury reviews), the educator uses a collaborative website (CoWeb) to conduct a mid-term jury review. This setting therefore provides two opportunities to study CDD, first as it usually occurs in the studio with the participants interacting in person, and second as it is transformed to use an online environment. Unlike the first setting, CDD is already an integral part of this learning environment and the instructor and critics are already very familiar with it, even though it is still new to the students. It is also an activity that students will continue to use throughout their education, instead of being a relatively unique experience as it is for the HCI students.

These two class settings provide several interesting opportunities to study CDD. Studying each setting independently provides a way to understand the details of CDD in that particular setting: how the participants interacted, what topics got discussed, what choices the educator made in creating the learning environment, and how they influenced the CDD that took place. These analyses help to deepen our understanding of what CDD looks like in practice and how it relates to the rest of the learning environment. Contrasting the two settings provides a way to consider CDD, and how to support it, more generally. Looking at the different choices made in supporting CDD in these two very different learning environments begins to illustrate how different choices lead to different outcomes. It also shows why educators might make different choices depending on their particular circumstance and demonstrates the range of options available. No other learning environment will exactly duplicate the ones studied, so more general insights will be the most useful when creating new learning environments. Finally, within the second setting is another opportunity to understand more about CDD. The use of the CoWeb for the mid-term jury review is an experiment in how technology can be designed to support CDD and, at the same time, how CDD activities need to be adjusted to work with a particular technology. Comparing the CDD from the CoWeb with in-person CDD from the same class provides further insight into how dialog is influenced by the environment in which it takes place.

## Research Goal and Questions

As stated at the beginning of this chapter, the goal of this research is to understand how to support critical design dialog among peers and experts in different learning environments. Underlying this goal are three assumptions: 1) that CDD can have a positive impact on design learning, 2) that it can be a useful technique across a variety of design learning environments, and 3) that it is non-obvious how to support CDD in these learning environments. The main goal of this research is not to test these assumptions, but it provides some insight into each of them.

To achieve the research goal, this research addresses the following questions:

1. What does critical design dialog look like in different learning environments? How does it vary across these environments? What characterizes good critical design dialog?
2. What are the choices to be made in designing learning environments to support critical design dialog? What should educators and other designers consider in making these choices?
3. What are the potential roles of technology in supporting and improving critical design dialog? What should be considered in creating and using technology for critical design dialog?

Before continuing, it may be worthwhile to define some terms more clearly. A *learning environment* is the physical, social, and cognitive aspects of the situation in which students learn [Reiser, 1999]. A learning environment includes, among other things: the people in that environment and their roles, skills, and knowledge; the general goals and philosophy of the course; curriculum, pedagogy, and teaching strategies; specific assignments and activities; and the particular tools and media used. For the aspects of the learning environment that the educator can control, certain choices are better than others in helping students learn through CDD. For example, having students work on projects that have some common aspect may be a better choice than having every project be unique when using CDD among peers. If an educator does choose to have unique projects, he/she may need to be more proactive in helping students find common ground for their discussions. A learning environment is not a static “thing” with distinct boundaries but rather a way to think about all of the factors that are in play as students are working and learning.

*Support* for CDD can be provided by the educator, a technology, an activity, or any other aspect of the learning environment. These elements *support* CDD when they meet the needs of participants (teachers, students, critics) while using CDD. For example, participants need to understand a proposed design before they can begin to comment on it. Having students present their designs verbally before the discussion is one way to meet this need. Distributing written descriptions in advance is another. Using a standardized way to describe the design (if a standard exists) can further enhance understanding among participants. Supporting CDD therefore requires identifying and understanding the needs of participants during CDD.

## Contributions

In answering these research questions, this research project makes the following contributions:

- An articulation of some of the choices to be made when using critical design dialog and a rationale for making those choices.
- A demonstration of the viability and benefit to using critical design dialog outside traditional studio settings.
- A description of critical design dialog as it occurs in a real classroom.
- An example of how technology can be used to support critical design dialog and an analysis of its design and use.

## Overview

Table 1-2 shows the relationship between the research questions, the chapters in this dissertation, and the two class settings. The rest of this dissertation is organized as described below.

**Table 1-2. Relationship of chapters, questions, and settings**

<table>
<tr><th colspan="2">Chapter</th><th>Research Question</th><th>Class Setting</th></tr>
<tr><td>III</td><td>Describing CDD</td><td rowspan="2">1. What does CDD look like?</td><td rowspan="3">Human-Computer Interaction</td></tr>
<tr><td>IV</td><td>Impacts of CDD</td></tr>
<tr><td>V</td><td>Discussion: Creating the Learning Environment</td><td>2. Choices in creating the learning environment.</td></tr>
<tr><td>VI</td><td>Technology for CDD</td><td>3. Choices in using technology.</td><td>Architecture</td></tr>
<tr><td>VII</td><td>Discussion: Parameters, Options, Considerations</td><td>2. Choices in creating the learning environment.</td><td rowspan="2">Both</td></tr>
<tr><td>VIII</td><td>Conclusion</td><td>All.</td></tr>
</table>

Chapter II, “Background and Related Work”, presents a review of the literature relevant to this research. First, it reviews several theoretical viewpoints about how students learn through dialog. These theories offer different explanations of why and how dialog can support learning and provide a foundation for interpreting the dialog we observed. The second section reviews empirical studies that explore some of the factors that facilitate learning through dialog. Since our concern is also with facilitating learning through dialog, it is important to integrate our findings with what others have found. The third section describes several projects in which students are learning through design and pays special attention to their use of dialog. These projects show that supporting students in learning through design requires considering the total learning environment and how all its different elements work together. They also demonstrate the varied forms and roles that dialog can play in design learning. The final section reviews how online environments have been used to support design dialog. The design for our online environment drew inspiration from several previous projects, and our results echo some of their findings.

In Chapter III, “Describing Critical Design Dialog”, examines the CDD that occurred when an experienced professor adapted activities from design education for her undergraduate class on the design of computer interfaces. Transcripts from several CDD sessions (pin-ups and jury reviews) are coded and analyzed to understand how participants interacted and what was discussed. Findings show that students were able to initiate and sustain discussions among themselves during the pin-ups with only occasional input from the professor. However, student-to-student dialog tended to be at a very concrete level, concerned more with improving the design than learning from the activity. The professor played an important role in the dialog, helping students move away from the individual projects to consider broader issues and connect their experiences to other ideas in the domain. In the jury review, jurors controlled the dialog by asking questions which students answered. The majority of questions asked by jurors were clarification questions which helped them to understand each team’s design problem and proposed solution. During all the CDD sessions examined, clearly communicating the design and the rationale behind it was a significant task.

Chapter IV, “Examining the Impact of Critical Design Dialog on Students’ Designing”, considers what effects critical design dialog can have on students’ designing.

Data (posters, assignments, a design journal, and final report) collected from four project teams is used. Issues raised in each CDD session are identified and tracked through the rest of the data, noting when they were revisited and by whom. Findings showed that the two pin-ups impacted students' designing in several ways: by bringing new issues, ideas, and problems to their attention; by helping them develop the description and rationale for their project; by providing feedback on specific questions; and by allowing some teams to work through design problems on the spot. Findings also showed that different teams took different lessons from the pin-ups, which were not always directly related to the issues raised during the discussion of their own projects. Jury reviews played a different role than pin-ups and may have influenced students by pushing them to think beyond their current concept of the design.

Chapter V, "Discussion: Creating a Learning Environment for Critical Design Dialog", discusses how the professor created this particular learning environment: What choices were made and why? What were the outcomes of these choices? Parameters related to the project and the critical design dialog are identified. For each of these, the choice made by the professor, the rationale for that choice, and the outcome of that choice are explored. Much of the knowledge that the professor used in making these choices was tacit—a result of her experiences as an educator and researcher. This discussion is an attempt to recover that knowledge, making it explicit and therefore accessible to others. Choices made in creating a learning environment are interrelated and constrain one another. They are also influenced by the professor's views on learning and her goals for the class. After presenting each parameter, the chapter discusses how these factors influenced the choices made in this class. The final section describes our first attempt to support CDD with technology: the Electronic Pin-up Session. Even though its use fell far short of our expectations, it provided many valuable insights about the problems of integrating technology into a classroom activity.

Chapter VI, “Using Technology in Critical Design Dialog”, documents a study that took place in a freshman architecture studio where an instructor was trying a new activity—having remote critics use the web to view and comment on students’ design projects. This activity was modeled after the in-person jury reviews which are common in architecture education. Lessons from a previous effort are presented along with the design of this new activity and technology, called *Student-Curated Galleries*. This chapter has two goals. The first is to understand the affordances and shortcomings of this particular *technology* and *activity* for CDD. The second is to understand more about *CDD itself* and what is needed to support it. These two goals are addressed by comparing the online review with typical in-person reviews. Results showed that this learning environment supported CDD by allowing critics to participate remotely and by being similar enough to in-person reviews to be easily understood by the participants. The main shortcomings were that the slow pace and narrow communication channel limited the dialog and that the design did not take into account some important aspects of the in-person reviews. The analysis also revealed several insights about creating learning environments for CDD: the demands of a flexible pedagogy, the need to clarify participants’ understanding, and the role of the educator in mediating dialog between students and critics.

Chapter VII, “Discussion: Parameters, Options and Major Considerations”, continues the discussion started in Chapter V which looked at how the educator in the human-computer interaction (HCI) class created a learning environment that supported CDD. The learning environment considered in this chapter is the design studio—in particular, the design studio that was the setting for the study in the previous chapter. The same set of parameters developed in Chapter V is used here to examine the choices the educator made in creating this learning environment. Using the same set of parameters facilitates comparing the two class settings. For each parameter, the choice made in the design studio is discussed and compared to the HCI class when interesting differences occur. Comparing the two settings provides a starting point for thinking about these parameters more generally. Therefore, some more options and some things the educator should consider in choosing between them are also discussed.

Chapter VIII is the “Conclusion” and summarizes the results of this research. Results show that there are four important tasks that need to be supported by a learning environment that uses CDD. They are: 1) clear communication of the design idea, 2) a balance of diversity and commonality in student projects, 3) publicness of the dialog, and 4) the role of the educator in mediating and guiding the dialog. The chapter discusses the importance of each of these and suggests ways to support them. Additionally, the special advantages and challenges in using technology to support CDD are discussed. Finally, it identifies directions for future work and provides some closing thoughts about supporting dialog.

# CHAPTER II

# BACKGROUND AND RELATED WORK

This chapter presents a review of the literature relevant to this research. First, it reviews several theoretical viewpoints about how students learn through dialog. These theories offer different explanations of why and how dialog can support learning and provide a foundation for interpreting the dialog we observed. The second section reviews empirical studies that explore some of the factors that facilitate learning through dialog. Since our concern is also with facilitating learning through dialog, it is important to integrate our findings with what others have found. The third section describes several projects in which students are learning through design and pays special attention to their use of dialog. These projects show that supporting students in learning through design requires considering the total learning environment and how all its different elements work together. They also demonstrate the varied forms and roles that dialog can play in design learning. The final section reviews how online environments have been used to support design dialog. The design for our online environment drew inspiration from several previous projects, and our results echo some of their findings.

## Theories of Learning Through Dialog

There is a wide range of theoretical support for the use of dialog in learning, especially when learning from complex activities such as design. This section presents several theories that take different viewpoints on the role of dialog in learning: as a form of reflection, as a way to link the internal and external worlds, as a way to allow incremental and situational understanding, and as an essential part of participating in a community. These views are not necessarily in contradiction. Rather, they highlight the complex relationship between dialog and learning, and they suggest that dialog may play multiple roles in learning, perhaps simultaneously. They inform this research by providing a variety of ways to interpret the dialog we observe in real classrooms.

### Dialog as a Form of Reflection

From a purely cognitive stance, **case-based reasoning** (CBR) theorizes that students must *reflect* on their experiences in order to learn from them [Kolodner, 1997], [Kolodner & Guzdial, 2000]. That is, they must actively organize and express what they have learned. In this view, an effective dialog is a form of reflection during which students make sense of their experiences and connect new knowledge to their existing knowledge.

Case-based reasoning is a general model of cognition that highlights the role of previous experience in responding to present conditions [Kolodner, 1993]. In CBR, previous experiences, called cases, are called upon in order to solve current problems, evaluate solutions, and interpret new situations. CBR is not only relevant to reasoning using previous experiences—it also has implications for learning from experience. Simply having experiences does not ensure that they can be retrieved in relevant situations. What allows a relevant experience to be retrieved is how it is indexed in memory. Experiences, therefore, need to be properly indexed in order for them to be retrieved at appropriate times. Educators have operationalized this idea by having students reflect on their experiences in order to learn from them. Researchers from a variety of disciplines have determined that reflection is a key activity for turning experience into learning even if they do not specifically subscribe to CBR (e.g. [Dixon, 1991a], [Collins, Brown, & Newman, 1989], [Chi, et al., 1994]).

CBR makes some specific recommendations about what needs to happen when students reflect on their experiences or the experiences of others [Kolodner, Hmelo, & Narayanan, 1996]. To make knowledge available for future use, students need to understand: 1) the problem and the solution proposed, 2) to what extent the solution solved the problem, 3) the outcome of solving the problem in this way, and 4) the factors responsible for its success or failure. Students should also think about where this knowledge may be applicable in the future and which of their previous experiences are relevant to the current situation. Dialog, especially when facilitated by the educator, is an important opportunity for students to explore these issues.

## **Linking the Internal and External Worlds**

Through dialog, participants can make their thoughts a part of the external world so that others can be aware of them and respond to them. Others, of course, do not merely respond, but may internalize some of these thoughts and combine them with their own ideas. They then externalize these new ideas through further dialog. Several viewpoints focus on this aspect of dialog— how it serves as a link between the internal and external worlds.

**Cognitive apprenticeship** [Collins, Brown, & Newman, 1989] is a framework for designing learning environments that emphasizes the role of guided experience in developing cognitive skills and the importance of context in learning. It takes the notion of learning through traditional apprenticeship (e.g. craftsman, artisan) and applies it to the learning of cognitive (i.e. unobservable, internalized) skills. In a cognitive apprenticeship, dialog serves mainly to make cognition external and explicit. It makes educators' expert thinking available to students so that it can be imitated, questioned and eventually internalized by students. It also makes students' thinking available to educators, so that appropriate guidance can be provided. The process can also help students become aware of their own thinking and ways of learning.

**Vygotsky's** theories about the relationship between language and thought state this connection even more strongly [Vygotsky, 1978]. One of his central premises is that learning is a social process, specifically an internalization process:

> Every function in the child's cultural development appears twice, on two levels. First, on the social and later on the psychological level; first *between* people (*interpsychological*), and then *inside* the child (*intraspsychological*)….All the higher [psychological] functions originate as actual relations between human individuals. [Vygotsky, 1978], (emphasis original)

This explains how a student achieves more over time through guidance and collaboration—he/she internalizes the cognitive functions until the social support is no longer needed. For this reason, Vygotsky placed great emphasis on the use of dialog and other forms of social interaction in learning.

## Incremental and Situational Aspects of Dialog

During dialog, participants put forth ideas, ask questions, point out contradictions, agree with each other, etc. Through this interaction, participants can gradually and incrementally build up an understanding of the concepts being discussed. The meaning in dialog is not just in the words that are spoken, however, but in the relationship between participants' words, actions, and the situation they are in. Actions can show what it is difficult to explain in words; words like "this" and "here" are only clear within a shared situation. The situational nature of dialog is what allows participants to begin building a common understanding that they can incrementally refine. Several theories consider how this combination of the incremental and situational aspects of dialog support learning.

Roschelle's theory of **convergent conceptual change** shows how dialog allows for the incremental development and refinement of ideas over time, even when using imprecise language [Roschelle, 1996]. This theory draws upon other research in conversational analysis which showed that during dialog participants build, monitor, and repair shared knowledge [Sacks, Schegloff, & Jefferson, 1974]. Roschelle's research showed that a pair of students was able to reach a new, shared, more scientific concept of motion by gradually refining partial and ambiguous concepts. As they worked, they questioned each other, explained things to each other, and held each other to increasingly higher standards of evidence. A paradoxical feature of their dialog was that they used ambiguous, imprecise, and metaphorical language—yet they were were able to communicate effectively. Roschelle explains that such an interpretation fails to take into account the situated aspect of dialog; they were able to communicate clearly because of the shared situation and shared concepts they had built.

Another theory that highlights the incremental nature of dialog is the **zone of proximal development** (ZPD), an idea put forth by Vygotsky to explain the interaction between learning and development in children [Vygotsky, 1978]. The ZPD is the "distance" between what a student can achieve when working independently and what he/she can achieve with guidance or collaboration from a more capable peer or adult. The student learns incrementally and over time is able to achieve more independently. The ZPD gradually shifts to include more complicated tasks. It is through dialog and social interaction, which the student is internalizing, that the ZPD is advanced.

Cognitive apprenticeship and other theories describe some dialog as **coaching**, particularly when it is between participants of unequal skill (usually an educator and a student). The key feature of coaching is that it occurs in the moment, reacting to what a student has said or done and invoking a further reaction from the student. It is highly interactive and immediately relevant to what the student is trying to achieve. Several strategies that coaches use are modeling (demonstrating a task that the student will eventually perform), scaffolding (taking over part of a task so that the student can complete it), and providing feedback, hints, and reminders. It is the incremental, reactive, and situated aspects of coaching that make it a useful pedagogical technique.

**Dialog as Participation in a Community**

Finally, several theories understand dialog as an important form of participation in a community. All of these theories are less concerned with how dialog affects the individual and more concerned with how it sustains and builds the community. Learning is then an integral part of continuing participation in the community, not a special task for students to undertake.

Lave and Wenger emphasize the fundamentally social nature of learning and view it as a process of increasing participation in a community of practice [Lave & Wenger, 1991]. Part of participating in a community, therefore, is using its terminology and ways of communicating. They contrast their position with Vygotsky's view of learning as an internalization process and disagree with the idea of a sharp contrast between the internal and external worlds. In their view, knowledge is not something that resides in our brains but exists in our actions and interactions with the world. Dialog, action, knowing, and learning are intertwined as one participates in the community.

Brown and Campione's "Community of Learners" [Brown & Campione, 1994] and Scardamalia and Bereiter's "Knowledge-Building Communities" [Scardamalia & Bereiter, 1996] also emphasize the relationship between community and learning. The researchers describe the activities of the Community of Learners classroom as "essentially dialogic" [Brown & Campione, 1994], meaning that the activities involve testing, comparing, and exchanging ideas. Some of these involve a literal dialog: for example, in reciprocal teaching, when students question one another about passages they have just read. Others are a kind of internalized dialog: for example, when students are judging the evidence for scientific claims. It is through these dialogic activities that students become a community and build a common voice, knowledge base, set of practices, and beliefs.

The idea of schools as Knowledge-Building Communities (KBC) comes from studying how other knowledge-building communities work, namely the research community. Individual members of the research community contribute to a common knowledge base (e.g. through journals and other publications); other members then build upon, challenge, and defend each others' work. As a result, collective knowledge grows. A central part of a KBC is knowledge-building discourse, defined as: 1) focusing on problems rather than topics, 2) being decentralized and aimed at building collective knowledge, and 3) interacting with the broader community [Scardamalia & Bereiter, 1996]. The researchers aim to emulate this kind of community-building and knowledge-building discourse in schools with the support of technology.

## Factors that Support Learning Through Dialog

This section presents empirical research about some of the factors that support students in learning through dialog. Our research supports and expands upon these findings.

### Facilitation of Full-Class Discussion

A frequent finding is that some facilitation from the educator during the dialog can support learning, especially when the aim is to arrive at a normative view of the domain or address specific learning goals. [Roth & McGinn, 1996] reported that a teacher's questions during full-class discussions brought students' attention to more scientific and technical concerns (the intended topics of the class). In [Enyedy, Vahey, & Gifford, 1998], the teacher guided students who were learning about probability through empirical tests to resolve their conflicting results and to formalize their conclusion with mathematical language. [diSessa, 2000] showed how a teacher helped students evaluate and combine their idiosyncratic representations of speed and acceleration to "discover" standard graphs. [van Zee & Minstrell, 1997] explored in detail how a certain kind of questioning, which they call a *reflective toss*, helped the teacher achieve certain learning goals in a high school physics class.

## Diverse Experiences or Ideas

Another feature shared by all of the studies mentioned above is that prior to the full-class discussion, students had a chance to experience a phenomenon or develop their ideas individually or in small groups. Additionally, these individual experiences were diverse, which provided both something to talk about and something unique for each student (or small group) to contribute to the discussion. For example, in [Enyedy, Vahey, & Gifford, 1998] students worked in small groups to determine through experimentation whether a coin-toss game was fair to both players. Different groups came to different conclusions based on the particular data that they generated, which set the stage for a discussion of probability and the limits of simulation tools. In another example [van Zee & Minstrell, 1997], the problem was to determine whether a hypothetical drunk driver should be charged, and students were given a set of conflicting measurements of the drivers' blood alcohol level. In making their decision, students had to explain how they arrived at a final number, raising the issue of error in measurement. These problems, and all the ones in the studies described above, have multiple interpretations and multiple valid outcomes. Design problems also have this feature by definition, which is why they provide a rich environment for learning (e.g. [Kolodner, et al., 1998], [Harel & Papert, 1991]).

**Artifacts to Anchor Dialog**

Dialog can also be facilitated by the artifacts that are available; different kinds of artifacts may also facilitate different kinds of dialog. [Guzdial & Turns, 2000] showed that providing *anchors* in an online discussion environment—a design to critique, a page of typical exam questions, or a student project—facilitated more sustained and on-topic discussion than an environment that lacked anchors. [Roth & McGinn, 1996] found that the dialog around an artifact varied depending on who had created it. Student-created artifacts facilitated discussion about topics of interest to students and allowed the discussion to start at their current level of understanding. Teacher-created artifacts led the discussion to consider mainly topics that the teacher had chosen but also facilitated use of more scientific language. In [Conanan & Pinkard, 2001], students reported that they felt that the way they had represented their software designs—as screen shots with descriptive text—encouraged discussion only on the visual and superficial aspects of their designs.

**Publicness of Dialog**

The most obvious example of public dialog is full-class discussion: everyone has access to what is being said. Not everyone gets a turn to speak—especially if the class is large—but the assumption is that students benefit by listening to the dialog as well. The Vicarious Learner project [Cox, et al, 1999] investigated this idea and showed that students learned as much from listening to a spontaneous dialog (between a student and tutor) as they learned from listening to an explanation (from the tutor only). Although this was a laboratory study and not in a real classroom, it suggests that there is some benefit from simply listening to dialog.

Publicness facilitates dialog in other ways as well. For example, [Kafai & Harel, 1991a] identify a phenomenon they call “collaboration in the air.” It refers to the unique kind of collaboration and dialog that occur as a result of working in a public environment, where students can casually see and hear what is happening around the classroom. Students spontaneously help each other, share information, and pick up new ideas. [Hmelo, Holton, & Kolodner, 2000] report a similar observation in their study. [O’Neill & Scardamalia, 2000] report on the importance of publicness in telementoring (communicating with mentors electronically). Their previous research showed that students did not always know how to take advantage of a telementoring dialog. Making the communication between mentors and mentees “public”, in a shared online environment, meant that students could (and did) look at other telementoring dialogs for ideas on what to do and what to expect.

Our research provides additional support for many of these finding but also adds some new insights. For example, we also document the importance of having the educator facilitate full-class discussion, but, in addition, we show that the educator plays an additional mediating role when external critics join the dialog. We build on the insight that students need diverse experiences to discuss by adding that they also need some common ground and perhaps help in finding it.

## Learning Through Design

The traditional design studio is not the only learning environment that makes extensive use of dialog. Many projects that have students learning through design use dialog as an important pedagogical technique. This section reviews several such projects with particular emphasis on their use of and findings related to dialog.

**Learning by Design** [Kolodner, et al., 1998], [Hmelo, Holton, & Kolodner, 2000] is an ongoing project that teaches middle-school science topics through design projects. Students are presented with a design challenge (for example, designing a car to carry a load over a hilly terrain) and then iteratively build, test, and conduct research to improve their designs. Dialog plays a central role in Learning by Design. Whole-class discussions led by the teacher help students manage their learning process and connect their experiences to science. These also give the teacher a chance to recognize misunderstandings and identify learning needs. Other events called "gallery walks" and "pin-up sessions" give students multiple opportunities to share their ideas, justify their designs, and constructively critique each other's work. Electronic discussions are also used as a way for students to interact across classes [Kolodner & Nagel, 1999]. More recently, dialog with experts is being included as a way to provide students with more feedback on their ideas and to clarify their understanding of science [Camp, et al., 2000]. During all of these, students have the chance to use science vocabulary in explaining their designs and rationale and asking questions of others. They also develop their science skills of explaining, justifying, and identifying patterns and trends.

In this project, dialog is part of a system of distributed scaffolding [Puntambekar & Kolodner, 1998] where different artifacts and activities help students complete and learn from the design challenges with which they are presented. In one study, there were no full-class discussions and researchers noted that students did not reflect or share ideas on their own [Puntambekar & Kolodner, 1998]. They also noted that students' lack of knowledge and rationale was not revealed until the very end of the project, when it was too late for the teacher to address them. These observations emphasize the need for dialog throughout the design process. The software tools used in Learning by Design and the lessons drawn from their use are discussed in the next section.

The **Instructional Software Design Project (ISDP)** [Harel & Papert, 1991], [Kafai & Harel, 1991a] examined how students learned fractions and Logo programming through designing and developing instructional software. Students worked in a "software design studio" that had many features of an architectural studio: a physically open setting where students could move freely and organize their own time; open-ended, self-directed design problems; a common problem but individual solutions; many opportunities for discussion with others; and an extended period of time in which to work. In addition to opportunistic dialog among peers and adults, the project had several whole-class "focus groups" organized on demand and monthly "demos" for the third-grade class (the target audience for the software being developed).

For the most part, dialog as used in this project was informal, opportunistic, and often between peers. Dialog occurred spontaneously within the collaborative and social environment that the project provided. A more specialized use of dialog was in the second phase of the project, when students who had designed software in the first phase acted as consultants for students who were just beginning their software designs [Kafai & Harel, 1991b]. Through this activity, the senior students reflected on their understanding of fractions, software design, and Logo as they attempted to understand and advise the younger students. The researchers attribute much of the success of this project to the social and collaborative aspects of this learning environment, which created both the need and the opportunity for students to share their knowledge and ideas with one another. They continue to investigate how children learn in this kind of learning environment (e.g. [Kafai & Ching, 2001]).

**Escher's World** [Shaffer, 1996], [Shaffer, 1998a] explored students' learning of mathematics and design concepts in a studio setting. The project approximated a traditional design studio by allowing students to spend extended periods of time working on their own designs to express some given mathematical concept and by including regular desk crits, pin-ups, and jury reviews. Students could also collaborate and talk with other students informally as they worked on their projects. One of the many findings from this project was that dialog played a key role in helping students turn their design activities into mathematical insights. Students were more likely to have a mathematical insight when talking with a peer and even more likely to have one when talking with a program leader (adult), as opposed to when working alone.

Although these projects have all dealt with teaching and learning through design, they have varied widely in their details. The subject matter, the particular activities, the time frame, and even the underlying theories are all different. The common thread however, is that they demonstrate the importance of supporting educational design activities with dialog. These projects inform the research presented here by showing the varied forms and roles that dialog can play in learning. Perhaps even more significantly, they are a reminder that classroom dialog is embedded in a larger learning environment, and that many parts of this environment must work together to support learning. These projects understand the learning environment as an interconnected set of people, tools, and activities; a view we share. They serve as models for creating and studying this kind of learning environment.

## Technology Supporting Online Design Dialog

Computers have been used for many different purposes in design education, including: as a constructive medium (e.g. [Harel & Papert, 1991], [Shaffer, 1996]), as a repository of knowledge and information (e.g. [Zimring, et al., 1995], [Wojtowicz, 1995]), and as a reflective medium (e.g. [Kolodner & Nagel, 1999], [Turns, 1998]). This research examines how computers can serve as a communication channel between peers and experts and support dialog about design. The first section below considers why an online environment for dialog might be useful, and the second reviews other projects that have used online discussion in support of design.

**Why Use Online Environments for Design Dialog?**

One of the most compelling reasons for using an online environment for dialog is that it can allow participants to overcome limitations of location and time. A variety of technologies are available that allow people to communicate at the same time (e.g. chat, videoconferencing) or at different times (e.g. email, collaborative websites) from any location with access to the internet. As a result, the dialog can be broadened to include participants who could not easily meet face-to-face. For example, remote experts can review and comment on student projects [Craig & Zimring, 2000], large classes can hold online discussions [Craig, et al., 2000], and students can comment on the work of their peers in other classes [Kolodner & Nagel, 1999]. An interesting side effect of some online environments is that the online dialog becomes an artifact in itself and open to further discussion beyond the initial participants. An accumulation of projects, discussions, and critiques can be a useful resource for future students as well.

An ongoing issue in the use of online environments, particularly for design, is the difficulty in bridging the online and offline worlds. Much design work is done in physical media (drawings, models, whiteboards, index cards), which are in many ways superior to digital media for some tasks. These media (or more specifically, these design representations) are often the foundation for dialog about design and therefore must be brought into the online environment. Currently this is a time-consuming task which can lead to impoverished (photos of physical models) or clumsy (scrolling around large images) versions of the original representations. It is likely that over time, this will be less of a problem as all-digital representations (e.g. [Gross, 1996]) and physical-digital hybrids (e.g. [Arias, et al., 1999]) become more sophisticated. For now, however, bridging the physical and digital worlds is both a problem and a challenge in using online environments for dialog about design.

## Online Environments for Design Dialog

General-purpose tools for online discussion such as **newsgroups**, **CaMILE** [Guzdial & Turns, 2000], and **CoWebs** [Guzdial, Rick, & Kehoe, 2001] have been used in classes to support discussion on a variety of topics, including design. Although they differ in their details, they all provide a mechanism for sharing messages with a group of people. Many have the additional feature of creating an archive of messages as they are written.

The **Design Discussion Area** [Kolodner & Nagel, 1999] and its predecessor, **WebSMILE** [Puntambekar, et al, 1997], were used in the Learning by Design project and were specifically designed to support the activities that students participated in during class. WebSMILE evolved from WebCaMILE and was used to share ideas across different classrooms and to allow peers to review each other's design alternatives. The Design Discussion Area (DDA) served a similar purpose, but provided much more specific scaffolding. It provided advice and guidance for students as they worked to describe their own projects and to give feedback to other groups in other classes. A study of DDA use showed that teachers used the software in unexpected ways, which made the scaffolding, and perhaps the software itself, less useful than expected [Kolodner & Nagel, 1999]. This study highlights the difficulty of designing software that is specific enough to help students accomplish their tasks but general enough to support a variety of uses. In a different study, where the software was used as expected, results showed that the discussion in the DDA was a good compliment to discussion among teammates and that different issues were discussed in each forum [Puntambekar, et al, 1997]. In the DDA, students offered and requested more justification for design decisions and discussed the high-level function of their designs, whereas within-team discussion was more concerned with the structural components of the design and the environment in which it had to operate.

The software used in the research reported here drew inspiration from the DDA in in the way it scaffolded the students' task of creating an online presentation of their work. Our software provided structure for the technical task of creating and arranging the images and text, while leaving the guidance in terms of content as a role for the instructor. The results of this research echo many of the findings from the DDA: that communicating the design idea is a key task, that balancing structure and flexibility in software is difficult, and that design justification and functionality seem to be natural across-group discussion topics.

**Studio Zone** [Conanan & Pinkard, 2001] is an online environment designed to scaffold students' thinking, in the form of prompts and guiding questions, as they present their design projects and critique the projects of others. It also acts as an archive of each design's development. A study of Studio Zone revealed the importance of creating shared norms for online critique. For example, some students withheld negative comments, not wanting to "create more work" for their peers. At the same time, other students complained that the comments they received were "too nice" [Conanan & Pinkard, 2001].

Not knowing what to critique and how to critique it was also reported as a inhibiting factor in the discussion. The guiding questions and asynchronous format were cited as strengths of the system, while the limited dialog structure, the time required to respond to all projects, and the emphasis on visual appearance over substance were cited as weaknesses.

Studio Zone was being created and studied at the same time as our software but many of the findings are complimentary. Our results also found that reviewing and responding to projects online was time consuming and that the dialog structure we used was limiting (although it was not a technical constraint as in Studio Zone). We did not encounter the lack of shared norms found in the Studio Zone study, perhaps because our participants were already familiar with the norms of critiquing found in architecture education.

In the **Virtual Design Studio** project, architecture studios from four distant universities collaborated for several weeks on a design project [Wojtowicz, 1995]. Their final jury review was held via video phone with critics participating from each location. Images to be discussed were distributed on video disk to the four locations prior to the review. The project uncovered many of the difficulties in this kind of synchronous online review, including: dealing with equipment breakdown, the need for high quality images, and a schedule that accommodates time zone differences. Overall, however, the project demonstrated the viability of using remote critics in design reviews.

A very different approach to using remote critics was taken by the **CoOLStudio** project [Craig & Zimring, 2000]. It used a CoWeb [Guzdial, Rick, & Kehoe, 2001], an asynchronous web-based environment that supported text and images, to allow remote critics to comment on the work of graduate students in an architecture studio. Rather than building support into the technology, CoOL Studio relied on participants' knowledge of offline reviews to guide them in conducting the online review. Students created pages on the CoWeb that contained images and text describing their project, and critics were asked to view the pages and add their comments wherever they seemed appropriate. Overall, the project was a success, but it revealed many issues that needed to be taken into account when conducting an asynchronous, written review with remote critics.

Our research builds very directly off the CoOL Studio project. It used the next generation of the CoWeb software in a very similar way, but some adjustments were made based on the lessons learned in CoOL Studio. Results from CoOL Studio and its influence on this research is discussed in detail in Chapter VI.

**Kvan, Yip, and Vera** make the surprising suggestion that "low-bandwidth" communication can sometimes be better for design communication than "high-bandwidth" [Kvan, Yip, & Vera, 1999]. Their study showed that pairs of designers using chat-room connections had richer design explorations than pairs using audio/video connections. In other words, the chat-room users discussed more high-level design ideas and spent less time discussing details. This more extensive exploration of the design space is believed to ultimately result in better designs.

These results suggest that using text-based design communication—which is generally cheaper, easier to use, and more widely available than high-bandwidth communication—may actually be beneficial during some parts of the design process. In the study, participants were collaborating on a design problem, but in our research, existing work is being reviewed by critics. In our software, students used both images and text to communicate their design ideas, but critics responded with text only. Additionally, the interaction in our study was asynchronous. Because of these differences, it is not clear whether the results of the study are applicable in our situation, but they do provide some justification for using text to communicate about design.

## Summary

This chapter has presented a variety of related work that has influenced this research. The theoretical viewpoints serve as a reminder of the complex relationship between dialog and learning. Empirical research identifies several key factors in facilitating learning through dialog. Several projects demonstrate the roles that dialog plays in learning through design. A review of other online environments for design dialog demonstrate the range of approaches taken and the lessons learned.

# CHAPTER III

## DESCRIBING CRITICAL DESIGN DIALOG

This study examines the critical design dialog (CDD) that occurred when an experienced professor adapted activities from design education for her undergraduate class on the design of computer interfaces. Transcripts from several CDD sessions (pin-ups and jury reviews) are coded and analyzed to understand how participants interacted and what was discussed. Findings show that students were able to initiate and sustain discussions among themselves during the pin-ups with only occasional input from the professor. However, student-to-student dialog tended to be at a very concrete level, concerned more with improving the design than learning from the activity. The professor played an important role in the dialog, helping students move away from the individual projects to consider broader issues and connect their experiences to other ideas in the domain. In the jury review, jurors controlled the dialog by asking questions which students answered. The majority of questions asked by jurors were clarification questions which helped them to understand each team's design problem and proposed solution. During all the CDD sessions examined, clearly communicating the design and the rationale behind it was a significant task.

## Introduction

Chapter I introduced the idea of critical design dialog (CDD) by listing some of its characteristics and contrasting these with other kinds of dialog. However, this is only an abstract and idealized description of CDD. Creating software or a learning environment to support CDD requires more detailed knowledge: Who is speaking? Who asks the questions? What are they discussing and why? To understand how to support CDD, it is important to study how it actually occurs in practice.

This study examines the CDD that occurred when an experienced professor adapted activities from design education for her undergraduate class on the design of computer interfaces (i.e. human-computer interaction (HCI)). This class was studied not only because of the professor's expertise, but because she was working within a class structure that was not set up to support CDD and with participants who were not familiar with it. These features are typical of classrooms outside of traditional design disciplines, and this study investigates CDD's viability in this environment. Transcripts from several CDD sessions (pin-ups and jury reviews) were coded and analyzed to understand how participants interacted, what they discussed, and what seemed to motivate their discussion.

Three different methods of analysis are used. First, patterns of participation in each session are examined. This shows, for example, who did most of the speaking, how the participants interacted, and how these patterns changed over time. Patterns of interaction highlight the distinctions between this kind of dialog and other classroom discussions. For example, the "teacher initiates—student responds—teacher evaluates" pattern of participation has been documented in classrooms by many studies (e.g. [Cazden, 1988], [Scardamalia & Bereiter, 1996], [Wilen, 1990]). This pattern illustrates both the typical roles for teacher and student and the typical proportion of speaking turns. The patterns of participation in CDD make for a notable contrast.

The second analysis examines the content of the dialogs. It begins by characterizing discussions as dealing with either the design *process* or the design *product*. It then examines how different speaker groups (e.g. the students and the professor) participate in each kind of discussion. Informal observation of CDD in other classes suggested that there might be important differences between the kinds of issues raised by students and the kinds raised by professors or other experts during the discussions. In particular, it seemed that professors would be more likely to focus on the design process, while students would emphasize the design product. This could be for a variety of reasons: professors might be more explicitly aware of the process; they could have more of a vocabulary to describe the process; or they may see the process as the generalizable knowledge to be learned from the class. Regardless of the reason, this potential difference in focus could be important in learning environments where the professor did not participate as actively in the discussion. The second half of this analysis shows how fifteen discussion topics are distributed across the different sessions and different speaker groups. The goal of this analysis was not to exhaustively document all the topics that were discussed, but to test whether or not discussion topics changed over time and if different groups discussed different topics. The topics were developed by reading each discussion and either assigning it a topic code from the existing set or developing a new code if none applied. The fifteen topics chosen for the final analysis were those that could be clearly defined and which occurred more than once in the dialog.

The final analysis identifies techniques that speakers seem to be using as they participate in the discussion. To say that a speaker is using a particular technique is to infer the goal behind a particular comment or question. Comments and questions are, in part, reactions to the discussion taking place, but they also provide some insight into how the speakers see their role in the discussion. For example, the professor might ask a student to expand further upon a comment he/she made. More than a simple request for information, the professor might also be testing the extent of the students' knowledge or trying to lead him/her to some insight about his/her project. In other words, she might have an evaluation goal or a learning goal in mind. Inferring the techniques of speakers based on what they say is highly speculative; they may not even be employing these techniques consciously. But as humans, we routinely make these kinds of inferences when we communicate with each other. The techniques in this analysis were identified by taking all the speaking turns from a particular group and examining them carefully for recurring kinds of comments. As with the analysis of discussion topics, the result is not an exhaustive list of techniques but a demonstration that there are some regularities in the kind of comments made by different speaker groups. Identifying these regularities (or techniques) provides some insight into participants' goals and roles in the dialog.

In summary, the purpose of this study is to understand in a more detailed way what critical design dialog is: what the features that distinguish it from other classroom activities and discussions; how it is different in different settings (i.e. pin-ups vs. jury reviews; what someone should expect when participating in CDD; and what roles might need to be filled.

## Setting

### Overview of Course

This study was conducted in an undergraduate introductory Human-Computer Interaction (HCI) course in the College of Computing at the Georgia Institute of Technology. This is a senior level course which is taken by approximately 40 students at a time. However, since the course does not have any prerequisites, students may take the course at any time in their academic career. The majority of students who take this course are computer science majors taking it as an elective, but it is also popular among other majors on campus (e.g. engineering, industrial design, psychology) because it does not require a great deal of programming knowledge. It is also cross-listed with the School of Psychology.

This course is taught by many different faculty members and instructors, who have a good amount of freedom to tailor the course to suit their strengths and interests. This particular study was conducted in Fall Quarter 1998 when the course was being taught by Dr. Wendy Newstetter, who defined the course goals as:

- To understand usability and usefulness of a computer system from the user's perspective.
- To gain awareness of human capabilities/limitations and how they impact interaction.

- To gain experience critiquing, analyzing and redesigning interfaces based on principles of user-centered design.

Dr. Newstetter has a particular interest in design education and experience with different techniques for teaching design, both of which played a central role in shaping the course. However, this was her first time adapting these techniques for this course.

The course met for two 90-minute periods each week for 11 weeks. In-class activities and short lectures covered a variety of topics including user-centered design, design representations, interaction styles, task analysis, requirements definition, design rationale, and evaluation techniques. Students were also assigned readings from the two texts for the course ([Newman & Lamming, 1995], [Norman, 1990]). Assessment was based on both an individual portion (40%) and a team project (60%). The individual portion was two short homework assignments done in the first half of the quarter (Weeks 2 and 4). The team portion was a design project that took place during the second half of the quarter.

## Team Project

Students were responsible for forming their own teams of 3-4 students and choosing a project in Weeks 3 and 4. Projects were open-ended and culminated in an electronic prototype of a proposed interface design. Students could choose one of the professor-suggested projects or propose their own. The professor solicited ideas from around campus and chose several that she felt would make for good projects. Some of the projects, therefore, had actual “clients” who were interested in the designs that students would be creating. In the case of the GVU Survey Website, one of the clients was also the teaching assistant for the class. For the CNS Help system, one student was employed by the client. Clients for other projects had no specific connection to the class. The professor also encouraged having more than one team working on the same project. Table 3-1 shows the topics of the projects for the class, who suggested each, and how many teams chose each project.

**Table 3-1. Projects and Properties**

| **Project Topic** | **Suggested by** | **Number of Teams** |
|---|---|---|
| In-Store Information Kiosk | Professor/Client | 3 |
| Website Administrator Monitor | Professor | 2 |
| Interface for JR | Client | 2 |
| CNS Help system | Client | 2 |
| GVU Survey Website | Client (TA) | 1 |
| Website Change Updater | Professor | 1 |
| Home Messaging System | Students | 1 |

Each potential project was described in a design brief prepared by the client or professor. Figure 3-1 is an example of a typical design brief, although some had more and many had less detail. Teams chose their projects based on these briefs, which is the extent of the information that they received about the project. The projects were purposely broad, requiring students to first define the problem more clearly before they could propose a solution. Teams were expected to research the topic and, under the guidance of the professor and the rest of the class, identify a more specific problem they would solve.

In-store Information Kiosk

Contact: Wendy Newstetter (wendy@cc.gatech.edu) for NCR

Description:

This system will provide information to customers within a physical retail store, such as Wal*Mart or Macy's. In considering appropriate functionality for the system, consider the types of tasks that consumers perform within a store. For example, consumers might want to get more detailed product information than they can get from the packaging or from a store associate. Or, they might want to know where a particular product in located within the store. You should also consider the ways in which an internet-based kiosk could interact with a virtual electronic store. For example, the consumer could search for product information on the Internet, and then enter the store to complete the transaction. Other issues to consider include:

- How can your underlying interface design transfer to other retail environments (e.g., from Wal*Mart to Blockbuster to The Gap?)
- How do issues such as branding come into play? How does the electronic store interact with the kiosk in the physical store?
- Speed of transaction, although important, is less critical than minimizing errors.
- The scope of this system does not include self-checkout.
- Consider the environment in which this system will be placed. How many should be in a store? Where should they be placed? How do consumers become aware of it and what it can do? How will store personnel interact with it?
- Where does content for the system come from? How is content updated?
- Think about how a retailer might cost-justify such a system. How does having such a system reduce operational costs or increase revenue?

Make the following assumptions about the system configuration:

- Touch screen
- Internet-based
- No alpha-numeric keypad (Implication: minimize user input)
- Credit-card swipe scanner integrated into hardware
- Integrated speakers

**Figure 3-1. Design brief for the In-store Information Kiosk project**

Methods of research included investigating existing systems, identifying and interviewing potential users, interacting with clients, observing behavior, and studying the physical environment. Teams chose methods that were appropriate for their projects.

A unique feature of the course was that teams made multiple presentations about their projects during the quarter. Figure 3-2 shows a timeline for these presentations. One

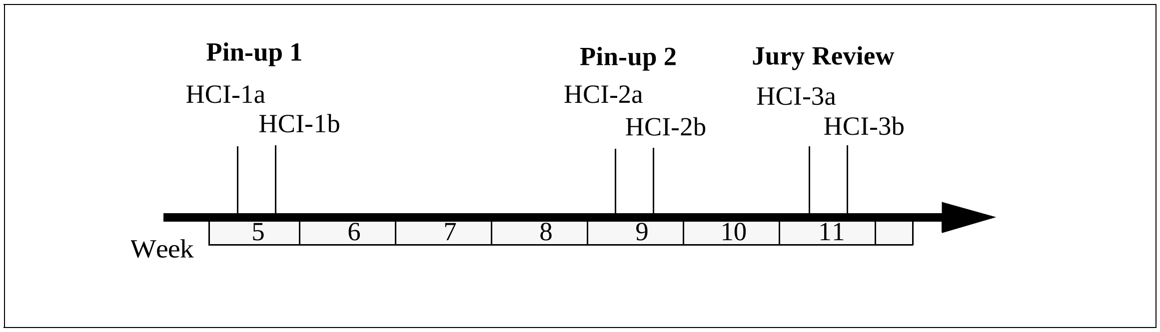


**Figure 3-2. Timeline of class presentations**

kind of presentation was a *pin-up*—a technique adapted from architecture education where students literally “pin up” their works-in-progress to discuss with their classmates and professors. There were two pin-ups held during the project, at Week 5 and Week 9 (the project development finished at the end of Week 10). Each pin-up required two 90-minute class periods (shown as -a and -b in Figure 3-2) so that all 12 teams would have a chance to present their work, with half presenting each day. Every team prepared a poster describing their project and their work up to that point. The first two sessions (HCI-1a and -1b) were conducted in a typical classroom, with desks pushed to the middle of the room to allow access to the walls for hanging posters. The next two sessions (HCI-2a and -2b) were conducted in a specialized pin-up area in the College of Architecture. This area allowed posters to be attached to the walls and the class to move around and view them easily. For approximately the first 20 minutes of each session, students wandered around individually to view the posters created by the teams presenting that day. Posters also included an area where viewers could leave written comments, and in some cases the team posed specific questions for viewers to answer. For the remainder of each session, teams presented their work one at a time. The professor and the rest of the class gathered around one poster while one of the team members stood near the poster, usually making a brief presentation and then opening the floor to comments and questions from the group. The professor acted as timekeeper, cutting off the discussion when it was time to move on to the next team.

The final presentation was a *jury review*, also adapted from architecture education, where students present their work to a panel of invited experts who are other professors or working professionals. In this case, the invited experts were professors from HCI and related fields. The jury review also took place over two 90 minute class periods in Week 11. A different set of invited experts attended each session. The session began with one team giving its presentation to the jury, explaining their problem, and walking through several scenarios to describe their solution. During and immediately following the presentation the team would answer questions of clarification. Then, a second team would present their project the same way. After this, the first team returned to join the second team at the front of the room, and the floor was opened for questions from the invited experts. As time permitted, other students were also allowed to ask questions or make comments. The discussions were organized in pairs to encourage comparison or highlight contrasts between the projects. The process was repeated with additional pairs of teams until the session was over. Once again, the professor acted as timekeeper and facilitator for the session.

## Investigation

Five of the sessions were audio taped and transcribed: the second part of Pin-up 1 (HCI-1b), both parts of Pin-up 2 (HCI-2a and HCI-2b), and both parts of the jury review (HCI-3a and HCI-3b). For logistical reasons, the first part of Pin-up 1 could not be recorded and is not included in this analysis. The same professor and approximately 30 students participated in all the sessions. A teaching assistant also participated in all but HCI-2b. Four invited experts participated in HCI-3a and a different set of three invited experts participated in HCI-3b.

There are a total of 1200 speaking turns in these five sessions. For the purpose of this study, a *turn* of dialog is an uninterrupted segment of speaking by a single speaker.[1] Examples of several sequential turns are shown in Figure 3-3.

For some analyses described in this chapter, turns are aggregated into *discussions*. A discussion is a sequence of turns that relate to one another. Discussions are distinguished by a new speaker, a new question, and/or a significant change in topic. An example of two sequential discussions are shown in Figure 3-4.

1. One aspect of the data which is not available because of this choice is the length of any turn. In other words, it does not differentiate between a long, multi-sentence turn and a short turn (i.e. “Yeah.”).

| | |
|---|---|
| Turn 1 | WN: What's the rationale for using the metaphor that you're using? |
| Turn 2 | S4: Basically, it seems to be...we're addressing a similar problem so, I guess the rationale is that since it's a similar problem so we're going to use a similar solution. |
| Turn 3 | S6: Lots of people imitate the Yahoo interface so it seems that more people would be familiar with that sort of interface. |
| Turn 4 | S4: I think it's like people will walk up and say "Oh, this is Yahoo. Let's use it like we use Yahoo." |
| Turn 5 | WN: What are the features or what are the components of a Yahoo interface that are critical to your redesign? |
| Turn 6 | S4: Um, let's see. Well, comparing it to this [current interface for the website], this has the listing by surveys but it's kind of opaque. You know it's a survey but if you don't know what's in the survey and you don't know exactly what you're looking for in the survey, you get the information that you want. I mean, you're going to have to go through every one. The way that Yahoo does it is, it has the category titles.. |

**Figure 3-3. An example of several sequential turns**

| | |
|---|---|
| Discussion 1 | S9: One quick question, how is JR going to fill out forms if he has to?<br><br>S7: He is just going to be able to go to the hypertext system and he would select the field that he wants to go to and if it's a text field then he would use text entry and that would pop up, if he was doing radio buttons he would just do select...yeah..<br><br>S3: Well, along those same lines...then while he's doing that..okay once he's finished filling in one element of the form, will he have to hit hypertext again, go through the entire process of subdividing it to go to the next one he wanted to do, then do that each time or would it be smart enough to figure out "okay, he wants to fill in this form" and just start bouncing between all the different form elements....<br><br>S7: We haven't..we haven't thought about that...<br><br>S8: ...a very good point...<br><br>S7: ...but that's a very good point. |
| Discussion 2 | S10: One thing that I was thinking of...a lot of times people read a web page with multiple screens...<br><br>S7: Okay...<br><br>S10: ...they're gonna need to scroll...it would be handy to have a button that would just turn on like a timed scrolling...<br><br>S7: As you can see on this poster right here...<br><br>[general laughter]<br><br>S7: ...it covers a variety of stop and move options...we spent about an hour working on how he would scroll and the way we...we had three sets of scrolling options... |

**Figure 3-4. An example of two sequential discussions**

Transcripts of the five sessions were read into the QSR NUD*IST software, a program designed to facilitate qualitative data analysis.[2] NUD*IST was used to associate codes developed by the researcher with different segments of the transcripts. Once coded, NUD*IST was then used in several ways to examine the data. One method was to select parts of the data for closer examination. For example, all of the professor's comments from HCI-2a could be extracted from the full transcript, making interesting patterns easier to find. (A single keystroke allows the context for any comment to be revealed as needed.) NUD*IST was also used to count the occurrence of items of interest. For example, the boolean search function was used to count the number of process-related discussions initiated by students across all the sessions. Executing this search returns the relevant segments of the transcript along with various statistics about these segments. These statistics are used in the analysis that follows. Finally, NUD*IST was used to verify the accuracy and consistency of the coding schemes. Accuracy was verified by searching, for example, for transcript segments with no "Speaker" coding. The results of this search were examined to verify that only researcher notes, transcript headings, etc. lacked a Speaker code. Consistency was verified by periodically extracting all of the transcript segments with a particular code to examine them side by side. The segments were compared to one another and to the code description to make sure the code was being applied consistently. Corrections and adjustments were made as needed. If the code description was adjusted, all of the transcript segments previously coded were reconsidered.

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2. Published by QSR International. (http://www.qsr.com.au/)

The transcripts were coded with six coding schemes. The first two, Session and Type (shown in Table 3-2) are used for bookkeeping purposes and to allow some automated analysis. For example, searches could be easily defined to consider only Pin-ups or only session HCI-1b. Each code was applied to the entire transcript for that session.

**Table 3-2. Coding scheme for Session and Type**

| **Session Code** | **Type Code** | **Description** |
|---|---|---|
| HCI-1b | Pin-up | 10/22 session |
| HCI-2a | Pin-up | 11/17 session |
| HCI-2b | Pin-up | 11/19 session |
| HCI-3a | Jury Review | 12/1 session |
| HCI-3b | Jury Review | 12/3 session |

Each turn in the transcripts was coded individually for Speaker and Phase according to the schemes shown in Table 3-3 and Table 3-4. These codes were straightforward to develop and apply. Student speaking turns were coded with both the "Student" code and the more specific "Presenter", "Teammate", or "Other" code.

The next two parts of the coding scheme (Product/Process and Topic) dealt with the content of the discussions and therefore required more interpretation. The schemes were developed iteratively, starting with some speculative categories and intuitive notions of how discussions could be classified. As more data was coded, the categories were reorganized and more precise definitions were developed for each. After several iterations, the schemes were finalized and all the data was recoded with the schemes shown in

**Table 3-3. Coding scheme for Speaker**

| **Code** | **Description** |
|---|---|
| Professor | The professor for the class. |
| Student (Presenter) | The student who begins the presentation for a team. |
| Student (Teammate) | Students on the same team as the presenter during the discussion for that team. |
| Student (Other) | Students who are on teams other than the one presenting. |
| Teaching Assistant | The teaching assistant for the class. |
| Juror | An invited guest for one of the jury reviews. (HCI-3 only) |

**Table 3-4. Coding scheme for Phase**

| **Code** | **Description** |
|---|---|
| Initial Presentation | The first speaking turn for a team and any subsequent turns by the presenter or teammates which are not in response to comments from another speaker. This phase represents the team's own concept of their project and their explanation of it. The transition to discussion is often marked by the presenter asking for questions. |
| Subsequent Discussion | Parts of the transcript which are not part of the initial presentation. Includes comments from the professor, other students, and responses from the team to those comments. |

**Table 3-5. Coding scheme for Product/Process**

| **Code** | **Description** |
|---|---|
| Product | Mainly discusses the product being designed, its features, how it works, what it looks like, etc. |
| Process | Mainly discusses how the team is going about designing the product, justification, background data, info about users, context, etc. |
| Other | Includes initial presentations, which ranged over a wide variety of topics, administrative comments (e.g. "Which team wants to go next?"), and other miscellaneous remarks. |

**Table 3-6. Coding scheme for Topic**

| Code | Description |
|---|---|
| Problem Scope | Defining the scope of the problem; setting a boundary for the design in terms of technology, goals, concerns, or user population. |
| User Constraints | Suggesting or questioning the ways in which the particulars of the user population constrain the design (i.e. reduce the set of possible solutions). |
| Plan for Info Gathering | Discussing plan for how or what information will be gathered and used in the design process. |
| Design Process/Technique | Describing and giving a name to some part of the design process or a particular technique. Could be a suggestion of what to do, a description of what was done, or a warning not to do something. |
| User Tasks/Goals/Needs | Identifying or referring to user tasks, goals or needs. |
| Report of Info Gathered | Presenting something found during information gathering. Could be to justify or explain a design decision. Could be a direct question about what was found. |
| Translation into Design | Considering how information gathered about users, needs, goals, etc. translate into design decisions. |
| Rationale | Understanding or questioning why a particular choice was made. |
| Design Suggestion | Suggesting that a particular change be made to the design (to add, remove, or change something). Could be in response to a problem identified. |
| Clarification | Asking a question to clarify what a team has just presented or to understand more fully the team’s proposed design. |
| Problematic Scenario | Asking the team what would happen in their design in a given situation. |
| Live Designing | Working through an actual design process: asking questions, proposing solutions, testing those solutions, making refinements, rejecting or accepting ideas. |
| Empirical Validation | Asking how the team tested their design empirically (or how they would) or how they know it is valid. |
| Info Gathering Process | Describing how the team did their information gathering. |
| Design Boundaries | Asking questions that test the boundaries of the design: how it would perform under different conditions, how it could be change to accommodate changes in user needs, how it fits into the larger context, etc. |

Table 3-5 and Table 3-6. The Product/Process coding scheme represents a broad classification of discussions as being mainly about the design process or mainly about the design product. The Topic coding scheme identifies the major topic of each discussion. Not every topic discussed in the dataset is included in this coding scheme. Only topics which could be clearly defined and which occurred more than once in the dataset are included.

All the turns in a single discussion were given the same code based on the overall sense of the discussion. Coding each turn independently did not make sense because each depended heavily on the turns surrounding it for context. The vast majority of discussions could be given a single code from each scheme, but there were some that could not, either because they did not fit any of the codes or because they fit more than one. When a discussion did not fit any of the codes, a new code was added temporarily and made permanent if it occurred more than once and could be clearly defined. Discussions for which a code could not be developed were omitted from the analysis. In other cases, more than one code seemed to apply to a discussion. When this occurred, the coding scheme was examined to see if definitions could be made more precise so that only one code applied. If this could not be done, the discussion was coded with more than one code. Discussions which were long, complex, or had many different speakers were particularly difficult to code because they often covered more than one topic.

For the last analysis, techniques being used by the different groups are identified: four techniques used by the professor (generalizing/naming, guiding, comparing, and probing), two techniques being used by students (suggesting features and posing

**Table 3-7. Coding Scheme for Techniques**

| Code | Description |
|---|---|
| Generalizing/Naming | Pointing out some aspect of the project as being an example of "X", where X is some more general category of things. |
| Comparing | Comparing two projects to raise the issue of how they are similar or different and why that is the case. |
| Guiding | Giving a fairly specific suggestion of what to do next. |
| Probing | Using a series of questions to reveal the team's understanding of their project, challenge their assumptions, and help them develop their rationale. |
| Suggesting Features or Improvements | Making a suggestion about what is missing from the design, a feature to include, or other ways it might be improved. |
| Posing Scenarios | Asking what would happen in a particular situation to clarify or uncover problems in the design. |
| Clarifying | Asking the presenter to clarify some part of their presentation, their design, or the problem they are addressing. |
| Pushing/Speculating | Asking the team to speculate about how their proposed design would hold up in different circumstances or meet changed requirements. |

problematic scenarios) and four being used by jurors (probing, clarifying, suggesting improvements, and pushing the design/speculating). These techniques, described in Table 3-7, were identified and defined in an iterative manner, similar to the development of the coding schemes described above. Unlike with the previous codes, however, the goal was not to exhaustively categorize all of the discussions as using a specific technique. Instead, the process was to identify questions and comments that seemed to have some intention behind them and then to infer what that intention was. The goal of this analysis then, was to demonstrate the existence of these techniques and to investigate whether or not different speaker groups used different techniques. No analysis was done to show how frequently the techniques were used; in fact, the majority of comments were not associated with any specific technique. There was some variation in the ways that different speaker groups used the different techniques. These variations are described in the subsequent analysis along with illustrative examples.

## Results & Analysis

### Participation Patterns

This analysis examines how the speaking turns were distributed between the different participants and how this distribution changed over time. It also examines who was initiating new discussions—asking a question or raising a new topic—and how this pattern changed with each session. The pin-ups and jury review sessions are analyzed separately in this section because of the differences in their formats.

#### Speaking Turns and Initiating Discussions in Pin-ups

As shown in Figure 3-5, the turns in the three pin-up sessions are distributed unevenly between the professor (19%), students (79%), and the teaching assistant (2%). Even though students have the vast majority of the speaking turns, the professor is the single most frequent speaker, accounting for almost one-fifth of the turns herself. The TA's participation in these sessions is negligible.

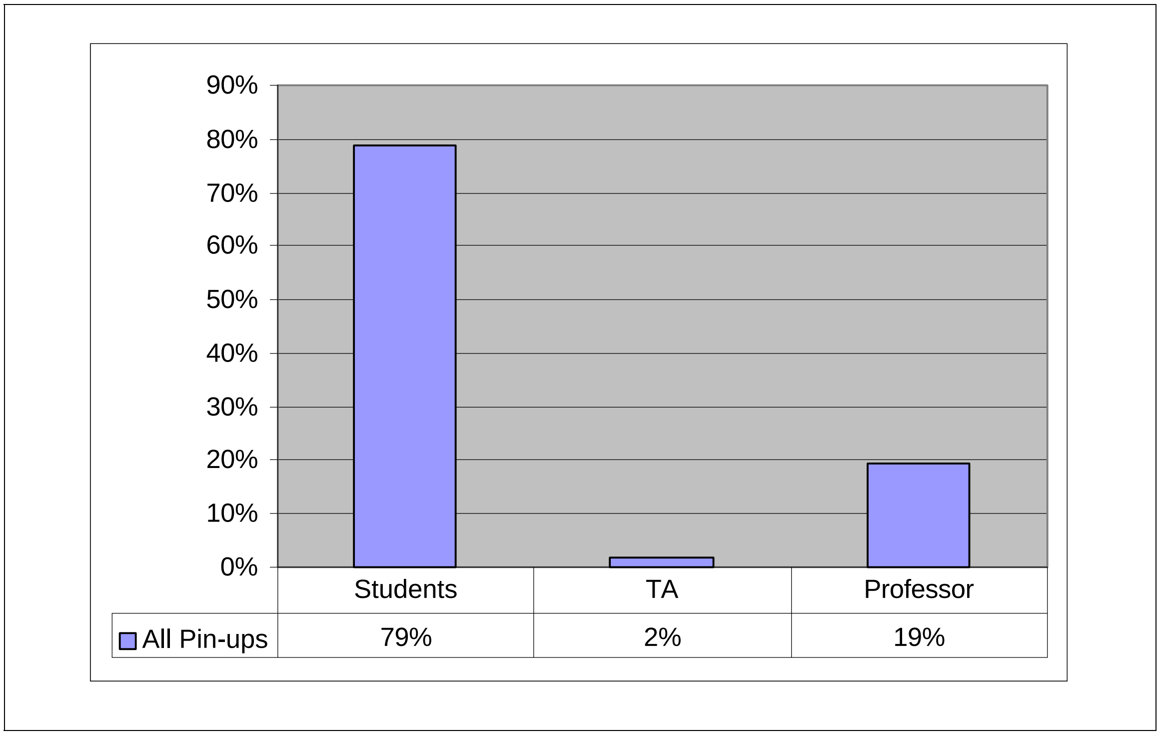



**Figure 3-5. Percentage of speaking turns across all pin-ups**

Examining each pin-up session individually, as in Figure 3-6, reveals that the professor's participation decreases over time (30%, 18%, and 15% in the three sessions respectively). We would not expect her participation to ever reach zero, however, because in addition to participating in the discussions, the professor also acts as timekeeper and high-level organizer for the session. For these three sessions, she spends a total of 21 speaking turns (16% of her turns) dealing with these kinds of administrative issues.

Since students are presenting their projects to the class, it is not surprising that they have a high percentage of the turns. However, the students' initial presentations, when they are explaining their project and what they have done so far, account for only 7% of their turns (although these are very long turns). The majority of students' turns are during the subsequent discussions. Figure 3-7 shows how student speaking turns during the

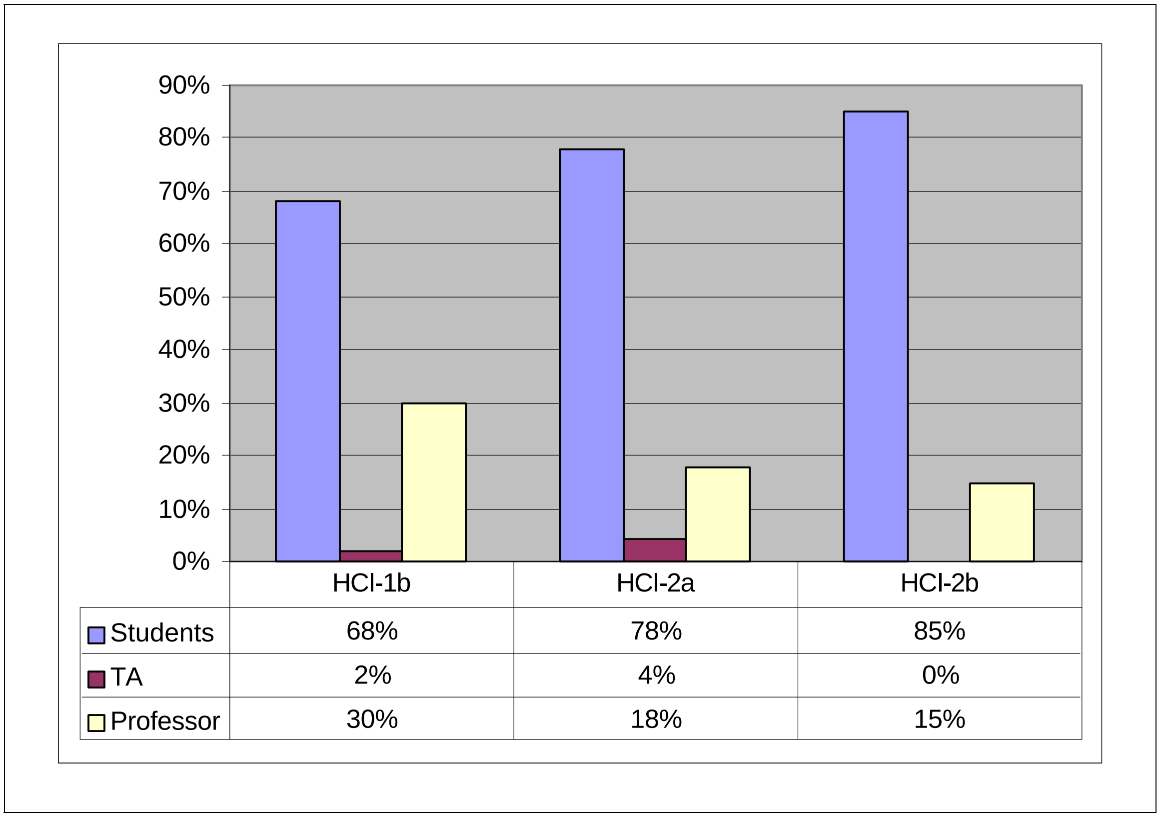



**Figure 3-6. Percentage of speaking turns in each pin-up**

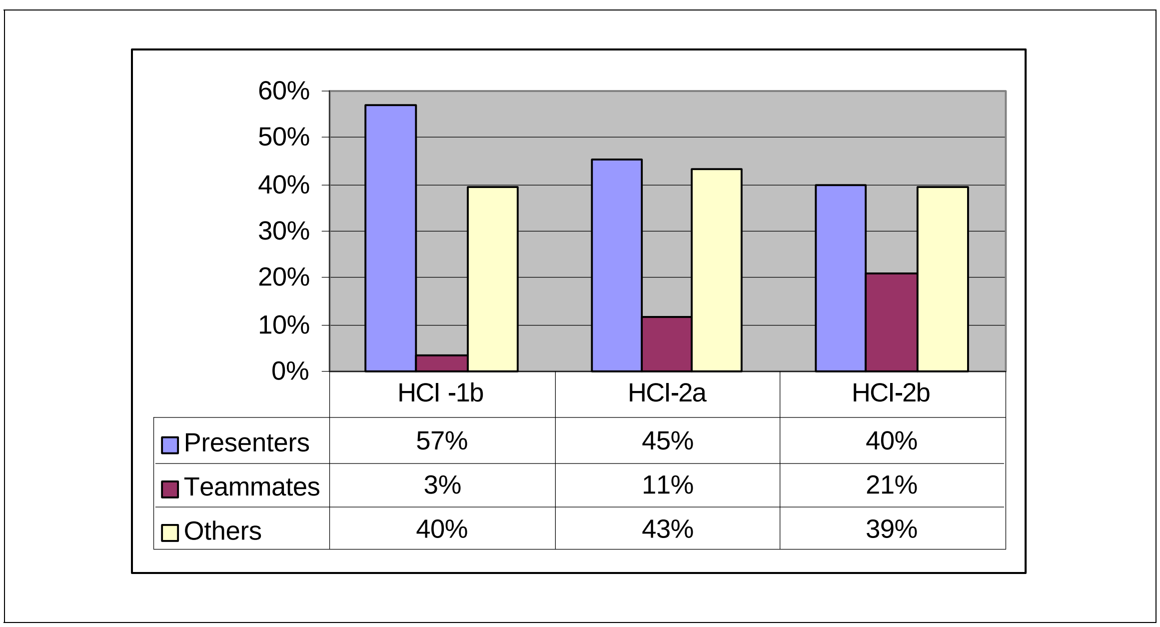



**Figure 3-7. Percentage of speaking turns for different student groups**

discussions are divided between different groups: the student who initially starts the presentation (Presenters), teammates of that student (Teammates), and the rest of the class (Others). The students who speak the most frequently are the presenters, even after the initial presentation is over. Especially during HCI-1b, the presenters serve as a spokesperson for their group, handling most of the questions on their own. Examining the transcripts shows that the sessions basically follow a question-and-answer format, with presenters or teammates having roughly every other turn. Interestingly, participation by teammates increases across the three pin-up sessions (3%, 11%, 21% of student turns, respectively). This data does not explain why this change occurred—perhaps teams became less concerned with the formality of their presentations or students became more comfortable speaking in front of the class. Regardless of the reason, having teammates participate more in the dialog is a positive trend.

A discussion is *initiated* by the first speaker in that discussion. For example, the discussion shown previously in Figure 3-3 is initiated by the professor (WN) and the two discussions in Figure 3-4 are initiated by students (S9 & S10, respectively). Figure 3-8 shows that 27% of the discussions are professor-initiated, 71% are student-initiated, and 3% are initiated by the TA. These results show that students are not simply responding to questions from the professor, but that they actively question and respond to each other. Students seemed to become more comfortable initiating discussions during the second round of pin-ups (HCI-2a and -2b), where they initiate the vast majority of discussions . When compared to the percentage of turns, it seems the professor is playing an even larger role as the initiator of discussions (19% of turns vs. 27% of initiations across all sessions).

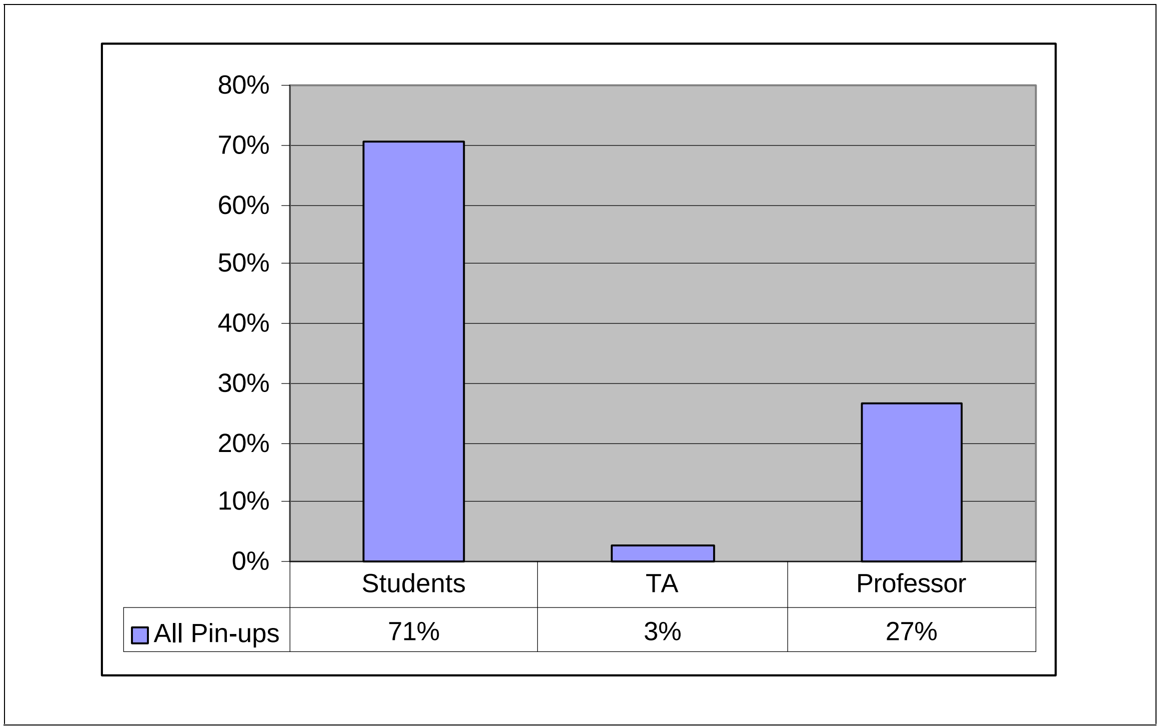
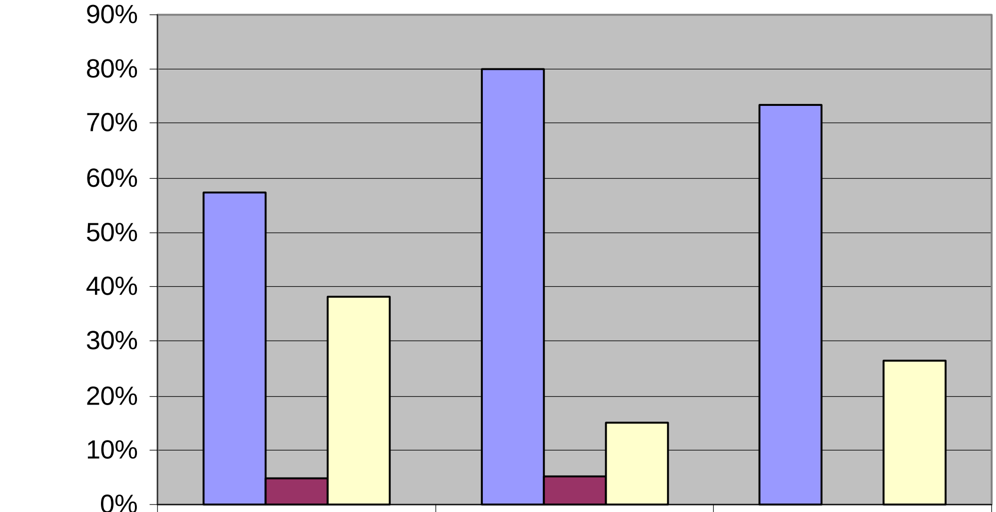



**Figure 3-8. Percentage of discussions initiated across all pin-ups**

In many cases, however, a number of the professor-initiated discussions are really just her concluding remarks about a project. These occur at the end of a project's presentation, raising some new topic (which makes them the start of a new discussion), but moving on to a new project immediately afterward (keeping her participation rate low, since it counts as only one turn). The professor initiates fewer discussions in the later sessions, as shown in Figure 3-9, but the trend of her decreasing participation is not as clear here as when looking at the number of speaking turns.

These graphs have shown that participation patterns in the pin-ups changed over time. The professor participated less and initiated fewer discussions in the later sessions. Additionally, more teammates participated in the discussion with each session. These changes were not the only differences between the sessions, however. Figure 3-10 shows




| | HCI-1b | HCI-2a | HCI-2b |
|---|---|---|---|
| Students | 57% | 80% | 74% |
| TA | 5% | 5% | 0% |
| Professor | 38% | 15% | 26% |

**Figure 3-9. Percentage of discussions initiated in each pin-up**

the total *number* of speaking turns increasing in each session, even though the time for each session is the same. One reason for the increase is that teams did not have to spend as much time explaining their projects to the rest of the class as they did in the earlier sessions, which left more time for discussion. Additionally, students may have become more familiar with the concept of a pin-up session, making them more willing to participate and requiring less time to get started. Figure 3-11 shows that the total *number* of discussions initiated in the first two sessions are the same but that the number increases in the third session (HCI-2b). A likely explanation for this is the way the professor organized the third session. She encouraged teams to ask questions of the rest of the class

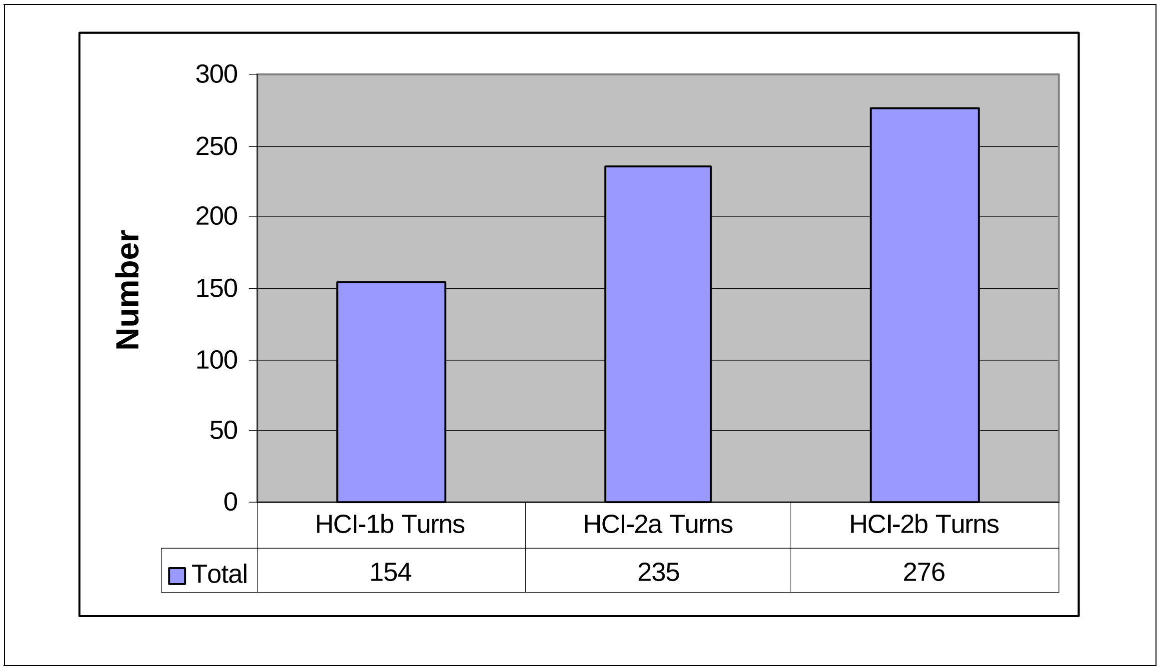



**Figure 3-10. Total number of turns in each pin-up**

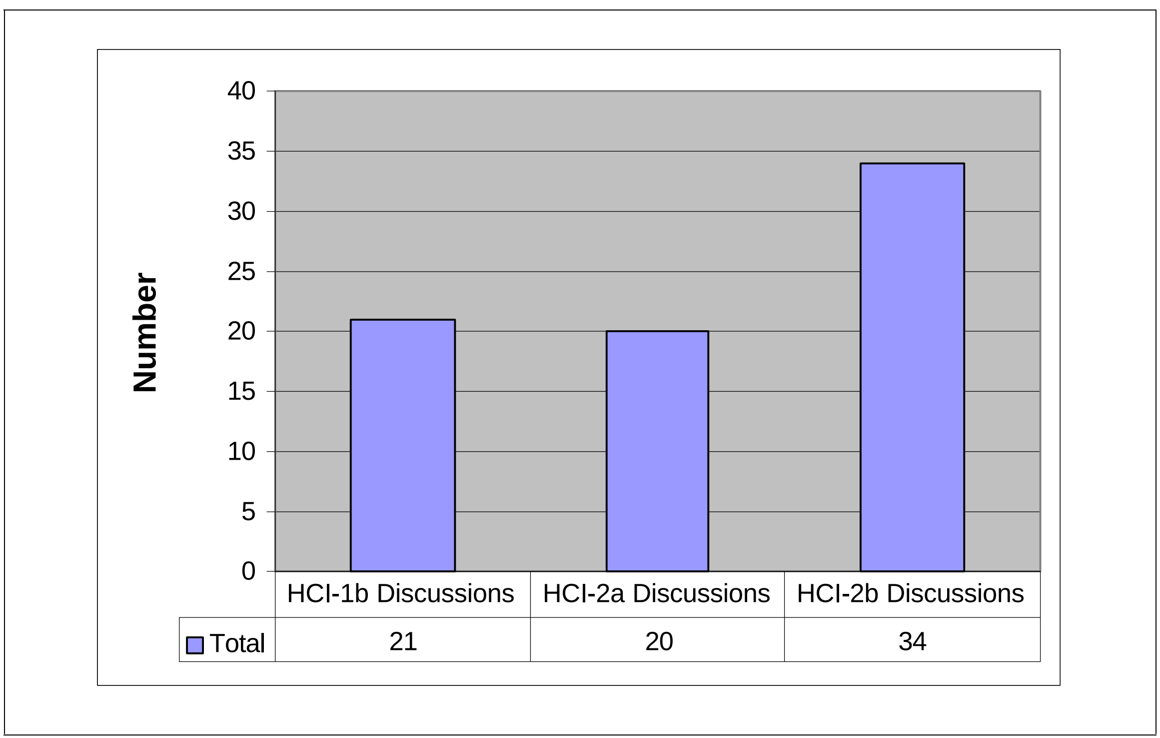
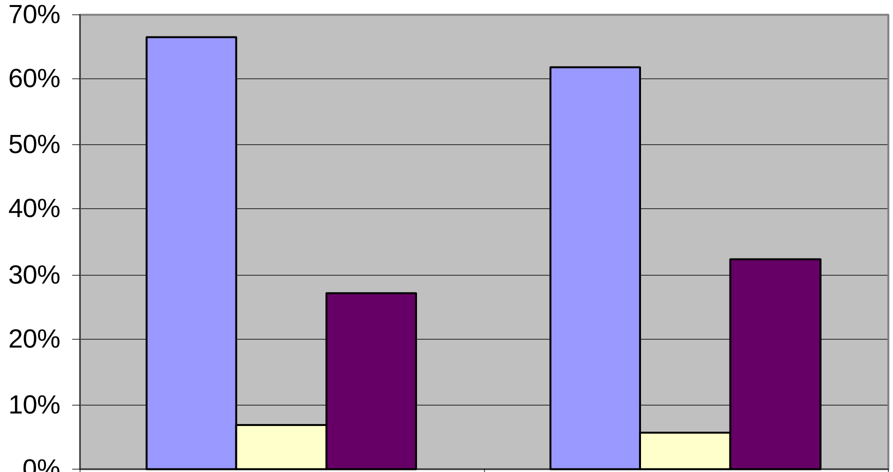



**Figure 3-11. Total number of discussions in each pin-up**

about things they wanted to discuss, rather than having the class ask the team whatever questions came to mind. Consequently, teams made very brief initial presentations or none at all, which allowed more time for discussion. She gave the teams these instructions in the days before the pin-up, so teams had time to think in advance about what they wanted to discuss. This eliminated the lag that sometimes occurred while students came up with questions to ask one another, increasing both the number of discussions and speaking turns that could fit into a session.

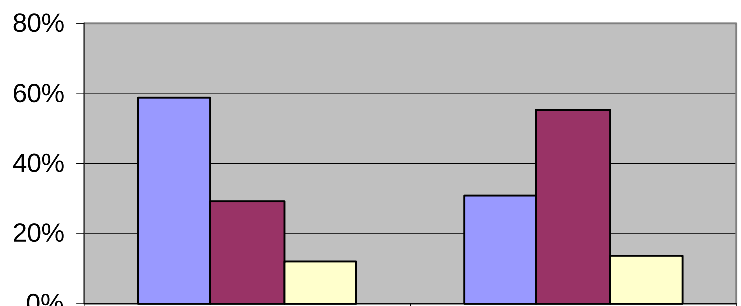
### Speaking Turns and Initiating Discussions in Jury Reviews

Similar analyses were conducted to examine the patterns of participation in the jury reviews. As with the pin-ups, the speaking turns are distributed unevenly between students (63%), the professor (6%), and invited jurors (31%), as shown in Figure 3-12. It might seem surprising that the turns are not more evenly distributed between jurors and students because much of the interaction is in a question-and-answer format, with jurors asking questions and students answering them. An examination of the transcripts shows that in fact, more than one student would often respond to a juror’s question, adding to what another student had said. The result is that there are many more student turns than juror turns. The professor’s participation in the jury review is extremely small and nearly all of her turns are administrative comments, asking jurors to hold their questions or telling teams when their time is up. The TA was present at the jury review, but did not participate in the discussion.




| | HCI-3a | HCI-3b |
|---|---|---|
| Students | 67% | 62% |
| Professor | 7% | 5% |
| Jurors | 27% | 32% |

**Figure 3-12. Percentage of speaking turns in each jury review**




| | HCI-3a | HCI-3b |
|---|---|---|
| Presenters | 59% | 31% |
| Teammates | 29% | 55% |
| Others | 12% | 14% |

**Figure 3-13. Percentage of speaking turns for different student groups**

Unlike the pin-up sessions, where other students accounted for approximately 40% of student turns (recall Figure 3-7), the majority of the student turns in the jury review sessions belong to the presenter and teammates, as shown in Figure 3-13. In other words, the jury reviews are mainly discussions between the jurors and the presenting team, with occasional questions from other students. The high percentage of teammate turns in HCI-3b is a result of the teams in this session choosing to divide up the presentation among the different teammates (e.g. one introduced the project, another presented scenarios of use, etc.). In HCI-3a, more teams chose to have a single member present their project.

Figure 3-14 shows that the vast majority of discussion in both jury review sessions is initiated by the jurors. This is not unexpected given that one of the purposes of the jury review is to get feedback from the invited jurors. The professor initiates a very small percentage of the discussions in these sessions. Other students asking questions account for the rest of the discussions.

Although the two jury reviews appear to be quite similar in terms of the turns and initiations for the different speakers, the raw numbers reveal a dramatic difference. Figure 3-15 shows that the second jury review (HCI-3b) has much more discussion, both in the number of turns and number of discussions for all three groups. This is because the jurors in the second review were far more likely to interrupt the presenter with clarification questions and to pursue a series of questions with the team during the discussion period. The jurors in the first session generally let teams finish their presentation before asking questions, which resulted in a lower number of turns and discussions, even though the total amount of speaking is comparable between the two sessions.

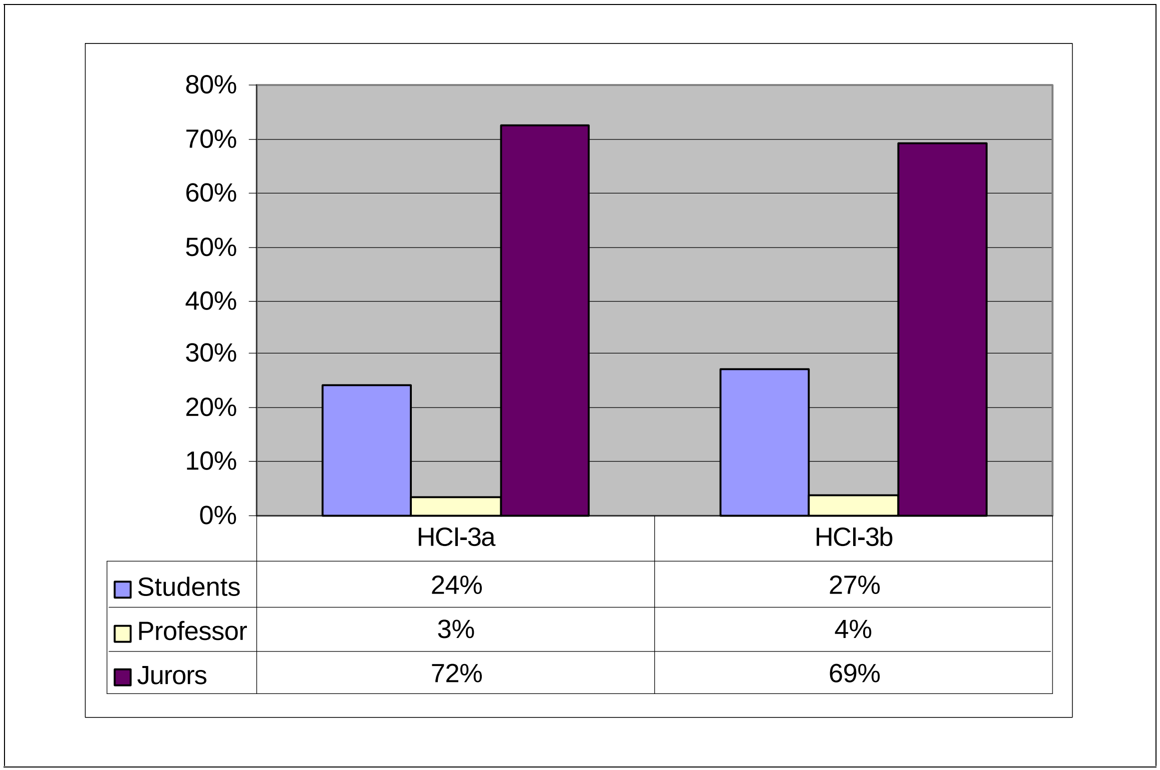
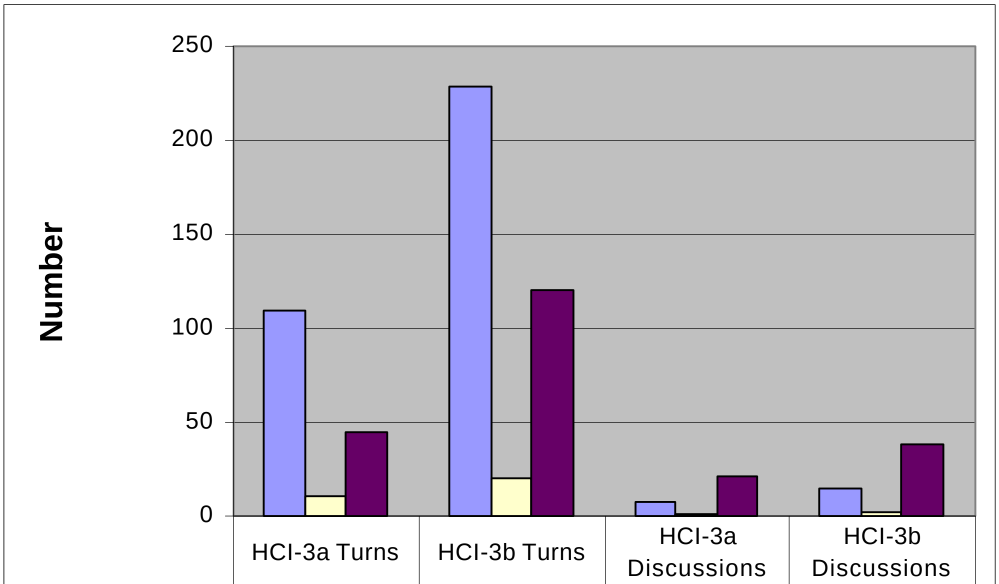



**Figure 3-14. Percentage of discussions initiated in each jury review**




| | HCI-3a Turns | HCI-3b Turns | HCI-3a Discussions | HCI-3b Discussions |
|---|---|---|---|---|
| Students | 110 | 229 | 7 | 15 |
| Professor | 11 | 20 | 1 | 2 |
| Jurors | 45 | 120 | 21 | 38 |

**Figure 3-15. Total number of turns and discussions in each jury review**

Summary of Participation Patterns

The dialog in the pin-up sessions was student-led and student-driven. Students accounted for the majority of the speaking turns in the sessions and also initiated the majority of the discussions. Most of the discussion was in a question-and-answer format with the team making the presentation. Participation by teammates increased with each session.

Even though students did the majority of the speaking in the sessions, the professor played a significant role as an active participant and initiator of discussions. She was the single most active speaker in the dialog. However, with each session, the professor accounted for a smaller percentage of the speaking turns. The TA's participation was too small to allow any general observations.

The total amount of speaking turns increased with every session, and the total number of discussions increased or stayed (nearly) the same. In other words, more dialog occurred with each session. This could be because students were becoming more familiar and with the pin-ups and each others' projects. It may also have been a result of making changes in the format of the sessions.

The jury reviews were quite different from the pin-ups in terms of participation patterns. They were controlled by the jury who accounted for approximately one-third of the speaking turns but who initiated two-thirds of the discussions. In these sessions, students played a more passive role which mainly involved responding to juror questions. The professor's participation was minimal.

The number of speaking turns and number of discussions was different between the two jury sessions because of the behavior of the jurors. In the second session, jurors frequently interrupted the students' presentations to ask questions which resulted in a much higher number of turns and discussions. A less dramatic difference might be found in other contexts where there was a more standard protocol for these kinds of discussions.

## Discussion Content

The previous analysis dealt strictly with structural features of the dialog—who spoke and who initiated discussions. This analysis goes the next step, examining the content of the discussions. First, two broad categories of discussion are considered: those focused on the design *process* and those focused on the design *product*. (These categories are defined more explicitly in Table 3-5 on page 59.) The analysis examines which speakers participate in and initiate different discussions and how this changes over time. The second analysis uses a set of fifteen discussion topics, which were derived from the data and chosen because they occurred more than once, to further investigate the content of the discussions. Transcripts from all five sessions are analyzed to show how the topics are distributed across the speaker groups and across the different sessions. (These topics are defined in the Table 3-6 on page 60.)

<u>Discussions of Product versus Process</u>

Figure 3-16 shows that there are more than twice as many product turns (431) as process turns (201) in the three pin-up sessions. It is more interesting, however, to examine who was speaking during these different turns. Figure 3-17 shows how the

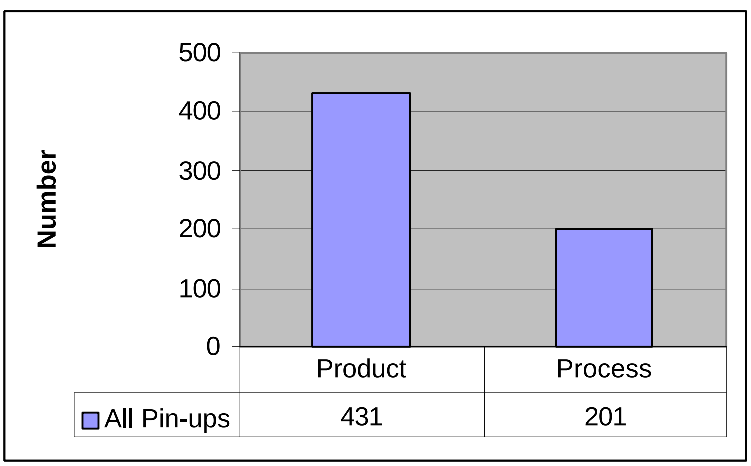



**Figure 3-16. Total number of product and process turns across all pin-ups**

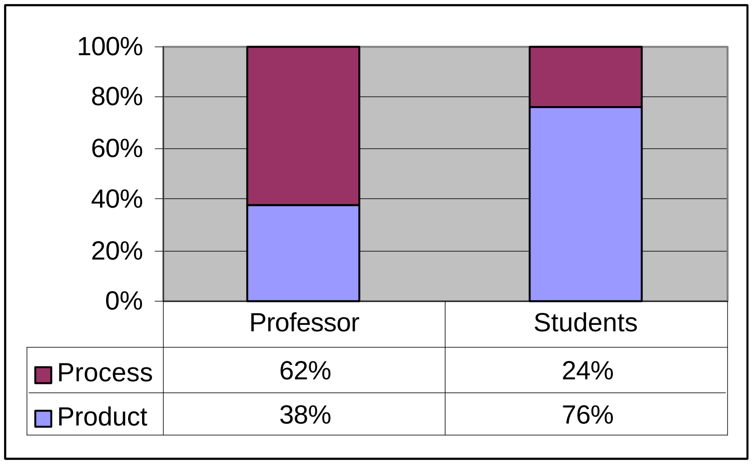
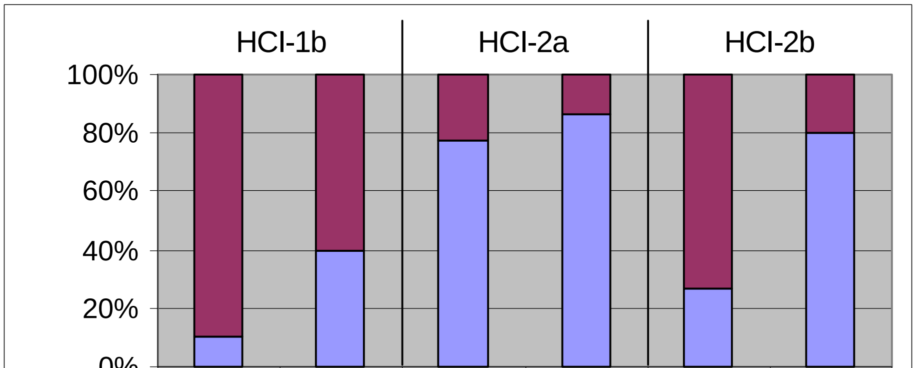



**Figure 3-17. Percentage of product vs. process turns across all pin-ups**

speaking turns are distributed between process and product for the professor and students. (The TA is omitted from this analysis because her participation was so small.) As expected, students spend many more of their turns discussing the design product (76%) than the design process (24%). The professor's turns are somewhat more evenly distributed, but her emphasis is on the design process (62%). Even more interesting aspects are revealed when each pin-up is considered separately, as shown in Figure 3-18. In HCI-1b, the professor's turns are almost all in process discussions. Notably, the majority of student turns in this session are process related as well, but not nearly to the extent of the professor. In HCI-2a, the majority of the discussion by both professor and students is product related. The differences between these two sessions can be partially explained by considering the students' point in the design process and the content of their presentations. In the first session, which was quite early in the semester, students were still trying to understand the design problem and learn about the context for their design.




| | Professor | Students | Professor | Students | Professor | Students |
|---|---|---|---|---|---|---|
| Process | 90% | 60% | 23% | 14% | 73% | 20% |
| Product | 10% | 40% | 78% | 86% | 27% | 81% |

**Figure 3-18. Percentage of product vs. process turns in each pin-up**

A few had rough concepts of a design product, but the majority were just presenting the results of their research and the constraints they had identified. In the second session a few weeks later (HCI-2a), all projects had developed an initial design concept and the presentations were explaining that concept. Also, some teams had started prototyping their designs, which required them to focus on the details of their design product. Given the time that had passed, it is not surprising that the two sessions have very different distributions of product and process discussions.

In the third session (HCI-2b), the professor’s participation is back to being mainly in the process discussions, while students continue to focus on product discussions. The contrast between the second and third sessions is particularly strange given that they are only two days apart. Although there are different teams reporting in the two sessions, the change is more likely related to the change in format in this session mentioned in the last analysis. (See page 68.) In this session, the professor repeatedly reminded students to "ask their own questions" of the rest of the class in order to get relevant input. Some made almost no introductory presentation and began immediately with their questions. This focused the discussion quickly on details of the design product that concerned the team. Other students in the class generally tried to answer the questions the team was asking or make suggestions about how to solve the problems they presented.

The preceding graphs showed that students actively participated in both product and process discussions. Another consideration was whether they also were *initiators* of both kinds of discussion. Figure 3-19 shows the percentage of product versus process

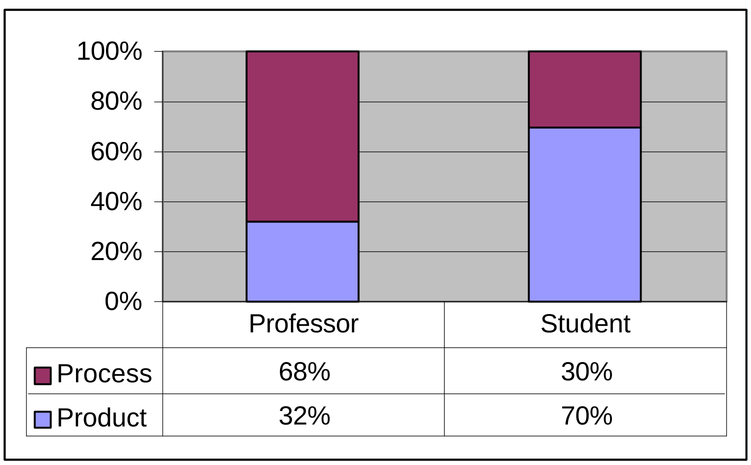



**Figure 3-19. Percentage of process vs. product discussions initiated across all pin-ups**

discussions initiated by each group. These percentages show roughly the same distribution as in the speaking-turns analysis, with the professor initiating mostly process discussion

(68%) and students initiating mostly product discussions (70%). Considering each session separately, as shown in Figure 3-20, also reinforces the observations from the previous analysis: the first session is heavily process-oriented while the second focuses mainly on product; the third session is again split, with the professor focusing on process and the students on product. These graphs show that students did initiate and participate in both kinds of discussions.

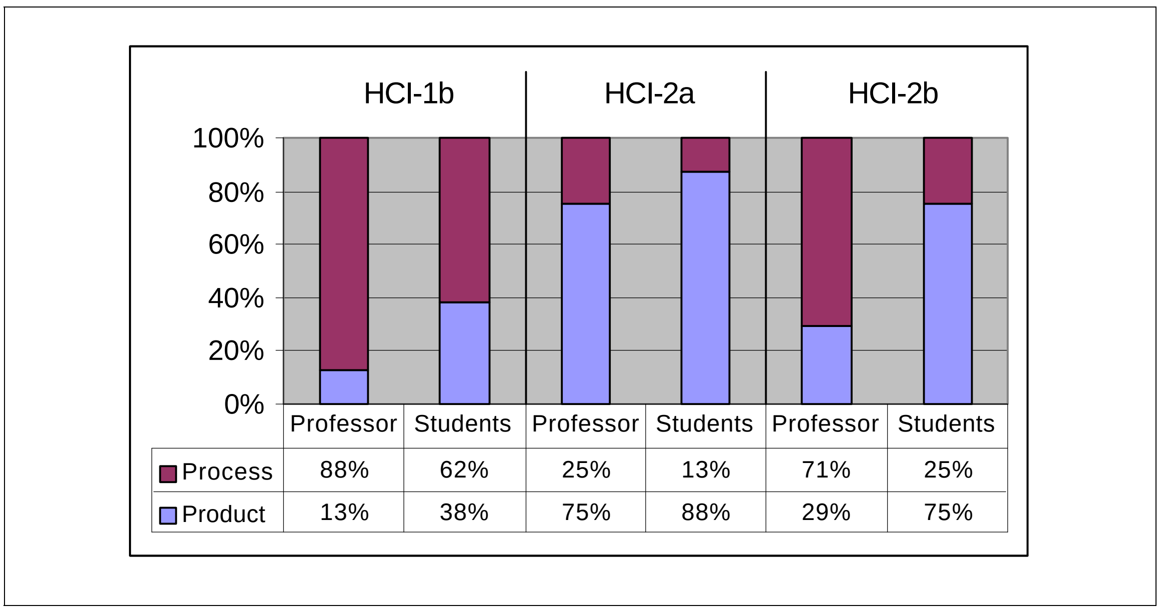



**Figure 3-20. Percentage of process vs. product discussions initiated in each pin-up**

Even though the initial expectation was accurate—that students would focus on product more than process and that the reverse would be true for the professor—the situation turns out to be more complex. Students frequently engaged in process discussions and also quite frequently initiated them. A final examination of this analysis shows an even more promising result. Figure 3-21 shows the percentage of each kind of

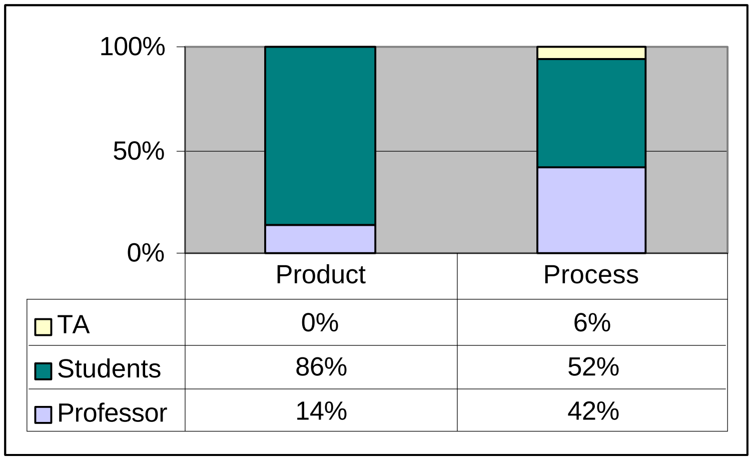



**Figure 3-21. Percentage of process and product discussions initiated by each speaker group**

discussion that was initiated by different speaker groups. More than half of the process discussions are initiated by students (52%). So, while students do spend a good amount of time talking about the design product, they are capable and willing to discuss the design process as well. What is not clear from this analysis is what role the professor might have played in steering the discussion in certain directions, and in what ways the discussion would have been different without her participation.

Discussion Topics

Through careful examination of the transcripts, fifteen recurring discussion topics were identified. This analysis shows which topics occurred in each session and which speaker groups (professor, students, jurors) initiated the different topics.

Table 3-8 shows how many times each topic was discussed in each session. The table is sorted by the total number of occurrences for each discussion topic, and the two most frequent topics of each session are highlighted. The first session (HCI-1b) is quite

**Table 3-8. Discussion topics in each session**

| Topic | Pin-ups | | | Jury Reviews | | Total |
|---|---|---|---|---|---|---|
| | HCI-1b | HCI-2a | HCI-2b | HCI-3a | HCI-3b | |
| Clarification | 2 | 9 | 5 | 10 | 29 | 55 |
| Design Suggestion | 2 | 6 | 14 | 7 | 11 | 40 |
| Problematic Scenario | 1 | 7 | 1 | 6 | 4 | 19 |
| Rationale | 1 | | 2 | 4 | 6 | 13 |
| Design Process/Techniques | 6 | 1 | 3 | | | 10 |
| Report on Info Gathered | | 2 | 4 | | 3 | 9 |
| Live Designing | | 2 | 3 | | | 5 |
| Problem Scope | 4 | | | | | 4 |
| User Constraints | 3 | | | | 1 | 4 |
| Empirical Validation | | | | 2 | 2 | 4 |
| User Tasks/Goals/Needs | | | 2 | 1 | | 3 |
| Translation into Design | | 1 | 2 | | | 3 |
| Design Boundaries | | | | | 3 | 3 |
| Plan for Info Gathering | 2 | | | | | 2 |
| Info Gathering Process | | | | 1 | | 1 |

different from the rest, focusing mainly on problem scope and the design process itself—topics which are appropriate for early design phases. Once students begin to introduce actual design solutions (i.e. in HCI-2a), much of the conversation shifts to clarifications, problematic scenarios, and design suggestions. In other words, the speakers in these sessions are trying to understand the solution the team is proposing and find ways to improve it.

All sessions cover a broad range of topics and the set of topics changes with each session. For example, some topics are emphasized in the earlier session (problem scope, design process/techniques) and others are emphasized in later sessions (empirical validation, rationale). These changes seem to correspond to the way a design problem develops and changes over time. Interestingly, certain topics are found throughout all the sessions (design suggestion, clarification, problematic scenario). These are not tied to a specific phase of design but instead help the questioner understand a design, regardless of what phase it is in.

One of the reasons for having different groups participate in the dialog is that educators hope they will bring new perspectives to the design. Therefore, it is useful to understand whether or not different speaker groups initiate discussions on different topics. Table 3-9 shows the discussion topics initiated by students in each session. Students initiated discussions on the broadest range of topics, perhaps because there were more of them than any other group. They also initiated more discussions than other groups. Students' main emphasis after the first session is on clarifying what the team is proposing and making design suggestions. They also make frequent use of problematic scenarios, perhaps as a way to further understand the design or to alert the team making the presentation to potential problems.

Table 3-10 shows the discussion topics initiated by jurors. As with the students, the jurors' emphasis is on clarifications and design suggestions. Jurors are the only set of speakers to initiate discussions on the process the students used in gathering information, how they validated their results empirically, and what the boundaries were on their designs. They probably inquired about the students' information gathering process because students often did not make this clear during their presentations. The other two

**Table 3-9. Discussion topics initiated by students**

| Topic | Pin-ups | | | Jury Reviews | | Total |
|---|---|---|---|---|---|---|
| | HCI-1b | HCI-2a | HCI-2b | HCI-3a | HCI-3b | |
| Design Suggestion | 3 | 5 | 14 | 3 | 4 | 29 |
| Clarification | 2 | 8 | 5 | 1 | 10 | 26 |
| Problematic Scenario | 1 | 6 | 1 | 2 | 3 | 13 |
| Report on Info Gathered | | 1 | 4 | | | 5 |
| Live Designing | | 2 | 3 | | | 5 |
| Problem Scope | 4 | | | | | 4 |
| User Constraints | 1 | | | | 1 | 2 |
| Plan for Info Gathering | 2 | | | | | 2 |
| Design Process/Techniques | | 1 | | | | 1 |
| User Tasks/Goals/Needs | | | 1 | | | 1 |
| Translation into Design | | | 1 | | | 1 |
| Rationale | | | | 1 | | 1 |
| Empirical Validation | | | | | 1 | 1 |

topics may not have been raised previously because they were most appropriate for the very late stages of the design process. Alternatively, they might just represent the interests of particular jury members.

Table 3-11 shows the most frequent topics of discussions initiated by the professor. Since she initiated very few discussions, no topics stood out in HCI-2a or HCI-3a and -3b. The professor's most frequent topic is the design process itself, during which she often points out examples of good things (i.e. generating alternatives) or bad things (i.e. jumping to a solution too soon) that teams are doing. She is the initiator of 8 of the 10 discussions on this topic. She does not initiate a large number of discussions overall, so

**Table 3-10. Discussion topics initiated by jurors**

| Topic | Jury Reviews | | Total |
|---|---|---|---|
| | HCI-3a | HCI-3b | |
| Clarification | 9 | 19 | 28 |
| Design Suggestion | 4 | 7 | 11 |
| Rationale | 3 | 5 | 8 |
| Problematic Scenario | 4 | 1 | 5 |
| Info Gathering Process | 1 | 3 | 4 |
| Report on Info Gathered | | 3 | 3 |
| Empirical Validation | 2 | 1 | 3 |
| Design Boundaries | | 3 | 3 |
| User Tasks/Goals/Needs | 1 | | 1 |

**Table 3-11. Discussion topics initiated by the professor**

| Topic | Pin-ups | | | Jury Reviews | | Total |
|---|---|---|---|---|---|---|
| | HCI-1b | HCI-2a | HCI-2b | HCI-3a | HCI-3b | |
| Design Process/Techniques | 5 | | 3 | | | 8 |
| Rationale | 1 | | 2 | | 1 | 4 |
| User Constraints | 2 | | | | | 2 |
| Translation into Design | | 1 | 1 | | | 2 |
| User Tasks/Goals/Needs | | | 1 | | | 1 |
| Design Suggestion | | 1 | | | | 1 |
| Clarification | | 1 | | | | 1 |
| Problematic Scenario | | 1 | | | | 1 |

any other patterns are difficult to detect. It may seem strange that she has so few clarifications and design suggestions, given that these were the most frequent discussion topics for students and jurors. A likely explanation it that she left this task to the other participants, preferring to let them do the talking. Since she also benefited from hearing the answers to clarification questions, there was no need for her to ask them herself. She also purposely refrained from making direct design suggestions, concerned that students would feel obligated to include her suggestions to get a good grade.

This analysis has shown that the set of discussion topics changes over time, perhaps in response to the current phase of the design and the particular projects being discussed. It has also shown that different speaker groups raise different topics of discussion, but that clarifying the design, posing problematic scenarios, and making suggestions for improvement are common responses to designs-in-progress.

### Summary of Discussion Content

Overall, more discussions were spent on the design product than on the design process. Students were more likely to initiate and participate in product discussions than the professor. Still, students initiated as many process discussions as the professor did and participated in many process discussions.

The earliest session recorded was the only one to focus more on process than product, perhaps because there was no product at that time. Once a product was introduced, the majority of discussion was spent asking clarification questions about it and suggesting improvements to the design.

A variety of topics were covered in the discussions and different groups initiated discussions on different topics. The most frequent topics from the second session onward were clarifications, design suggestions, and problematic scenarios. These seem to be used to help the person asking the question understand the design more clearly. Other topics of discussion in each session were related to the students' current design phase or the particular projects being discussed.

## Participation Techniques

This analysis, the most speculative of the three presented in this chapter, identifies recurring techniques used by different groups of speakers. Techniques were identified by examining the transcripts and noting common occurrences in the discussion. Occurrences that were unique to one group of speakers were of particular interest.

Unlike the previous analyses in this chapter, the goal here is not to compare the relative frequencies of the different techniques; in fact, the majority of participants' comments could not be assigned to a particular technique. The goal instead is to demonstrate that there are some regularities in the kind of comments made by different speaker groups. Identifying these regularities (or techniques) provides some insight into participants' goals and roles in the dialog.

The quotes used below were chosen because they are good examples of the techniques and show their use in practice.

### Professor Techniques

The professor in this case was a skilled facilitator of CDD and was therefore quite deliberate in the kinds of comments she made. These discussions by their nature are fluid, moving rapidly from topic to topic and calling upon a wide range of discussion techniques. While not all of the professor's comments could be classified as employing a specific technique, four recurring techniques were identified:

**Generalizing/Naming** - The professor points out some aspect of the project as being an example of "X", where X is some more general category of things. In addition, X tends to be a jargon word or phrase (in this case, relating to design or HCI). This kind of comment generally occurs at the end of a project's presentation/discussion and is not phrased as a question, but more of an observation. It is addressed to the whole class.

> I see something going on here that [another professor] and I talk about as *design fixation*.
>
> I'm noticing that there are a lot of boxes and windows that are open a lot and I'm wondering about *information overload*.
>
> The one thing I was thinking about with this whole presentation is, remember I brought up this issue of *programmatic* or *program* or *modularity*? We didn't discuss it that much but I get the sense with this that it is supporting a *programmatic approach* and what I mean by that is...
>
> I want to comment on what I see here overall which is a very interesting instance of *iterative design*.

**Comparing** - The professor compares two projects to raise the issue of how they are similar or different and why that is the case. A variation on this is for the professor to prompt the class to spontaneously make comparisons between the projects. This technique uses specific examples to bring out more general issues through comparison. It also generally occurs at the end of a project's discussion. Although it can be phrased as a question, it is not necessarily directed at the presenter—anyone in the class can provide an answer.

> ...well, let me ask you. Does anyone understand why this project is real different from any of these other projects? Can anyone see what's going on here?...Like why would this project be really different from the Web Changer?
>
> ...the system you've come up with - and you both started with exactly the same design brief - is real different. Can you tell us why you think it looks real different, I mean you've taken a really different tack, I'm not saying it's wrong, it's just really interesting to see the two.

**Guiding** - The professor gives the team a fairly specific suggestion of what to do next. This technique is intended to provide guidance without simply providing a solution to the problem the team has encountered. It is intended as specific advice for the team presenting, but also may provide ideas for the rest of the class.

> A suggestion is, you know, put yourself in this guy's shoes...and there you can kind of think through some scenarios of speech events that he has to participate, or he would like to participate in but can't.
>
> Okay, here's a suggestion for you....you're trying to support two different goals on one page, so, and I won't answer this to you, should you be trying to support those two on one page?

**Probing** - The professor asks the presenter a series of questions that probe the design or the presentation. It is generally triggered by something in the presentation or in the presenter's response to another question. This technique uses a series of questions to reveal the team's understanding of their project, challenge their assumptions, and help them develop their rationale. At the same time, though, the questions are used to bring issues to their attention and guide their thinking about them. The discussion generally goes back and forth between the professor and presenter—the rest of the class does not join the discussion. It is intended both to help the team and to model critical questioning for the rest of the class.

> What's the rationale for using the metaphor that you're using?
>
> What are the features or what are the components of a Yahoo interface that are critical to your redesign?
>
> Okay well, then, if that was used to get to those designs, how did that happen?
>
> That first screen - why is that there? What is it buying you?

There are a handful of examples in the pin-ups (5) where students use these techniques, but the vast majority of examples are from the professor. This is especially significant for the first two techniques because they are the ones aimed at helping students learn from their design experiences.

Student Techniques

Since there are many students participating in the discussions, all with different knowledge and discussion skills, it is more difficult to clearly identify recurring techniques. Two that stood out however, were:

**Suggesting features/solutions** - A student suggests that the design include a certain feature, sometimes in response to a problem identified in the design.

> It might be useful to keep track of what people look at on the site and then have a section for popular graphs...
>
> Do you have like a "Check Now" button or something, like maybe I'm looking at that and I want to see...if it's brand new. So can I like select it and then push a button and it would check it for me?
>
> Another suggestion might be to have it read the bookmark file or whatever in Netscape or Internet Explorer and have that...as the basis for adding stuff. It might say, "add bookmark file in here" or whatever...

> One thing I would suggest is if you're gonna basically have those operate as two separate entities on the screen, maybe throw a horizontal line between them that would show "this is a completely separate item than what's above it"...
>
> Well, if you're going to do something like that, what I would suggest is...have a dual system and say "okay, it's on A1" and then just pop up a little map that shows where you are, where A1 is with reference to the store.

**Raising problematic scenarios** - A student asks what would happen in a particular situation to clarify or uncover problems in the design.

> If I happen to not be using the change updater, and I just open my web browser and visit a site that happens to be on my list, and you know, when I go back to my change updater and it tells me that it's been updated, like, how does the change updater know what sites I'm visiting in the web browser?...
>
> How do you think changing the interface will affect people who are already very familiar with the existing interface?
>
> Have you though about...him not having as many inputs? Um, like with the implant not working after a while? Have you considered that at all?...
>
> One quick question, how is JR going to fill out forms if he has to?
>
> I know it happens to me and it happens to most of us...for example we go volume and we'll click one of the buttons that represents volume and it's way louder than what we want. Did you allow a way for error recovery that's going to really quickly allow him to back out of a selection?

The major contrast between these two student techniques and the professor's is that the former address the design in a very concrete way. They are mainly concerned with helping the team improve their design. The professor's, in contrast, often use the design as an example from which to generalize. That is not to say that these techniques were not useful or appropriate—often they led to important insights about problems with the designs and ways to improve them.

Juror Techniques

Jurors also use a variety of techniques during discussion, which have similarities to both the professor's and students' techniques. Four were identified in the jury review.

**Probing** - A juror asks the team about some aspect of their design or their design process, often about the rationale for a choice they made or the data that they collected. It is very similar to the Probing technique used by the professor in the pin-ups.

> What do you think would be his primary tasks or goals in using the web? What is he going to get out of it...
>
> I'm curious about why you have the statistic type, and there are many many options in there, but you're only allowed to show one at a time...
>
> So what would the value added be?
>
> You implicitly make the claim that the user wants to know the last date that the site had been updated and the time down to the second. And I was wondering about that, what was your thinking...do they even need to know when it was updated at all, even the date?
>
> I just want to ask the question, why [on the] refrigerator? I mean, think of the American kitchen...why don't you put it on the wall?
>
> So the question is, should the kiosk really be supporting the buying a gift for a friend or buying skiwear? So, how would you know that? How would you gather that information from users or whatever?

**Clarifying** - A juror asks the presenter to clarify some part of their presentation, their design, or the problem they are addressing.

> When you select something, is there a way to go back?
>
> Where you have the 7 copies left, it looks like a button and I don't understand why it looks like a button...
>
> How does the staff read the help requests?

> I don’t understand. What’s that on the left?
>
> If he wants to watch TV, what happens then?
>
> Tell me again why she has to type in the password?

**Suggestions for Improvement** - A juror makes a suggestion about what is missing from the design or other ways it might be improved. Suggestions often follow some other kind of technique. For example, a juror may ask a question to clarify some aspect of the design and then suggest a change to it.

> So, it might be reasonable to have a visual indicator of what criteria you’re filtering on, so you’d be able to see "oh this is what I’m looking at".
>
> I think what’s missing here is that you have really valuable channel of information that you could have access to and use in your design and that’s that Blockbuster knows what you’ve already rented.
>
> What I would have like is, don’t make me think about it in terms of settings, but maybe what are the different types of websites, this one I care about...
>
> So, I thought it was interesting that you spent alot of time looking at these sort of security issues going through a couple of scenarios where they were highly personal rather than maybe different kinds of messages, different degrees of urgency, how you find out who the message is from. If there are only four people in the family, why not have a little snapshot instead of their name?

**Pushing the Design/Speculation** - A juror asks the team to speculate about how their proposed design would hold up in different circumstances, how they might accommodate a change in the requirements, or what they would do if they had more time.

> I was wondering what were you thinking about future extensions, for example there’s lots of things that he can now do, then cycling would take much, much longer. How would you evaluate those kinds of trade-offs?
>
> So do you think that this is going to be all right for all paraplegics, not just JR?

> What happens if you go to the shop and you can't find the thing that you've bought? ....so there's a big line of people as a result of these administrative problems, proving you really bought something, or getting your money back from something that isn't in the store but is supposed to be there. How do you think that would work? Walk me through that sort of situation...
>
> What's your feel about the average number of transactions a person would go through where that [problem] happened that would be the threshold that would cause them never to use the system again?
>
> I heard you repeatedly say *we* think that JR might want to do this, *we* could see that JR might do that, if you had some time to spend with JR, what kinds of things would you like to validate?

A major task for the jury is simply understanding the design problem students were facing, their proposed solution, and the process they used to arrive at the solution. The techniques they use in this situation are similar to those used by students as they worked to understand each other's projects in the pin-ups. Once they understand the project, however, jurors have a large body of knowledge and experience which they share with students by pointing out potential problems in the design and offering suggestions for improvement. However, the jurors, many of whom were professors, also bring with them an awareness of learning goals, probing the team as the professor does and asking students to think beyond the current state of their design. These techniques both test the depth of students' knowledge and encourage them to think about their designs in new ways.

### Summary of Participation Techniques

Several techniques were identified for each group. The professor's are the most well defined since she was a single individual and was most familiar with the use of discussion in design. Several of the professor's techniques specifically place a focus on learning, asking students to reflect on what they have done and and to move the discussions to a more abstract level. She also guides the team and asks questions to test their understanding and assumptions.

The students mainly focus on understanding and improving the design and use techniques that help them in this process. Much of their discussion is concrete and concerned with the design product.

Juror techniques share similarities with both students and the professor. They use techniques similar to the students when they are trying to understand the projects being presented. At other times they use techniques similar to the professor's: for example, when they are probing the students' rationale for their projects.

## Discussion

The analyses in this chapter use a variety of methods to describe what was occurring in these CDD sessions. From these results, some observations can be made that have direct implications for using CDD in other situations:

**Communicating the design problem and solution is a major, ongoing issue.** Once a design concept had been developed by the team, much of the discussion was spent communicating that idea to the other participants. This was especially evident in the jury review, where jurors were faced with the difficult task of giving substantive comments on a project to which they had just been introduced. The implication for other situations is that sufficient time and effort needs to be put into this aspect of the dialog before any more critical discussion can occur.

**Jury reviews and pin-up sessions are very different.** Some of the differences in this case were intentional: for example, the change in format and location. But bringing in outside visitors, particularly when they are colleagues of the professor rather than of the students, cannot help but change the patterns and content of the discussions. Calling them "jurors" also implies that they are there to judge what students have done, whether or not that is part of the actual agenda. The implication for other situations is that educators need to think carefully about what kind of discussion they want to encourage and whether or not they should invite jurors to participate.

**Discussion topics and patterns change as the project changes.** Design projects, almost by definition, change as time goes on and as students learn more about the context of their project. One of the advantages of using CDD is that it can react to this changing situation and stay relevant to whatever the students encounter. The implication for other situations is that educators need to be aware of the state of the projects and make changes in the CDD sessions when needed. It also implies that there may be different points in the project where different forms of CDD (e.g. using jurors) might be more useful than others.

**Different speaker groups play different roles in the discussion.** In the pin-ups, students were willing and able to direct the discussion, but their main goal seemed to have improving the design. The professor, on the other hand, maintained the focus on helping students learn from what they were doing. The implication is that in situations where the professor might not be as active a participant, students may need some form of guidance in reflecting on and learning from their design projects. But, they may not need as much help in finding problems in or ways to improve a design.

## Summary

This study examined critical design dialog as used by an experienced professor in an undergraduate HCI class. Students were able to initiate and sustain discussions among themselves with only occasional input from the professor. However, student-to-student discussion tended to be at a very concrete level, concerned more with improving the design than learning from it. The professor played a very important role in the discussions, helping students move away from the individual projects to consider broader issues and connect to other HCI ideas. Discussion covered a wide range of topics which shifted over time as the project progressed and new participants (the jurors) joined the group. A major task in all the sessions, however, was communicating and understanding the design problem and proposed solution. Several recurring discussion techniques used by the participants were identified. The next stage of this research will investigate how the CDD impacted students' designing as shown by their design journals, posters, and other artifacts.

# CHAPTER IV

# EXAMINING THE IMPACT OF CRITICAL DESIGN DIALOG ON STUDENTS' DESIGNING

This chapter considers the question, "In what ways can critical design dialog impact students' designing?" Data (posters, assignments, a design journal, and final report) collected from four project teams is used. Issues raised in each critical design dialog (CDD) session are identified and tracked through the rest of the data, noting when they were revisited and by whom. Findings showed that the two pin-ups impacted students' designing in several ways: by bringing new issues, ideas, and problems to their attention; by helping them develop the description and rationale for their project; by providing feedback on specific questions; and by allowing some teams to work through design problems on the spot. Findings also showed that different teams took different lessons from the pin-ups, which were not always directly related to the issues raised during the discussion of their own projects. Jury reviews played a different role than pin-ups and may have influenced students by pushing them to think beyond their current concept of the design.

## Introduction

The reason for having dialog about design is the assumption that it can have a positive impact on students' designing and learning. Both the traditions of design studio education and research in cognitive science support this view. Often during a dialog, "issues" are raised that must be subsequently dealt with by the designers. For example, the following is an exchange between two students in a Human-Computer Interaction (HCI) class discussing the redesign of a popular website:

> S5: How do you think changing the interface will affect people who are already very familiar with the existing interface?
>
> S4: Yeah, we have to be concerned about the expert users. I think the way that we're going to do it is that we're not going to change the way the information is displayed, really, we're just going to change how quickly users can get to it.[...]

The issue being raised in this case is how to accommodate both existing and new users. Further discussion reveals that the current website provides information using a particular categorization scheme. The team redesigning the website plans to keep the current categorization scheme, but organize the interface differently to (hopefully) allow faster access to the information. For the purposes of this analysis, an issue can be a question, an observation, a suggestion, or an idea that is raised by either the team itself or by others which becomes the topic of conversation.

Critical design dialogs raise issues spontaneously. They cover a wide range of topics and can raise many issues in a short time. For these reasons, it is unlikely that every issue raised during a discussion will be recorded (or remembered) and dealt with by a project team. Explicitly addressing a particular issue—either through their designs, documents, or subsequent dialog—suggests that the team assigned a certain significance to that issue. For this analysis, issues are considered to have had an impact if they are revisited in student-created artifacts or in future discussions, particularly if they are raised by the team themselves.

## Setting

This study uses data from the same undergraduate HCI course as the study described in Chapter III. Details of the course and its organization can be found in that chapter. The description of the team project is repeated here for clarity. More detail about project deliverables is provided here than in the previous chapter.

### Team Project

Students were responsible for forming their own teams of 3-4 students and choosing a project in Weeks 3 and 4. Projects were open-ended and culminated in an electronic prototype of a proposed interface design. Students could choose one of the professor-suggested projects or propose their own. The professor solicited ideas from around campus and chose several that she felt would make for good projects. Some of the projects, therefore, had actual "clients" who were interested in the designs that students would be creating. In the case of the GVU Survey Website, one of the clients was also the teaching assistant for the class. For the CNS Help system, one student was employed by the client. Clients for other projects had no specific connection to the class. The professor also encouraged having more than one team working on the same project. Table 4-1 shows the topics of the projects for the class, who suggested each, and how many teams chose each project.

**Table 4-1. Projects and Properties**

| **Project Topic** | **Suggested by** | **Number of Teams** |
|---|---|---|
| In-Store Information Kiosk | Professor/Client | 3 |
| Website Administrator Monitor | Professor | 2 |
| Interface for JR | Client | 2 |
| CNS Help system | Client | 2 |
| GVU Survey Website | Client (TA) | 1 |
| Website Change Updater | Professor | 1 |
| Home Messaging System | Students | 1 |

Each potential project was described in a design brief prepared by the client or professor. Figure 4-1 is an example of a typical design brief, although some had more and many had less detail. Teams chose their projects based on these briefs, which is the extent of the information that they received about the project. The projects were purposely broad, requiring students to first define the problem more clearly before they could propose a solution. Teams were expected to research the topic and, under the guidance of the professor and the rest of the class, identify a more specific problem they would solve. Methods of research included investigating existing systems, identifying and interviewing potential users, interacting with clients, observing behavior, and studying the physical environment. Teams chose methods that were appropriate for their projects.

In-store Information Kiosk

Contact: Wendy Newstetter (wendy@cc.gatech.edu) for NCR

Description:

This system will provide information to customers within a physical retail store, such as Wal*Mart or Macy's. In considering appropriate functionality for the system, consider the types of tasks that consumers perform within a store. For example, consumers might want to get more detailed product information than they can get from the packaging or from a store associate. Or, they might want to know where a particular product in located within the store. You should also consider the ways in which an internet-based kiosk could interact with a virtual electronic store. For example, the consumer could search for product information on the Internet, and then enter the store to complete the transaction. Other issues to consider include:

- How can your underlying interface design transfer to other retail environments (e.g., from Wal*Mart to Blockbuster to The Gap?)
- How do issues such as branding come into play? How does the electronic store interact with the kiosk in the physical store?
- Speed of transaction, although important, is less critical than minimizing errors.
- The scope of this system does not include self-checkout.
- Consider the environment in which this system will be placed. How many should be in a store? Where should they be placed? How do consumers become aware of it and what it can do? How will store personnel interact with it?
- Where does content for the system come from? How is content updated?
- Think about how a retailer might cost-justify such a system. How does having such a system reduce operational costs or increase revenue?

Make the following assumptions about the system configuration:

- Touch screen
- Internet-based
- No alpha-numeric keypad (Implication: minimize user input)
- Credit-card swipe scanner integrated into hardware
- Integrated speakers

**Figure 4-1. Design brief for In-store Information Kiosk**

**Presentations and Deliverables**

Assessment for the team project was based on three components: a design log, a design recovery website, and three presentations made during the quarter. Figure 4-2 shows a timeline for the three presentations and other deliverables for the team project.

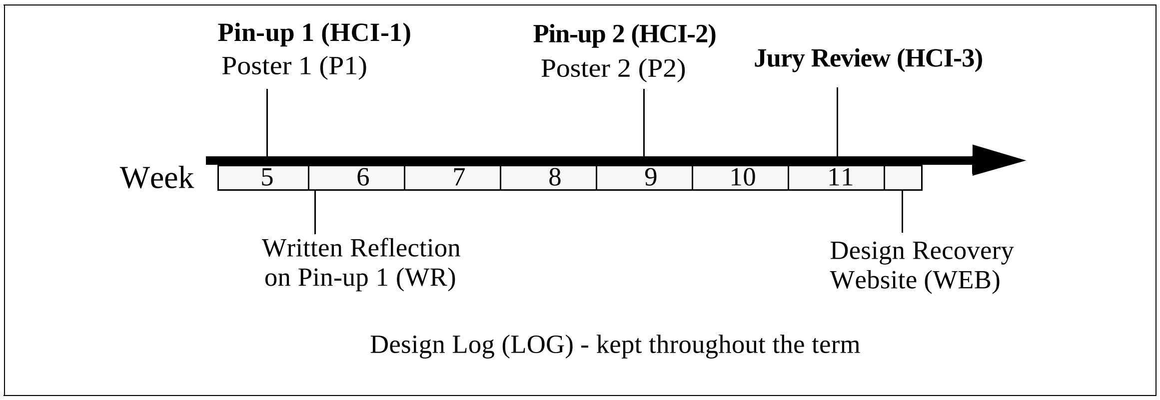



**Figure 4-2. Timeline of class events and team project deliverables**

Each of these is described below.

Teams were required to keep a *design log* to chronicle their design and their design process as it developed. Each team chose one person to keep a log of meetings, including: what ideas were brought to the table, how they related to the evolving design, what decisions were made, how the team was working, and what progress they were making. The log was to include notes, sketches, lists, scribbles, data, and anything else the team generated as they went along. The goal was to have an informal but detailed record of the teams' work.

At the end of the term, in lieu of a final exam, each team was to create a *design recovery website*. The goals for the website were:

- to give students a chance to reflect on the work they did during the quarter,
- to give the professor and teaching assistant a way to review what students had learned during the quarter,
- and to provide a resource for future students taking this class.

Students were instructed to include in the website a description of the project and their final design solution. They were also to use the information from their design log to write 3-5 “stories” about how different aspects of their design came to be and to include their thoughts and opinions on these aspects in retrospect.

The other part of the team grade was based on three presentations made during the quarter. One kind of presentation was a *pin-up*—a technique adapted from architecture education where students literally “pin up” their works-in-progress to discuss with their classmates and professors. There were two pin-ups held during the project, at Week 5 and Week 9 (the project development finished at the end of Week 10). Each pin-up required two 90-minute class periods so that all 12 teams would have a chance to present their work, with half presenting each day[1]. Every team prepared a poster describing their project and their work up to that point. The first two sessions were conducted in a typical classroom, with desks pushed to the middle of the room to allow access to the walls for hanging posters. The next two sessions were conducted in a specialized pin-up area in the

1. For the analyses in this chapter, the two class periods are treated as one session, since each team made their presentation in one period or the other.

College of Architecture. This area allowed posters to be attached to the walls and the class to move around and view them easily. For approximately the first 20 minutes of each session, students wandered around individually to view the posters created by the teams presenting that day. Posters also included an area where viewers could leave written comments, and in some cases the team posed specific questions for viewers to answer. For the remainder of each session, teams presented their work one at a time. The professor and the rest of the class gathered around one poster while one of the team members stood near the poster, usually making a brief presentation and then opening the floor to comments and questions from the group. The professor acted as timekeeper, cutting off the discussion when it was time to move on to the next team.

After Pin-up 1, teams were required to turn in a *written reflection* document on their experiences during the pin-up session. The document was to include an evaluation of how well they presented their project, what they learned from the session, constraints they identified for their design, and a plan for making progress in the next two weeks. They were not required to write anything after the second pin-up.

The final presentation was a *jury review*, also adapted from architecture education, where students present their work to a panel of invited experts who are other professors or working professionals. In this case, the invited experts were professors from HCI and related fields. The jury review also took place over two 90 minute class periods in Week 11. A different set of invited experts attended each session. The session began with one team giving its presentation to the jury, explaining their problem and walking through several scenarios to describe their solution. During and immediately following the presentation the team would answer questions of clarification. Then, a second team would present their project the same way. After this, the first team returned to join the second team at the front of the room, and the floor was opened for questions from the invited experts. As time permitted, other students were also allowed to ask questions or make comments. The discussions were organized in pairs to encourage comparison or highlight contrasts between the projects. The process was repeated with additional pairs of teams until the session was over. Once again, the professor acted as timekeeper and facilitator for the session.

## Investigation

### Data

The projects of four teams who agreed to participate in this study were examined using the transcripts from the three CDD sessions and five student-created artifacts. These included the design log and design recovery website, as well as the posters each team created for the two pin-ups and the written reflection they submitted after Pin-up 1. Table 4-2 shows how each of these types of data are coded in the subsequent analysis. Transcripts of the CDD are coded with “HCI-” and a number (which corresponds to the coding using in the previous chapter). Posters that students created for those sessions are coded with “P” and the corresponding number. Other student-created artifacts are coded with a descriptive abbreviation. They appear in this table and in the tables created for the analysis in essentially chronological order. It is not strictly chronological because the

**Table 4-2. Codings for data collected**

| Code | Description |
| --- | --- |
| P1 | poster created for Pin-up 1 |
| HCI-1 | transcript from Pin-up 1 |
| WR | written reflection after Pin-up 1 |
| P2 | poster created for Pin-up 2 |
| HCI-2 | transcript from Pin-up 2 |
| HCI-3 | transcript from the Jury Review |
| LOG | design log |
| WEB | design recovery website |

design log (LOG) was created throughout the term and the design recovery website (WEB) may contain materials created at different points in the term.

Not all data was available for all of the teams. The very first pin-up session was not audio taped so the transcript of Pin-up 1 is not available for the Kiosk (GT Bookstore) team. Additionally, there was not enough time in this session for the Kiosk (Blockbuster) team to make a presentation, so there is no transcript for them from Pin-up 1. The other missing pieces of data were not collected from the teams. Teams voluntarily contributed their materials for this research and not all of the teams submitted all of their materials. Table 4-3 shows which artifacts were collected from the four teams examined.

**Table 4-3. Artifacts collected from each team**

| Team | P1 | HCI-1 | WR | P2 | HCI-2 | HCI-3 | LOG | WEB |
|---|---|---|---|---|---|---|---|---|
| GVU Survey Website | | X | X | X | X | X | X | X |
| Kiosk (GT Bookstore) | X | | X | X | X | X | X | X |
| JR (Environment) | X | X | X | X | X | X | | X |
| Kiosk (Blockbuster) | X | | X | X | X | X | X | X |

## Method

To examine what issues were raised in the discussions and how they impacted students' designing, the following method was used. For each team:

1. The central "issue" of each discussion[2] during that teams' segment from the transcript of Pin-up 1was identified and recorded along with a supporting quote from the transcript. The person who first raised the issue in the session (the professor, the team presenting, or another student) was noted.
2. Each piece of data collected after Pin-up 1, including the transcripts from subsequent sessions, was examined for any reference to the issues identified in Step 1. Any references found were recorded along with a supporting quote from the data.
3. The procedure was repeated for Pin-up 2 and the Jury Review, identifying the issues raised in each session and noting by whom they were raised (with the additional possibility of having been raised by a juror in the Jury Review). Data collected both before and after each session was examined for references to the issues identified.
4. A table was constructed listing the complete set of issues raised and showing in which

2. A *discussion* is a sequence of speaking turns that relate to one another. Discussions were distinguished by a new speaker, a new question, and/or a significant change in topic.

sessions and artifacts the issues were revisited.

5. For two teams, a more in-depth analysis was conducted. For each issue raised by these teams, a short history of the issue was created detailing when and how the issue was raised, showing how it developed through the life of the project (if it did) and describing how it was manifested in the final design (if it was).

Since the purpose of this analysis was to understand how CDD impacts students' designing, issues which were raised but were never the topic of discussion are not considered. For example, when a team is making its initial presentation, they may raise a variety of issues that never get discussed by the group. Another example would be issues raised in a team's design log that they never bring up during their presentations. These kinds of issues are omitted from this analysis because they are never the subject of discussion. The one exception is when the first pin-up session transcript was not available, so the written reflection was used to identify the issues raised in that session. In this case, some issues were noted in the written reflection which were not specifically a topic of discussion. They are included in the analysis, however, because they are a direct outcome of the discussions, even if they were not explicitly discussed.

## Results and Analysis

For each team, the results are summarized in a table showing when each issue was initially raised and in which pieces of data it is revisited. Issues are listed in the order in which they occurred in the dialog. For the first two teams a more detailed description of each issue is presented, showing how it developed through the course of the project and how it was manifested in the final design. A brief analysis for each team is presented. Broader themes and observations comparing the teams are presented in a separate discussion at the end of this chapter.

## TEAM 1: GVU Survey Website

The problem selected by this team was that a popular research website was receiving more email than they could keep up with. The content of the email was often a request for help, which suggested that people were having a hard time finding information on the website. The complete design brief is shown in Figure 4-3. Ultimately, the team decides that the website needs to be redesigned to help people find information more easily, which they hope will reduce the number of email requests. The details of the redesign are the main focus of this team's project. The team revisits most of the issues raised in the Pin-up 1 in their written reflection and again in their final jury presentation. Issues from the other sessions are not revisited explicitly again. This team's design journal and design recovery website are incomplete, explaining why very few issues are revisited in them.

### Issues Raised in Pin-up 1

**Providing a search function**. During the initial part of the session, someone leaves a written comment on this teams' poster that says, "Search Functions?" At the end of the teams' initial presentation, the presenter turns to the written comments and reads this one out loud. He says that they thought about providing a search function, but did not include it because they were not sure how to implement one. Now that they realize that they do not

**Website for GVU's WWW User Survey**

Contact: Colleen Kehoe (colleen@cc.gatech.edu) & GVU's WWW Survey Team

Description:

*Background on the Survey*
The World-Wide Web is clearly one of the most popular Internet resources. Yet because of its distributed, global nature, very little is known about its users, their characteristics, and why they are using the Web. A better understanding of these users, and their reasons for accessing the Web will lead to improved development of Web related tools and technologies as well as make the Web more usable by all users. The Graphics, Visualization, & Usability (GVU) Center's World Wide Web User Surveys are a public service effort to address these issues. To date, over 100,000 responses have been collected through nine surveys and a basic analysis of responses is available to the public for free. These results are cited very widely and are used by researchers, developers, businesses and policy makers for a variety of purposes. The survey contains questions on: demographics, web usage, privacy, online purchasing, virtual banking, politics, webmasters, web authors and others. It is one of the more high-profile projects in the GVU Center.

*The Problem*
The data collected from the survey, along with hundreds of graphs, analysis and related documents are all available on our website: http://www.gvu.gatech.edu/user_surveys/. We also maintain an email address for people to send questions which receives hundreds of emails per month. The content and quantity of these emails suggests that many users have trouble finding information on our site. (Another hypothesis is that some users don't even try to find the information themselves and would rather just ask us.) What should we do so that users can more easily find what they need? How can we decrease the amount of email we have to deal with?

**Figure 4-3. Design brief for GVU Survey Website**

have to implement it, they will reconsider. Examining this team’s design log (LOG) shows that indeed the idea had been mentioned at the very first meeting, but had not been developed further by the first pin-up. The team also records in their design log the written comments they received on their poster, which includes the query about search functions. The issue of including a search function is not raised again until the final jury review (HCI-3), when another student suggests that a search function might be useful. The presenter chastises himself and his team for not including one, noting that they had been told several times to include one but somehow it was overlooked in the final design.

**How changing the website will affect experienced users; balancing expert and novice needs**. A student asks the presenter how changing the website will affect people who are already very familiar with its current design. The presenter acknowledges the problem—they have to consider expert users when making changes to the website. He explains that the changes will not be so dramatic that experts will find it unfamiliar, but that it will be easier for novices to find information. In the written reflection (WR) this issue is revisited in a somewhat broader form when the team realizes that they need to consider not just expert/novice differences, but differences among other user groups and how their goals and needs differ from one another. They make this point explicitly during Pin-up 2 (HCI-2) and express some frustration in trying accommodate all the different user groups with a single design. In their design recovery website (WEB), they describe the different user groups that they have identified by analyzing the email sent to the survey researchers. In their final Jury Review (HCI-3), they include in their design goals the need to accommodate both novice and expert users, stating that the website needs to expose the information on the site (to aid novices) but still it needs to be fast to navigate (to accommodate experts). They further describe how a "Yahoo"-style[3] interface accomplishes both of these.

3. http://www.yahoo.com - Yahoo! is a very popular web site with a wide audience that uses a hierarchical structure to organize a large amount of information.

**Rationale for the "Yahoo" design metaphor; what is the "Yahoo" metaphor?** The professor asks what the rationale is for the metaphor they are using. The presenter says that "Yahoo!" is their metaphor and they chose it because Yahoo solves a problem similar to theirs. A teammate adds that since many people are familiar with Yahoo, they will also understand how to use the GVU Survey website when they see it. The professor presses the issue further, asking what components of the Yahoo interface they will use? After some discussion, they conclude that it is the hierarchical or taxonomy aspect that they will use. In the written reflection (WR) the team notes that the professor asked about the justification for their Yahoo metaphor, which they then restate and slightly elaborate. They also infer, based on the questions they were asked, that they did not present the justification for their design very well and resolve to do better next time. The issue is not revisited again until the final Jury Review (HCI-3) when during one of their scenarios, a character who is relatively new to the internet remarks that the new interface design looks similar to Yahoo and realizes that this site works the same way.

**Designing the taxonomy for the data; whose perspective will it represent?** The professor asks the presenter how the team will go about designing their taxonomy. Will it represent the perspective of the survey researchers or the users of the website? The presenter acknowledges the dilemma but suggests that the two perspectives might not be that different. However, in the written reflection (WR), the team says that, "the most important insight we gained from the presentation came from Professor Newstetter's comment on category divisions...It would be better to determine the appropriate categories through a more scientific method....It may reveal differences between user groups."

Ultimately, however, the team does not document considering any other taxonomies. In the Jury Review (HCI-3) they state that they used the existing taxonomy to remain compatible with the old website.

**Having a special section for popular graphs**. In Pin-up 1, a student suggests that a way to help people find what they are looking for more quickly is to have a special section for popular graphs. The presenter acknowledges it as a good idea, but questions whether it would help, given the diversity of user groups. In the written reflection (WR) the team rejects the idea, unconvinced that presenting the most popular graphs would help people find information faster. They note that if they did decide to use this idea, they would have different sections tailored to the different user groups.

Issues Raised in Pin-up 2

**Deciding between a menu-style or Yahoo-style interface.** The presenter states that they are currently trying to decide between a menu-style or a Yahoo-style interface, referring to two different screen mock-ups the team has made for their poster (P2). The professor then leads them through a discussion of the pros and cons of the two designs. The dilemma is not mentioned again in the data, but the team does present a single interface as their final design which has elements from both.

**Treating navigation and information acquisition separately; focusing on user goals**. After discussing the pros and cons of the two interface styles presented, the professor points out that user activity is goal-directed and identifies two different goals being supported in the designs: navigation and information acquisition. She raises the question as to whether these should be treated separately or together. She and the presenter discuss what it would mean to separate them and how it might be done. This issue is not specifically referred to again.

**Narrowing the design goal**. As a strategy for managing their design, another student suggests that they narrow their design goal “like the JR groups have done” and just deal with novices or experts, but not both. The team responds that they will look into that, but that their task was to design a site that would accommodate all users. Buried in one of the documents on their poster (P2) is a statement that shows that they had already simplifying the problem this way, but their client rejected the idea.

Issues Raised in the Jury Review

**How the solution solves the stated problem**. A juror asks how they know that their solution solves the problem that they originally identified—to reduce the number of emails the survey receives. They reply that they do not know for sure but they explain more of their research and rationale for the design.

**Providing a search engine that understands questions**. A student notes that many of the emails seem to contain questions, so he suggests a search engine that can understand questions. The presenter wonders how this could be done, but agrees that there should be a search engine of some kind.

**How to find information not listed on the main page**. A juror asks how someone could find information that does not seem to fit any of the categories on the main page. The presenter suggests that a search engine could be used but also reiterates that the category structure is based on the structure of the data in the survey, so all the information available fits into the category scheme.

**Appeal/interactiveness of the system**. In a lengthy exchange, a juror raises the issue of how the system will attract users and suggests some ways in which it might be made more interactive. The team is somewhat confused by these suggestions and repeats the goals and constraints of the design problem as they understood it. They state that their expert users want a standard “web-like” interface, not something interactive or complicated.

Analysis

Table 4-4 summarizes the issues raised in the three sessions and where each of the issues recurred in the rest of the data. For the three CDD sessions, the letter in the box indicates who raised the issue in that session, as described in Table 4-5. For the other types of data, an X indicates that that issue was mentioned in some form in that piece of data. Parentheses indicate that the issue is modified from how it originally appeared. For example, in the written reflection (WR) and design recovery website (WEB) the GVU Survey Website team discusses differences between several different user groups, not just novice/expert differences. Even though the initial issue raised was about the impact of design changes on expert users, they are closely enough related to be considered the “same” issue for the purposes of this analysis. Another example is in the Jury Review (HCI-3), where the team says that they based their taxonomy on the existing categories in the survey website. The initial discussion was about whose perspective would be

**Table 4-4. TEAM 1: GVU Survey Website - Issues and where they are mentioned**

| Issue | P1 | HCI-1 | WR | P2 | HCI-2 | HCI-3 | LOG | WEB |
|---|---|---|---|---|---|---|---|---|
| search function | | S | | | | S | X | |
| novice/expert users | | S | (X) | | T | T | | (X) |
| Yahoo metaphor | | P | X | | | T | | |
| taxonomy design | | P | X | | | (T) | | |
| popular graphs | | S | X | | | | | |
| menu vs. Yahoo | | | | X | T | | | |
| two goals | | | | | P | | | |
| narrow design goal | | | | X | S | | | |
| address the problem | | | | | | J | | |
| search engine/questions | | (S) | | | | S | | |
| other categories | | (J) | | | | J | | |
| appeal of system | | | | | | J | | |

**Table 4-5. Coding for who raised the issue in the session indicated**

| Code | Issue Raised by |
|---|---|
| T | the Team presenting |
| S | another Student |
| P | the Professor |
| J | a Juror (in HCI-3 only) |

represented in the taxonomy. In the Jury Review, the discussion is not about representing different perspectives, but instead states the choice the team made. The column for Poster 1 (P1) is grayed out in this table because it was not collected from this team. Boxes which are light gray help identify issues that were raised in a particular session. For example, the first five issues listed are those raised in Pin-up 1, the next three are raised in Pin-up 2, and the last four are raised in the Jury Review. Issues are listed in the order in which they occurred in the sessions.

Several observations can be made from Table 4-4:

- All but one of the issues raised in the first Pin-up (HCI-1) are mentioned in the written reflection (WR). This indicates that this team was hearing the major points being made, at least in the first pin-up.
- Only one of the issues raised in Pin-up 1 (HCI-1) is revisited in Pin-up 2 (HCI-2) and it is raised by the team themselves. This suggests the team was making progress in the design, since they are not revisiting the same issues over and over again. However, the fact that they raise this issue in Pin-up 2 and in the Jury Review (HCI-3) suggests that they see it as a central issue in their design, and perhaps a problematic one.
- Only one issue mentioned in any of the sessions is mentioned in the design log (LOG). After the team recorded the written comments from Pin-up 1, they made no further entries.
- Only one issue is mentioned in the design recovery website (WEB). The website is incomplete and does not record much after the analysis phase of the project. Although they have sections for “Design of Solution” and “Implementation”, these are left empty.

- Two of the issues discussed in Pin-up 2 (HCI-2) were also on the poster the team made (P2) for that session. This session more than the others was directed by the team's own questions rather than questions from others. The team did get to discuss at least some of the issues they had planned to, but the discussion was not limited to those.
- Two of the four issues raised in the Jury Review (HCI-3) are related to issues raised in the first session (HCI-1), even though they are not exactly the same. One is raised by a student in both sessions (search engines) and may be the result of him having remembered the issue being raised before. It is also an obvious solution to the problem the team has. The other issue, the category divisions, while raised in different forms by the professor in the first session and a juror in the last session, suggests that they both recognize it as a central issue in this design problem. Another juror agrees and mentions this explicitly, that the success of the design depends on the category scheme.

**TEAM 2: Kiosk (GT Bookstore) Team**

The problem for this team was quite broad: to design an in-store information kiosk for some sort of retail environment. A significant task, therefore, was to define a problem that was manageable within the available timeframe. The team struggled with this issue initially, not realizing that they need to narrow the project to complete it. They realized this after Pin-up 1 and as a result, changed their project dramatically, using the campus bookstore as their target environment. The complete project brief is shown near the beginning of this chapter, in Figure 4-1. Issues from both pin-ups are revisited by the team in their final jury presentation, their design log, and their design recovery website. A large number of new issues are raised during the jury review by both students and jury members, perhaps because of their familiarity with the target environment.

The first pin-up session for this team was not recorded due to logistical issues. Therefore, the issues from Pin-up 1 are identified using the written reflection (WR) instead.

Issues Raised in Written Reflection

**Choice and clarity of metaphors**. The team is considering two metaphors for their kiosk design to assist customers in a store: a map and a customer service desk, which they present on their poster for Pin-up 1 (P1). Based on the questions they receive in their presentation, they conclude that these metaphors are not as clear or obvious as they had thought. Their design log (LOG) shows that they considered these two metaphors before the pin-up, with each being advocated by a different member in the group. They decide to pursue both for the time being. The issue of using a metaphor is raised again in their design log several weeks later, after they have decided to change the focus of their project (more on this below). Finally, in their design recovery website (WEB) they describe their early design ideas and how they considered two different metaphors.

**Map metaphor and possible improvements**. From the feedback in Pin-up 1, the team concludes that the map metaphor is the better of the two, but also considers not using either of them. They record a list of suggestions from the discussion that they are considering incorporating if they use the map metaphor. Notes from Pin-up 1 recorded in the design log (LOG) also mention this issue.

**Getting "real" users' perspectives**. On their poster for Pin-up 1 (P1) the team lists some of the questions they plan to use in their interviews. In the written reflection, the team realizes that not having interviewed real users by now is a problem and that they cannot just "pretend to be users" to evaluate their own designs. However, their design log (LOG) documents on several occasions their efforts to design and revise their surveys and to make arrangements to interview real users, many of which occur before Pin-up 1. The design recovery website (WEB) explains the situation more fully, describing how the team encountered many problems in getting permission to interview users in the different stores they were targeting. Because they could not find a way to conduct the interviews, they tried creating "mock users" to help them keep their user group in mind. Changing their project focus allows them to change to a more accessible user group (i.e. students, faculty, and alumni). They present the results of their interviews on their poster for Pin-up 2 (P2). They also refer to the results of the interviews to justify several design decisions during their final Jury Review (HCI-3).

**Reconsidering project choice**. In the written reflection, the team states: "Although the comments we received from our peers, teacher and TA were very helpful in helping us choose the correct order in which to perform our tasks, we feel that seeing what the other groups have done was more helpful....Seeing what the Blockbuster Kiosk group has done, we were frustrated that we had picked such an enormous task for our Kiosk rather than a smaller, more manageable one." Because of the scope of the project they have chosen and the difficulty they have encountered in getting access to real users, the team, in consultation with the professor, decides to shift the focus of their project to designing a kiosk system for the campus bookstore. The design log (LOG) documents this issue being raised in a team meeting after Pin-up 1, but before they turn in their written reflection. The design recovery website (WEB) also recounts this story of them having trouble with the interviews and becoming frustrated, and how seeing what the other groups had done was adding to their frustration. By changing to a more accessible user group, they were able to make progress in their project. The team describes this change in focus and the reasons for it during their second pin-up (HCI-2).

Issues Raised in Pin-up 2

**Should they keep a redundant button for consistency's sake?** The team presents a design for their screens which has a "Main" and a "Back" button on each screen. The presenter asks the audience whether or not they should keep both buttons for consistency with the other screens, even on screens where both buttons lead to the same place. But before anyone can respond, the presenter moves on to another question. The team listed this question on their poster (P2) along with a space for written comments. The two responses that were left argue for consistency and keeping both buttons. In the final design, all screens (except the main menu itself) have both of the buttons placed consistently. The design recovery website (WEB) deals with the issue of internal consistency more explicitly, stating that keeping the same elements throughout the design will help people apply their knowledge about one part of the system to other parts of the system. They reiterate this rationale in their Jury Presentation (HCI-3).

**Design of the Sale button**. The presenter asks the audience whether the “Sale” button should be the same as the other buttons or whether it should be a different color or flash to attract users’ attention. Another student suggests changing the wording on the button to be more clear, but offers no input on the specific question asked. This question is also listed on their poster (P2) where the written responses say that the color should be changed and the wording should be changed, too. Although it is referred to by the team as the Sale button (both in the text of the poster and verbally), the button on the screen shot reads “Sales Items”, which is somewhat more confusing. In the final design, the wording has been changed to “Items on Sale”, and the button is the same color as all the others.

**Conceptual consistency of the Sale button**. The professor says she was confused by the “Sales Items” button, which did not seem to support a specific task the way the other buttons did. She also wonders why it would be listed first. The team does not get a chance to respond to this issue before the next one is raised. The professor has also written comments along these lines on the team’s poster (P2): “What do you mean by Sales Items? Items on sale? Why is this a separate category? What ‘activity’ would this button support?” The issue is revisited in the design recovery website (WEB) where the team calls it the “most misplaced button” in their design.

**Programmatic design/external consistency**. Following up the point she made about the Sales Items button, the professor raises the issue of programmatic design[4] and tells the team that they need to address external consistency of their design—how it relates to the existing bookstore's organization, color scheme, logos, etc. The issue is raised once in their design log (LOG) after the second session, where they note that they "Need BUZZ!!!" (the Georgia Tech mascot) for their prototype. The issues of the Sale button and external and internal consistency are discussed together and in detail on the design recovery website (WEB). The team notes that the Sale Items button was "out of place" and did not "mix well" with the other buttons because it was not related to a specific department in the bookstore. They then describe how moving the button to the bottom of the screen allows them greater external consistency with the physical bookstore, and how this is further reinforced through colors and logos. They make the same point again in their final Jury Presentation (HCI-3).

**Keeping the screen simple**. The presenter comments that the team has the same problem as another group, which is to present a lot of information at once (e.g. search results) while still keeping the screen as simple and easy to understand as possible. The team runs out of time, so no further discussion on this issue takes place. In the design recovery website (WEB), the team discusses how they originally wanted to have a shopping list available on screen at all times, but how when they built a model of this, it became obvious that the screen would be too cluttered. Since their goal was simplicity, they moved the shopping list to its own screen. They mention the goal of simplicity in screen design again in their Jury Review (HCI-3), saying that they tried to avoid clutter and wanted users to be able to get the information they needed as quickly as possible.

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4. A *program* is a comprehensive system organizing the elements of a design such as shapes, sizes, colors, themes, terms, and concepts.

Issues Raised in Jury Review

**Required vs. recommended textbooks**. A juror asks whether the system has a notion of required versus recommended textbooks, a distinction the bookstore currently makes. The presenter responds that they only deal with required books in the current design, but that they had considered the issue and felt it would be easy to add.

**Clarification of "list" shown in prototype**. The presenter says that by swiping a student ID through a card reader, the system creates a list of textbooks the student needs based on the classes for which he has registered. The student can then add any of these books or others to his shopping list as he desires. Later in the discussion, a juror asks the presenter to explain the purpose of the list again.

**Clarification of screen mock up**. A juror asks if the "thing on the right" in their screen design is a scrollbar or not. The presenter responds that it is and jokingly apologizes for his artistic skills.

**Is the data from interviews?** A juror asks if the data they are showing is from the interviews that they conducted. The presenter responds that it is.

**How to input size of cap**. The team describes a scenario in which a user purchases a fitted cap. Another student asks how the person ordering the cap would input the size of the cap they want. The presenter explains that the person is just paying for it using the kiosk system, and that they will still need to go pick up the cap off the shelf themselves. Since all the sizes cost the same, entering the size is not an issue.

**Purchasing textbooks not on your list**. A student asks whether you can purchase textbooks that are not on your list required books. The presenter says that you can and demonstrates how to choose that option with the system. The student asks further whether you can do both, first use your ID to get a list and then add more text books? The presenter says that you can.

**Keep a running total on screen**. A student notes that you can choose many items to purchase, but that you do not know the total cost until you go to check out. He suggests keeping a running total on the screen. The presenter states that they had considered keeping the shopping list on the screen at all times, but that they decided to present more books instead. He suggests that users can keep a running total of their purchase in their heads.

**Selecting and adding to the list**. A student points out that the system is assuming that a student will buy all the books for the classes they have registered for when it adds them automatically to his shopping list. The presenter says that this is not what happens, that the books are just selected, not added to the shopping list automatically. They discuss what it means for something to be selected in this system and again revisit the purpose of the list.

**New vs. used books**. A student asks whether the system has a concept of new versus used books. The presenter says that they decided not to deal with used books because most people want to inspect them in person before they buy them.

**How to handle administrative problems outside the “kiosk” itself**. A juror asks the presenter to speculate on how the bookstore would handle administrative problems related to the kiosk system, for example if the customer cannot find the thing they have paid for already. The presenter acknowledges that a customer service person would need to get involved, either refunding the money or helping the person find the item. The juror asks how many problems like this a user would tolerate before they stop using the system. They discuss the issue more and the presenter decides it would probably only take 2 or 3 problems for someone to stop using it, depending on how they were resolved.

**How to verify the correct things have been paid for**. A student asks how the bookstore will make sure that people only pick up the things that they've paid for. The presenter responds that most of the items will need to be demagnetized anyway, so the person doing that will check each item against the receipt. In the design recovery website (WEB), the team documents a suggestion by a juror (perhaps made privately after their presentation) that the Buzzcard (student ID/debit card) could carry an electronic receipt to make checking out easier.

**Security of Buzzcard, other forms of payment**. A student asks what would happen if someone's Buzzcard was stolen and used. The presenter replies that this is a general problem with any debit system, and that there is no security in this case. The student asks further whether a regular credit card could be used, and the presenter says that it could.

Analysis

Table 4-6 summarizes the different issues and where they occur for the Kiosk (GT Bookstore) team. The column for Pin-up 1 (HCI-1 ) is grayed out because the presentation was not recorded for this team. The same coding scheme is used as was used in the table for the previous team with one exception. In the written reflection, the team did not record who raised each issue. It can be assumed that they were raised by either another student or the professor, but it is impossible to definitively say which. These are recorded as “S/P” in the table.

**Table 4-6. TEAM 2: Kiosk (GT Bookstore) - Issues and where they are mentioned**

| Issue | P1 | HCI-1 | WR | P2 | HCI-2 | HCI-3 | LOG | WEB |
|---|---|---|---|---|---|---|---|---|
| metaphor choice | (X) | | S/P | | | | (X) | X |
| map metaphor | | | S/P | | | | X | |
| real users | (X) | | S/P | (X) | | (T) | X | X |
| project choice | | | T | | T | | X | X |
| redundant button | | | | X | T | T | | X |
| sale button design | | | | X | T | | | |
| sale button concept | | | | (X) | P | | | X |
| external consistency | | | | | P | T | (X) | X |
| simple screens | | | | | T | T | | (X) |
| required vs. recommended | | | | | | J | | |
| what is list for? | | | | | | J | | |
| is that scrollbar? | | | | | | J | | |
| survey data | | | | | | J | | |
| select cap size | | | | | | S | | |
| books not on list | | | | | | S | | |
| running total | | | | | | S | | |
| what is selection? | | | | | | S | | |
| new vs. used | | | | | | S | | |
| administrative problems | | | | | | J | | |
| correct items | | | | | | S | | (X) |
| Buzzcard security | | | | | | S | | |

Since a transcript of Pin-up 1 is not available, there are two caveats in interpreting these results. First, inferring the issues raised in Pin-up 1 from the written reflection may underestimate the number of issues raised. A page in the team's design log where a member of the team was taking notes during the first pin-up provides a more accurate view. The writer recorded over 30 bullet points from the the session, including 12 from the discussion of the team's project, 10 from comments written on their poster, and 8 from the discussion of other team's projects. The written reflection they create only covers a small number of these points, but they are presumably the ones they felt were the most important or most relevant. The other thing to consider is that the fourth point raised in the memo (reconsidering the project choice) is almost certainly not discussed during the session. The idea to change their project focus is a direct consequence of the session, but it is not a topic of discussion in the same way that the other issues are.

Keeping these things in mind, there are several observations to be made from Table 4-6:

- All but two of the issues raised in the first two sessions (WR, HCI-2) are covered in the design recovery website (WEB). This indicates that the team understood and remembered most of the issues being raised in the first two sessions.
- All of the issues from Pin-up 1 (WR) are recorded in the design log (LOG), but only one issue from Pin-up 2 (HCI-2) is recorded. Unlike the GVU Survey Website team, this team keeps updating the design log until the end of the term. After Pin-up 1, however, few design issues are recorded in the log.

- Only one of the issues from Pin-up 1 (WR) recurs in the final Jury Review (HCI-3). This is not surprising, given that the team changed their project dramatically after Pin-up 1.
- Three of the issues raised in Pin-up 2 (HCI-2) are also presented in the Jury Review (HCI-3). This was not the case for the GVU Survey Website team, and it is difficult to say whether this difference between the teams is significant or not.
- An extremely large number of issues are raised in the Jury Review (HCI-3), none of which have been raised before. This team has longer to discuss their project than some of the others, because the professor decides there is not time to discuss the rest of the projects and gives them the remaining time. This extra time may simply allow for more issues to be raised. Another possibility is that both students and jurors (who are faculty) are intimately familiar with the campus bookstore and the process of buying textbooks. This familiarity with the details of the target situation may allow them to ask more detailed questions about how the system handles different scenarios.

**TEAM 3: Interface for JR (Controls) Team**

This team's project was to design part of an interface for JR, a paraplegic who was participating in an ongoing medical research project. JR is paralyzed from the nose down and is therefore severely limited in the ways he can interact with the world. As part of the research, he had an electrode implanted in his brain which he learned to use to control a mouse cursor. The team cannot interact with JR directly, but instead must rely on information from his doctor and other researchers involved with the project. The complete design brief is shown in Figure 4-4. The problem as given in the design brief is also rather broad, and this team also goes through a process of narrowing the project to something manageable. They decide to work on an interface that will allow JR to control his environment (e.g. radio, TV, bed, lights). The other team that chooses this project develops a web browser for JR. Both projects incorporate a selection-cycling interface style. The selection cycles sequentially through all the buttons on the interface, and the user clicks once when the button he/she wants becomes highlighted. They borrow this style of interaction from other software designed for users with limited input capabilities.

Analysis

For this team, only the final table of issues and where they occur is presented. The coding is the same as in the previous tables. The column for the Design Log (LOG) is grayed out because it was not collected from this team.

There are several observations to be made from Table 4-7, many of which repeat the patterns seen in the previous tables:

- All of the issues raised in Pin-up 1 (HCI-1 ) are mentioned in the written reflection (WR). This again reinforces the impression that students understood the major points of the discussion.

## Interface for JR

Contact: Greg Montgomery (gtxxxx@prism.gatech.edu, (770)xxx-xxxx)

Description:

JR is a 52 year old male who survived a cortical hemorrhage of the ventral pons in the late summer of 1997. The ventral pons is the area of the brain stem traversed by the descending corticospinal tract that controls movements and speech. Consciousness and the sleep/wake cycle are preserved because the dorsal pons and midbrain were not damaged. JR is able to move his eyes and eyebrows, he has to use a mechanical respirator for breathing.

In March of 1998, JR volunteered for an experimental project in which two electrodes were implanted in his motor cortex in the area that controlled arm movement prior to the stroke (see Kennedy 98 for details). The electodes consist of an glass cone which acts as an insulator for the two gold electrodes inside. Neurites from the surrounding neurons are induced to grow into glass electrode by coating it with three types of nerve growth factors. This growth stage takes about two months during which the neurons grow around the gold electrodes and for the myelin sheath to develop surrounding the new tissue. Once this growth has occurred, the electrode assembly is securely in place and does not move relative to the cortex and reliable signals will persist for at least 18 months based on non-human primate studies.

Using auditory and visual feedback, JR has trained himself to produce two patterns of nerve firing that have been mapped to horizontal and vertical cursor movement with digital signal processing of the analog data. Given that he can move the cursor but there is currently no third signal for selection, how can we best design a computer system that JR could use to type messages. Convert these messages as well as a number of commonly used phrases to synthesized speech. JR would like to use the internet as well, would current browsers be a problem?

Extra credit: Interface a local communications network so that JR could control his television, radio, bed, lights and call the nurse.

1b- In the real world, Dr. Kennedy is having problems with one of the signals. JR has good horizontal control via a continuous signal. The vertical signal is currently not continuous, we can get a pulse so could move down a line or block at a time. We are looking at using a scanning system in which JR moves the signal down to the correct line and then scans across and dwells on the item for selection.

1c - Another variation on this problem is to use eye movement only for the interface.

Greg Montgomery is in the Real World Lab group - Enabled Solutions that has developed an augmentative communications program called TalkAble.

**Figure 4-4. Design brief for Interface for JR**

**Table 4-7. TEAM 3: Interface for JR (Controls) - Issues and where they are mentioned**

| Issue | P1 | HCI-1 | WR | P2 | HCI-2 | HCI-3 | LOG | WEB |
|---|---|---|---|---|---|---|---|---|
| working with Enabled Solutions | (X) | S | X | | | | | |
| consider user needs | | P | (X) | | | T | | X |
| accommodating fewer inputs | | S | X | | | T | | |
| focus on constraints | X | P | X | | | T | | X |
| shortcuts available? | | | | | S | | | |
| control of electrode | | | | | S | (J) | | |
| quick error recovery | | | | (X) | S | | | |
| how controls work | | | | | (S) | J | | (X) |
| numbering of radio presets | | | | | | J | | |
| control of other devices | | | | | | J | | |
| how to adjust radio volume | | | | | | J | | |
| use more than one device at a time | | | | | | J | | |
| extend design to more con-trols | | | | | | J | | |
| origin of cycling idea | | | | | | J | | |
| scripted interaction | | | | | | J | | |
| JR’s capabilities | | | | | | J | | |
| suitability for other paraplegics | | | | | | J | | |
| use of color to aid learning | | | | | | S | | |

- All but one of the issues raised in Pin-up 1 (HCI-1 ) is repeated by the team themselves in the Jury Review (HCI-3). A similar pattern was observed with the GVU Survey Website team for Pin-up 1 and with the Kiosk (GT Bookstore) team for Pin-up 2.
- Few issues raised in the discussions appear on the design recovery website (WEB), and most of those that do were raised in Pin-up 1 (HCI-1 ). This was also the case for the GVU Survey Website team.
- A large number of issues (10) are raised in the Jury Review (HCI-3) that were not raised previously. The majority (6) of these are clarifications of how the system works, how JR's electrode works, and what his capabilities are. Some of these may have been raised in the pin-ups during the discussion for other team working on the Interface for JR project.

**TEAM 4: Kiosk (Blockbuster Video) Team**

This team started out with the same design brief as the Kiosk (GT Bookstore) team, shown in Figure 4-1. Unlike that team, however, they immediately focused on one particular store, Blockbuster Video. They also rapidly narrowed their design to consider only one activity, renting movies, which is the primary focus of the store. Their main innovation is the idea of a "Personal List" that a customer can use to keep track of movies that they want to see but have not yet rented.

Analysis

As with the last team, this team's issues are only presented in summary form. The column for Pin-up 1 (HCI-1) is grayed out because this team did not make a presentation during that session. Unfortunately, the class ran out of time, and a few teams were not able to make their presentations. Instead, they relied on the written comments made by students and the professor during the first part of the session as the feedback for their written reflection. As with the Kiosk (GT Bookstore) team, this team did not always record in the written reflection who raised each issue. When it is not clear whether an issue was raised by a student or the professor, the issue is coded as "S/P".

There are several observations to be made from Table 4-8:

- Only one of the issues raised in the written reflection is revisited in any of the other discussions. It is an issue the team raises themselves—that they need to explain the justification for their design decisions better, which they follow through on in future presentations.
- A very large number of issues (10) are raised in Pin-up 2 (HCI-2), compared to the other teams. Because they did not get a chance to present in Pin-up 1, this team gets to present first in Pin-up 2, which might explain why they cover more issues than other teams.

**Table 4-8. TEAM 4: Kiosk (Blockbuster Video) - Issues and where they are mentioned**

| Issue | P1 | HCI-1 | WR | P2 | HCI-2 | HCI-3 | LOG | WEB |
|---|---|---|---|---|---|---|---|---|
| number of kiosks per store | X | | S/P | X | | | X | X |
| search-by-date function | | | S/P | (X) | | | X | X |
| what is “electronic store”? | X | | S/P | | | | X | X |
| forecast of future rentals | X | | S/P | | | | X | X |
| basis for system design | | | P | | | | X | X |
| benchmarking progress | | | T | | | | | X |
| lack of justification | | | T | | (T) | (T) | | X |
| navigating to main menu | | | | X | T | | | X |
| key-in search | | | | X | T | | (X) | X |
| limited screen space | | | | X | T | | | X |
| how big is screen? | | | | | S | | | |
| ordering of buttons | | | | | T | | | X |
| programmatic design | | | | | P | | (X) | |
| access to personal list | | | | | S | | | |
| purpose of personal list | | | | | P | T | | X |
| rental suggestions | | | | | S | J | | X |
| image of box | | | | X | S | J | X | X |
| rent movies at kiosk? | | | | | | S | | |
| “number of copies” label looks like a button | | | | | | J | | X |
| how to find movie in store after found on kiosk | | | | | | J | | X |
| goal for system/value added by system | | | | | | J | | |
| rental suggestions | | | | | S | J | | X |
| image of box | | | | | S | J | | |
| utility for browsing vs. search-ing | | | | | | J | | |
| advantage of kiosk for showing previews | | | | | | S | | |
| time between finding on kiosk and picking up | | | | | | S | | |

- More than half of the issues raised (17 of 26) are also presented in the design recovery website (WEB). This is a much higher percentage than any of the other teams. The reason for this is that this team produced a written reflection after each of the presentations (including the Jury Review), recording and reacting to many of the points made.

## Discussion

The previous section presented an analysis that examined what issues had been raised in each CDD session and whether or not those issues were revisited in future sessions or student-created artifacts. Even though the teams' projects and design processes varied widely, some general observations can be made based on the patterns of issues shown in the tables.

Teams seemed to generally understand the main points being made in the discussions. When a transcript of Pin-up 1 was available, the analysis showed that teams covered most of the major points from the discussion in their written reflections of Pin-up 1. All teams revisited at least some of the topics raised in discussion at some other point.

Each session raised a substantially new set of issues. Although some issues were revisited in subsequent sessions, new issues were always raised. This reflects the fact that teams are making progress in their designs. As the project develops and understanding grows, both among team members and the rest of the class, new issues arise that must be considered.

During the Jury Review, many issues from previous sessions were revisited, but often by the teams themselves. These were revisited either during their initial presentation or as ideas embedded in their scenarios. In this sense, the earlier sessions seem to have helped students develop their rationale and description of their designs.

For two teams, Pin-up 1 seemed to be more influential than Pin-up 2. The GVU Survey Website team and the JR (Controls) team revisit almost all the issues from Pin-up 1 in their Jury Review presentation and none of those from Pin-up 2. This may be because Pin-up 1 raised issues that were fundamental to the project, or alternatively, these issues may have become fundamental to the project as a result of having been raised in Pin-up 1. The Kiosk (GT Bookstore) team does not revisit many of the issues from Pin-up 1—perhaps because they change their project so dramatically afterward. Instead, they emphasize many of the issues from Pin-up 2 in their Jury Review presentation. In this case, Pin-up 2 was their “first” presentation on their project and may have had the same effect as Pin-up 1 on the other teams. Since the Kiosk (Blockbuster) team does not make a presentation for Pin-up 1, the session may have had less significance for them.

In the two pin-ups, discussion often addressed issues that were also mentioned in the posters the teams had prepared, but they were never limited to those issues. This suggests that one of the values of these sessions is that it brings issues to the attention of the team that they had not considered previously. Some issues were simply clarifications of what the team was proposing, while others brought in substantially new ideas and insights.

Based on these observations, it seems clear that the sessions did have an impact on the teams. A more interesting question to consider is what *kinds* of impacts these sessions had on the teams. The impacts of the pin-ups are considered first, followed the impacts of the Jury Review.

**Impacts of Pin-ups**

**The pin-ups brought new ideas, information, and problems to the attention of the team.** In each case, new issues were raised that had not been considered by the team previously (or had at least not been documented by them up to that point). This is probably the most obvious impact expected from this kind of discussion. Because students and the professor have different knowledge and experiences than the team, and because they are not deeply involved with the project, they can bring a new perspective to what the team has done. In this example, one JR team asks the other whether they plan to address what would happen if JR's electrode stopped working:

> S1: Have you though about, uh...him not having as many inputs? Um, like with the implant not working after a while? Have you considered that at all?
>
> S13: Right....we know that like one of them isn't working. One of the electrodes still works, but one of them has decayed or rusted or something and the doctor replaced it with like a foot control so he'll have two inputs, but we're hoping that…basically we're doing all of this on the assumption that at least….the remaining electrode will work until the quarter is over, but you know we have no idea...

Ultimately, the second JR team did plan for this scenario by developing a design that only required one input.

**The pin-ups also helped teams develop the rationale and description for their projects.** The questions asked by the professor and other students required teams to defend their designs, explaining why they made the choices that they did. Teams had to articulate (or even consider for the first time) their design rationale, which might have otherwise remained tacit. Other times, questions led teams to discover that some parts of their design (or their explanation of it) were confusing. Through the discussion, teams were able to develop ways to convey their ideas more clearly. Teams then incorporated the rationale and description developed in the pin-ups into their Jury Review presentations. For example, in response to being asked during a pin-up why they are using a Yahoo-style interface, a teammate responds:

> S4: I think it’s like people will walk up and say "Oh, this is Yahoo. Let’s use it like we use Yahoo."

In the Jury Review, the presenter from the pin-up includes this same reasoning in one of their scenarios:

> S14: [...] Okay, so he comes to the website and looks at it. He's not real familiar with the internet, but he's seen Yahoo and he thinks, you know, this looks alot like Yahoo.

In another pin-up, the Kiosk (Blockbuster) team realizes that their Personal List feature is not clear to the rest of the class. (Note also that the student asking the first question is alluding to the rationale for the Personal List feature, which he thinks is a list of favorite movies.)

S24: I was just curious, in your research, did people rent the same movies often?

S25: [teammate] They don't often rent the same movies...the personal list...

S1: [presenter] That's not the purpose of [the personal list]. The purpose of that is, when the movie's out in the theaters and you go to the "Coming Soon" and you see it and you go "Oh! I want to see that and I know I'm not going to get a chance to go" you add it to your personal list. So when it's on your mind you create your list and then you can check it later. Is that not clear? Because if it's not then we need to...

S26: It wasn't clear to me. That's why I put that down as one of the questions. I didn't understand what the personal list was for...

In the Jury Review, the team gives a scenario using the Personal List, clarifying its use:

S5: [...] We see that there aren't any copies in stock, so we can't rent Godzilla today, so we're gonna instead add it to our personal list so that next time we come into Blockbuster and log in we can go to our personal list and see that we had wanted to see Godzilla before.

**The pin-ups allowed teams to get input on specific design decisions with which they were struggling.** Particularly in Pin-up 2, the teams themselves raised many of the issues discussed. When teams posed specific questions to the group (e.g. "should we do X or Y?"), the group's answer was generally accepted and incorporated into the final design. In this example, the Kiosk (Blockbuster) team is looking for suggestions on how to manage a long list of movie titles. A member of another team offers the solution they settled on for a similar problem:

S1: [...] The other [question] is "how can we put long lists of titles on one screen without making it too cluttered?" This one <?>...I mean, they've got hundreds and you don't want to have to look through more titles and I mean, maybe there should be a separate one for each letter but...instead of chunks of letters. I don't know. What suggestions do y'all have for that?

S18: We dealt with the same thing and we decided to scroll that little window where you would have all the selections...Scroll it using the up arrow and the down arrow - you wouldn't print a new screen every time, you just scroll down and up.

**Less common than the other impacts, the pin-ups gave some teams the opportunity to "work through" design issues with prompting from the professor.** The GVU Survey Website team has the most clear demonstration of this in their pin-ups. Instead of just answering questions and gathering information from the group, the professor and team work through several design issues on the spot, developing new ideas, testing them, and then either rejecting them or developing them further. In this very long example, the presenter has just discussed the main problem the team is struggling with, which is deciding which of their two designs to use. After asking them the pros and cons of each, the professor asks:

WN: So rearticulate the problem on that, the design problem right now for you.

S16: Rearticulate the design problem?

WN: The design problem right at this particular very local design challenge. Which is this one page.

S16: This one page?

WN: Yeah.

S16: To present as much information as possible in the most coherent manner possible for the broadest set of users possible.

["whoa", giggling]

S16: I think we just set some stakes.

[laughter]

S16: Um...

WN: It might be too broad, right?

S16: Yeah...but at the same time I kind of question whether anything more narrow would actually satisfy the necessary requirements.

S17: [teammate] The way that I look at it is...right now we're stuck on basically navigation between different data. We're trying to make it easier and faster to get from say one graph to something completely different because we see that as the main problem is that people...it's taking them too much time and it's too hard for them to go through and find different things, so they're just sending email.

WN: Okay, here's a suggestion for you. Most activity that people engage in is goal-oriented, we do things for reasons because we have goals in mind. And it seems to me that what you're trying to support is two goals: one is getting...navigation, which is a goal in its own right, "I want to get to this place", versus the second goal is "I want to get this information" which is information extraction. So you're trying to support two different goals on one page, so, and I won't answer this to you, should you be trying to support those two on one page? You know, what is the...is there a goal that supersedes? Does one of those goals hierarchically supersede another goal?

S16: Well, the goals you're saying...they're trying to find the information and then actually, trying to...

WN: Navigate to it, yeah...

S16: ..navigate *and* acquire the information?

WN: Uh-huh.

S16: Well, as I see it those are so intrinsically related that...how can they be separate?

WN: Not necessarily. I mean, one is, you know...the bottom one it seems to me is...you're displaying information, right, in text fashion, but you're still allowing them to navigate on the left side, right? So you're supporting two kinds of different events. So, why...if...

S16: So we could remove this and sort of...and reduce the amount of navigation information on this page to the amount that would be necessary to go...to like do error correction, go back...

WN: Or maybe you support only the navigation events that would be relevant to the information on that page...see, so it becomes more cohesive. Those seem to be two different events as I understand it...it's another suggestion...

There a few other examples of this as well, but not with the other teams in this analysis.

These are general ways in which the pin-up sessions had impact on the teams. A point worth making however, is that the sessions had different impacts on each team. In their written reflections for Pin-up 1, each team identifies a different major lesson or benefit that they took from the discussion. The GVU Survey Website team says that the “most important insight” they took from the session was that they needed to consider the design of the taxonomy for the website more carefully. The Kiosk (GT Bookstore) team states that while the questions and comments were helpful, “seeing what the other groups had done”, particularly the other Kiosk group, was the most helpful to them. They dramatically changed the focus of their project as a direct result. The Interface for JR (Controls) team finds that the pin-up session was particularly useful for “seeing the other team that is working on an interface with JR and what they have currently designed.” They also found the comments and questions from the other team particularly useful and continued to exchange ideas with them throughout the rest of the project. Finally, the Kiosk (Blockbuster) team states that their major insight was that they did not provide enough justification for their design decisions. In seeing the other team’s projects, they “discovered how these aspects of their presentation made it easier to understand the scope of their project.”

With the exception of the first team, none of the other major insights described by the teams were “issues” that were discussed during the pin-up. This suggests that the pin-ups impacted the teams in more ways than is shown by this analysis, some which are more general impacts of the discussions. Two of the insights noted by the teams above are instances of *benchmarking*—comparing the progress and presentation of one's own team to other teams. This is the major lesson for both of the Kiosk teams. The other benefit mentioned is the opportunity to *share information and resources*. Although all teams share information in a general sense through the discussion, the two JR teams are in the unusual position of having closely related projects where information is scarce because of JR's unique situation and the difficulty in communicating with him. These examples show that impacts of CDD on students' designing goes beyond explicitly raising and resolving issues. They also have more general impacts, allowing teams to benchmark their progress, share information, and build a common ground.

**Impacts of Jury Review**

The Jury Review, since it occurred after the project was completed, was not in a position to impact the designs in the same way as the pin-ups. Having to present their project in front of invited guests probably helped motivate teams to complete their projects and to spend time preparing their presentation. The one team that did include a written reflection on the Jury Review recorded several "good suggestions" that they had received from the jurors, but since the project was not going to be developed further these suggestions did not impact the design in the same way suggestions made earlier might have. However, the way a Jury Review could impact students' designs is by pressing students to think one step beyond the design they propose. This can be by suggesting a refinement or a new feature, approaching the design from a new angle, or asking students to speculate about how the design would respond in different situations or how it might incorporate different requirements. The Jury Review in this study included examples of each of these. Through this kind of discussion, the design can be advanced beyond its current stage, even if only in the minds of the discussants.

## **Summary**

This chapter examined the impacts that CDD can have on students' designing. The data from four design teams was used. Issues raised in each of the sessions were identified and subsequent data was examined to track where these issues were revisited and by whom. It is clear from the analysis that the pin-up sessions did have an impact on the students participating in them. Students seemed to generally understand and remember the major issues being raised in the discussions. They often incorporated the explanations and rationale developed in these discussions into their future presentations. The pin-ups brought new ideas, information, and problems to the attention of the team. They also provided the teams with opportunities to get feedback on specific decisions they were facing. Beyond these issue-oriented impacts, the sessions provided the teams with opportunities to see what the other teams were doing and to exchange ideas and information. The Jury Review could not impact the project in the same way the others did because it took place after development ended. However, the Jury Review can potentially impact the projects by challenging students to think beyond their final design.

# CHAPTER V

# DISCUSSION: CREATING A LEARNING ENVIRONMENT FOR CRITICAL DESIGN DIALOG

This chapter discusses how the professor created this particular learning environment: What choices were made and why? What were the outcomes of these choices? Parameters related to the project and the critical design dialog are identified. For each of these, the choice made by the professor, the rationale for that choice, and the outcome of that choice are explored. Much of the knowledge that the professor used in making these choices was tacit—a result of her experiences as an educator and researcher. This discussion is an attempt to recover that knowledge, making it explicit and therefore accessible to others. Choices made in creating a learning environment are interrelated and constrain one another. They are also influenced by the professor's views on learning and her goals for the class. After presenting each parameter, the chapter discusses how these factors influenced the choices made in this class. The final section describes our first attempt to support CDD with technology: the Electronic Pin-up Session. Even though its use fell far short of our expectations, it provided many valuable insights about the problems of integrating technology into a classroom activity.

## Introduction

The previous two chapters described critical design dialog (CDD) and showed some of the impacts it had on students' designing. This chapter considers how the professor created this particular learning environment and how it supported CDD: What choices were made and why? What were the outcomes of these choices? The important insight is not that a choice needs to be made—it is quite obvious, for example, that students either work in teams or individually, or that teams must make their presentations in some order—but that choices can be made that specifically support CDD. Furthermore, certain choices can work together (or interfere with one another) in supporting CDD.

In this chapter, I identify a set of choices made by the professor in creating this learning environment. It is not an exhaustive list, but I believe it represents significant choices made by the professor that had identifiable outcomes. Much of the knowledge that the professor used in making these choices was tacit—a result of her experiences as an educator and researcher. This discussion is an attempt to recover that knowledge, making it explicit and therefore accessible to others.

This discussion represents my emergent understanding of how this learning environment supported CDD which resulted from my participating in the class and from conducting the analyses in the previous chapters. I was the Teaching Assistant for the HCI class in this study and helped with planning and carrying out many of the class activities, including the CDD sessions. Much of the following is based on my personal observations and reflections on these activities. In cases where I am not sure of the professor's rationale for a particular choice, I will sometime speculate based on my knowledge of her goals and my recollection of the class. Other times I will provide a general rationale for a particular choice, especially if it is a common practice in undergraduate computer science classes. The outcomes I identify from each choice are also based on my own observations and insights.

The chapter first discusses both the choices the professor made about the project and those she made about the CDD sessions. Although each choice discussed separately, the choices are not made independently. They interrelate in complex ways, as in any design problem. In the next section, I point out some of these relationships and how the different choices influence one another. What underlies all of these decisions, however, are the professor's views on learning and her goals for the course; these are discussed near the end of the chapter. The chapter concludes with a description of the Electronic Pin-up Session—our first attempt at supporting CDD with technology.

## Choices About the Projects

Table 5-1 lists a set of parameters related to the project and the choices made by the professor in the HCI study. This section discusses each of these parameters, why a particular choice was made, and the outcome of that choice.

**Project groups.** Students worked in teams of 3 or 4, which they formed themselves. Professors often have students work on projects in groups because they can take on more complex problems by sharing the workload (which in turn might be more motivating for students), and also because it simulates professional working conditions. In addition, students may benefit from exchanging and developing ideas with one another.

Working in groups also has its drawbacks. For example, in some cases team members do not all contribute equally to the project or communicate well with one another [Turns, 1998]. Communication and coordination among team members becomes another aspect of the project for students to manage.

The more practical benefit to using groups in this case was that it made the number of projects small enough that they could all be discussed by the whole class. If students had worked individually, the number of projects would have been much larger, requiring much more time to discuss them (or smaller discussion groups might have been used instead). Using groups therefore allowed the professor to implement the CDD as full-class discussions because it reduced the number of projects to be discussed.

**Table 5-1. Project parameters**

| **Parameters** | **Choice made in HCI study** |
|---|---|
| project groups | students worked in teams of 3-4 |
| having clients | some projects had clients; clients had varying degrees of involvement; all projects had to do user research |
| commonality among projects | the set of projects was very diverse, but some projects had more than one team working on them |
| length of project | eight weeks with classes meeting 3 hours per week; students worked on projects outside of class |
| process scope | from general description through electronic prototype, there was no formal evaluation of the design other than through the discussions |
| project scope | projects were broad in scope and each had different issues to take into account |

**Having clients**. Many of the projects for this class were suggested by people who had real problems to be solved. On the one hand, this provided motivation for the students and a source of information about the problem. Working with clients provided real constraints on the solution that students had to take into account, and it made them answerable to someone other than the professor. Some teams who did not have clients seemed to have a harder time clearly identifying users, their tasks, and a problem to be solved. On the other hand, the realistic problems suggested by clients were very complex and introduced issues that might have been beyond the scope of the class.

For example, I was the client for the GVU Survey Website team, and I requested that they take into account how all the diverse groups of users (e.g. researchers, journalists, students, etc.) would make use of the website in creating their new design. Although this is an important criteria for an actual solution, the students found it overwhelming. They asked me at one point whether they could focus on just one group, but I told them that they could not just ignore the rest of the users. The class also identified the breadth of their user group as a source of their design problems during one of the pin-ups. In retrospect, I wonder if it might have made for a better learning experience if the team had been able to simplify the project to focus on one group of users. It would not have been a satisfactory solution to the problem—it fact, it would have fundamentally changed the problem—but perhaps the problem given was too complex for the length of the project.

In another case, a team had to abandon their design when they began prototyping because they did not know how to build the prototype in the language the client requested.

The professor was able to help some teams decide when to soften clients' requirements to keep the project manageable, but in these two cases the students worked closely with the clients, making them harder to ignore. Teams wanted to satisfy their clients, which is a commendable goal, but the professor may need to work with clients and students to keep projects manageable and aligned with the learning goals of the class.

**Commonality among projects**. The professor encouraged the class to have multiple teams working on the same project. One reason for doing this was that it demonstrated how there are many solutions to any given problem, and in fact, many ways to interpret the problem given the original design brief. Another reason might have been that there was a limited number of problems with real clients to offer to the students. There were four projects that had multiple teams working on them and three projects with only one team.

The set of projects students worked on provided an interesting mix of commonality and diversity. At the most general level, all of the projects had one thing in common—that they were designing computer systems for people to use. This provided some common ground for discussion. Many of the professors' questions, when she addressed the whole class, were aimed at this level and were designed to help teams understand the projects in more general terms. But because not everyone was working on the same project, different teams faced different issues which could then be discussed by the whole class, broadening students' learning beyond their own personal experiences. Comparing projects' similarities and differences also seemed to be a way to help students connect their experiences to more general concepts in HCI and design.

Having some projects with multiple teams working on them also provided some interesting outcomes. Teams who worked from the same design brief tended to differentiate themselves by purposely choosing different aspects of the problem to work on. Only in one case did two teams develop systems that would be alternatives for the same situation, rather than complimentary systems. Students did seem to find it useful to have other teams working on the same or very similar problems. The two teams who designed systems for the paraplegic, JR[1], where information was scarce, reported that they were glad to be able to share resources and ideas. These two teams ultimately developed complimentary systems for JR and coordinated their designs to use the same interaction technique. Teams who were working on similar projects also played an important role during the discussions. Because they had such intimate knowledge of the problem, they seemed to be able to ask each other more specific questions and point out problems of which the rest of the class, including the professor, might not have been aware.

**Length of project**. The project in this class was scheduled to last for approximately 8 weeks of the 11-week course. It is common for professors to assign a term-long (or nearly term-long) project in undergraduate classes for which students are expected to do most of the work outside of class time. The length of project, in a sense, reflects the importance that professor places on the project as a primary method for learning in the class. I was not able to record how much time students actually spent on the project since much of it occurred outside of class time. My sense from talking to students was that it did require substantial time, but that it was comparable to other term-long projects.

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1. See Figure 4-4, “Design brief for Interface for JR” in Chapter IV.

There is a notion in design education that the quality of a design solution and of design learning is related to the extent to which the problem space is explored [Schön, 1987]. Having such a long project allowed students to conduct interviews, observations, and other research to understand the design problem and identify important issues and constraints before they even started proposing solutions. It also gave students time to develop and explore several different design ideas, at least in theory. Some teams did use this time to their advantage and considered more than one alternative, but other teams fell into the common novice design trap of fixating on their first idea. Perhaps even more significantly, having the project span eight weeks allowed time for several pin-ups, so that the class and professor could see how the projects were developing and changing over time.

**Process scope**. Process scope refers to the phases of the design process that the students work through during their project. The professor must choose a certain starting point and ending point depending on her goals for the class and the resources and time available. In this class, teams began with an incomplete description of a problem or situation to be addressed. (An alternative would have been, for example, a partial or complete set of requirements.) I believe the professor did this to emphasize the importance of researching the situation and defining a manageable problem before proposing a design solution. Students spent more time than expected gathering information and defining their problems, delaying the project schedule and taking time away from the later phases. Some teams never developed a convincing problem definition which plagued them throughout the rest of the project.

The ending point for the projects was an electronic prototype demonstrating their design. The professor chose not to have students implement their designs because she felt it worked against the objectives of the class. Not only is implementation extremely time consuming (much more so than students usually estimate), but it also introduces a whole new set of constraints into the design related to the programming language, algorithms, data storage, hardware, network infrastructure, etc. These constraints are extremely important in creating a real solution to the problem, but here they might actually be a distraction from the learning goals. Most of the students in the class were computer science majors and were therefore comfortable with implementation issues and technical constraints. The professor wanted students to focus on user-related issues, not technical issues, which she thought they might overlook if they knew they would ultimately be implementing the design. One team who was working on an interface design for a system they were actually implementing in another class had exactly this problem. They made inferior choices from a user's perspective because they did not know how to implement the better choice or thought it would be too hard. Another team focused on technical issues all through the process, despite repeated warnings from the professor that they were moving too fast and needed to go back to the users' goals. The result was a very weak design from a user-centered perspective.

Looking back, there was some confusion about what it meant to make an electronic prototype of a design. My interpretation was that teams should use a relatively simple tool (HTML or PowerPoint) to make a mock-up of part of their system that they could use to demonstrate several scenarios of use. Making the prototype electronic meant that it could be easily shown to the whole class using a projector and that it could give viewers a good sense of the interaction. In computer science however, a rough implementation is also sometimes called a prototype. Perhaps using this notion, several teams chose to use a regular programming language and partially implement their designs. Not only was this time consuming, but it also often required substantial changes in the design as students discovered that they did not have the time or skills to recreate the original design with the language they chose. Even teams who did create mock-ups spent a good deal of time making their prototypes look good and work properly. Perhaps using an even simpler method of demonstrating the design, such as a paper prototype or storyboard, would be worth considering.

The project schedule did not include an evaluation phase or second design iteration. In retrospect, I think students would have benefited greatly from having some form of evaluation as part of the project. Particularly in HCI, where intuitions of novice designers are often misleading, watching a user struggle to use a design that seemed so clear and self-explanatory is a powerful learning experience that demonstrates many of the central points of HCI. In addition to user testing, HCI has a variety of methods for evaluating designs that do not require extensive prototyping or implementation and are fairly simple to use (e.g. heuristic evaluation, cognitive walkthrough). Without some form of evaluation, students must rely on their own judgement and the judgement of the professor and other experts about how well a design achieves its objectives. Students seemed at times to be overconfident about their designs, disagreeing with jurors about potential problems that they pointed out or dismissing the problem as not likely to happen.

Although the class stressed the need to gather information about the design situation and use this information to justify design decisions, it omitted the other half of this process, which is to take the design ideas back to the design situation to test it and learn more about it.

**Project scope.** The projects in this class were broad in scope, meaning that students had to take into account many issues in their designs. There were no strict rules about what issues to consider which to ignore and, in addition, the central issues naturally varied from project to project. It was understood that projects generally did not have to take into account issues like development cost or system maintenance, although these did come up during the discussion for some projects. Teams had to identify the important issues for *their* particular project. For example, the JR teams had to take into account how JR would interact with the system, since this was a key element in the design. The Blockbuster team had to take into account some visual aspects of the system to fit into the existing stores' color scheme and design. The GVU Survey Website team had to consider how their new design could actually be implemented in hundreds of web pages that already existed on the website. On the other hand, many teams made simplifying assumptions to ignore certain issues. We encouraged teams to ignore implementation and technical issues for the most part, but I did not think we should allow students to make outrageous technical assumptions, like the availability an error-free voice recognition system. Surprisingly, though, students tended to err on the conservative side. For example, one team was initially hesitant about including a search engine in their design, even though it is obviously a widely available technology. Students seemed to be basing these judgements on their own skills and had a hard time judging what were reasonable technical assumptions. I personally felt that defining the project scope—what constraints to take into account, what issues to address, what assumptions to make, what counted as an implementation issue—was one of the most difficult aspects in managing and evaluating the projects. No initial design can take into account and address all of the possible relevant issues, especially in such a limited time frame. Drawing these design boundaries seemed to me very arbitrary and made it hard to judge the adequacy of the design.

## Choices About the Critical Design Dialog

Table 5-2 lists a set of parameters related to the CDD sessions and the choices made by the professor. This section discusses each of these parameter, why a particular choice was made, and the outcome of that choice. The parameters are divided into three groups related to scheduling, the procedure used during the CDD sessions, and the presentations that the students made.

### Scheduling

**Number, Frequency and Timing.** There were three CDD sessions scheduled: two pin-ups and one jury review. The first one (HCI-1) occurred a week into the project, HCI-2 was four weeks later, and HCI-3 followed two weeks after that. Originally, HCI-2 was scheduled to occur a week earlier, so that all of the reviews would be evenly spaced, but the professor decided (and students agreed) that they needed more time to work on their projects before the second pin-up. The number and frequency of the CDD sessions in this

**Table 5-2. Dialog parameters**

| **Parameters** | **Choice made in HCI study** |
|---|---|
| **Scheduling** | |
| number, frequency, and timing | two pin-ups were spread across the project duration plus one final jury review |
| length of sessions | reviews lasted approximately 140 minutes spread across two class periods (10 minutes per group) |
| location | 3 of 4 pin-ups took place in a specialized pin-up area; jury review was in the regular class-room |
| **Procedure** | |
| project preview | for some of the pin-ups, the first 20-30 minutes was reserved for students looking at and writ-ing comments on each others’ posters |
| full-class session | the remainder of the sessions were conducted as full-class discussions, with the attention of the class focused on one project at a time |
| amount of educator participation | the educator did not participate in the pin-ups much because she wanted students to ask ques-tions of each other; similarly she wanted the students to interact with the jurors |
| source of questions | during the pin-ups, students were the main source of questions, and in the later sessions the teams asked questions of the audience; dur-ing the jury review, the jurors asked the ques-tions |
| using jurors | only the final session used jurors |
| order of presentations | projects that were related were usually pre-sented together on the same day |
| **Presentation** | |
| amount of guidance | the professor provided guidelines but wanted students to address the problem of how to communicate their ideas for themselves |
| representations | teams used mostly idiosyncratic representa-tions although they were asked to use a few standard representations |

class was intuitively based on the number of projects (12), the length of the project (8 weeks), and the desire to allow a reasonable amount of time between sessions for students to make progress on their designs. Having more than one pin-up was very useful because with each session, students became more familiar with each others' projects and more comfortable with the format. One clear benefit to this was that students spent less time introducing and explaining their projects in the later sessions, making more time available for discussion. It might also explain why student participation in the discussion increased with each pin-up.

The timing of the sessions meant that HCI-1 was during the research/initial concept phase, HCI-2 was during detailed design/prototyping, and HCI-3 was after the design was completed, which is typical timing for a jury review. Different issues are more relevant at different phases of the design process. Different phases of design raise different issues, and having the two pin-ups occur during different phases of the design allowed the discussion to cover these issues as they became relevant. Although they were not initially conceived as "defining" the different phases of the design, the pin-ups also seemed to serve as milestones for students, motivating them to make progress and complete their current tasks so that they could report the results in their next presentation.

**Length of session.** Each of the sessions lasted for two class periods (160 minutes per session total) with half of the projects being presented in each. Since the class only met twice per week, this meant that one solid week of class time was dedicated to each pin-up. One reason for this was logistical—the course was scheduled as a typical lecture course which limits the length of each class period to 80 minutes. Although this might not have been the ideal way to schedule the class, it allowed it to fit more easily into students' schedules and also simplified finding classroom space. Another reason for this solid-block style of scheduling is that it mimics the style found in the design studio, where all projects are usually presented in a single CDD session. I'm not sure of the particular reason why design studios use this format, but it is one of the few times where the class comes together for an extended period. (Recall that students spend much studio time working independently side-by-side.)

There were 12 teams in the class, so allowing about 20 minutes for setting up and previewing the projects leaves approximately 10 minutes for each team to present and discuss their work during the pin-ups. This is very little time, and the class was under constant pressure to get through all the projects. For many of the projects, the professor had to stop the discussion to move on to the next one. The need to monitor the time carefully and cut off discussions was made clear during the very first pin-up (HCI-1a) when several teams were not able to make their presentations because time ran out. In the reflections they wrote after the session, these teams said they were very disappointed and some felt they had been cheated out of the opportunity to get feedback on their project, especially from the professor. The subsequent pin-ups were managed more carefully so that the problem did not recur. However, the class again ran out of time during the jury reviews, and a few teams had to present their projects in a third session scheduled during finals week. Part of the problem in this case was that students took much longer than expected to explain their projects to the jury. Cutting off the discussion at the planned time (about 12 minutes) would have left hardly any time to interact with the jurors. Finding ways to help students communicate their projects more clearly and quickly might have helped this situation, if the time for the session could not be expanded.

**Location.** The first part of HCI-1 was held in a regular classroom, as were both parts of HCI-3. The other sessions were held in a specialized pin-up area that allowed posters to be easily attached to the walls. It was also very open, allowing the class to move around freely and gather around each poster as it was discussed. The pin-up area was used both for practical and pedagogical reasons. It made hanging and gathering around the posters much easier, but it also allowed a change from the usual classroom dynamic. By moving the students to a different area, the professor hoped to disrupt the normal patterns of classroom discussion—which are usually teacher-centered—and encourage students to talk directly to each other. She also sat slightly off center and to the rear of the group to further deemphasize her role in the discussion. This strategy seems to have been successful, based on the amount of interaction among the students and their high percentage of speaking turns. The jury review occurred in the regular classroom because it had computers with large displays that students could use to demonstrate their prototypes for the jurors. There were no computers available in the pin-up area.

## Procedure

**Project preview**. For the first pin-up, the professor decided to have students spend the first part of the class visiting each others' posters. In a sense, this was a test of whether or not the poster could really function as a stand-alone presentation, as the assignment specified, without a team member standing by to explain it. The professor included this requirement because she wanted students to deal with the issue of representation—to think about how they could communicate their ideas other than through a verbal explanation. An additional goal, however, was to give students a chance to individually examine and think about each project. She wanted them to form their own reactions to the projects and questions about them before the group discussion began. She hoped that this would get the conversation going quickly and make it more likely that students would have questions for the other teams. It was difficult to tell through observation to what extent these goals were met. Most teams spent some time explaining their posters at the beginning of their presentations, which made their projects much clearer, in my opinion. But even though teams may not have succeeded in creating stand-alone presentations, they might still have benefited from the attempt. Many students did seem to examine the posters closely and leave written comments and questions for the teams. These were often discussed further during the session and there was rarely a lack of conversation. Is is difficult to know, however, whether this would have been different without the previews. It is also unclear whether all of the students visited all of the posters, and if not, whether this was because of a lack of time or because some of the posters, in fact, did not explain the projects very well.

Space was left on the posters for students and the professor to leave written questions and comments for the team. In the second pin-up, teams included specific questions on their posters and asked the rest of the class to write suggestions. After making an initial presentation, teams reviewed these questions and comments for the audience, who would then sometimes elaborate further. If there were many additional questions from the audience, the professor would tell the presenter to handle those questions first since they could review the written ones later. An interesting side effect of this approach was that it allowed questions to be relatively anonymous unless the person asking chose to reveal themselves. It also created a written record of some of the questions that students could review later. On the other hand, visiting the posters and writing the comments took up a significant portion of the class time (20-30 minutes). It was not clear whether using the time this way, instead of giving more time to each presentation, was a worthwhile trade-off or not.

**Full-class session.** After the preview period in each pin-up, the full class gathered around each project in turn to discuss it. Two general goals of the pin-ups are to familiarize students with each other's work and to have them learn from each other's experiences. It also gives them a chance to compare what they have been doing with what others have been doing, benchmarking their own progress. Using a full-class format, where everyone is focused on the same project at the same time, has the additional benefit of helping the students and professor develop a shared understanding of the projects. Everyone hears the same set of ideas and arguments, and everyone gets their attention brought to the same issues. These can then be a common reference point for discussion in later sessions. Another benefit to a full-class format is that it allows students to be observers as well as participants in the discussion. They get to overhear the discussion around the project, especially the professor's discussion. Here, the professor can model critical questioning for the rest of the class, and students (other than the team fielding the questions) can observe and interaction between the professor and the team. The professor can also do some didactic teaching, using the projects as examples or starting points for discussion. Typical design studio pin-ups also use a full-class format, probably for similar reasons.

A full-class session was also the format used for the jury review, as is typical in the design studio. Again, the reasoning is probably similar for both situations—because it is believed that students benefit from hearing projects discussed by experts.

**Amount of professor participation.** As was mentioned previously, the professor wanted to have the students do most of the talking during the pin-ups. Even though she probably had many questions and useful suggestions for the team and could have easily dominated the discussion, she chose to let students speak instead. This approach was also apparent outside the CDD sessions as well, where she often preferred to have students learn by discussing their own experiences and ideas rather than through her lecturing. This decision is a combination of several factors. In part, it simply reflects her teaching style, which is a product of her previous experience and comfort with not being in control of the discussion. But it also reflects a certain view on learning, one that places an emphasis on students' being actively engaged in the discussion over having them listen to an expert opinion. Because she minimized her own participation, students instead spoke directly to each other and accounted for most of the speaking during the pin-ups. In the jury review, the professor also participated minimally, but in that case it was to allow the jurors to speak, rather than the students.

**Source of questions.** In the first pin-up, the audience mainly asked questions of the teams presenting. But in the second pin-up, teams were encouraged to ask questions of the audience to get input on specific topics. The professor made this change because she wanted to find ways to make the best use of the time available. The early part of the design process is a broadening phase where students are trying to expand their understanding of the problem to be solved. Questions from the audience help with this, bringing new ideas and issues to the attention of the team. Later in the design process is a narrowing phase, where teams are focusing their efforts to propose a specific solution. At this point it is less useful to introduce new ideas—teams are already struggling with a set of issues or decisions they must resolve to complete the design. It makes sense in the later phases for the team to ask their fellow students and the professor for help on specific issues. The professor did not strictly limit the source of questions in either session, but she did encourage a certain focus that she felt would help the project most at the given time. In the jury review, jurors were the main source of questions, since the point of the session was to hear their feedback on the projects.

**Using jurors.** A jury of other professors was invited to hear the final presentations of the students. This idea came from the jury reviews in the design studio which serve a variety of purposes, including: providing students feedback on their work, developing their presentation skills, and evaluating the project [Anthony, 1991]. Here, the goals were probably similar, but were not fully articulated. Knowing that jurors would be attending probably motivated students to give a good final presentation. It also provided them with another authoritative source of input on their project, which until that point had only been from the professor. A drawback, however, was that jurors were not familiar with the projects, which varied widely, and did not have time to read the short written overviews that the teams had prepared. Students spent much of their presentation trying to explain the design and the problem it was addressing. Jurors also wanted to know more about the process that led to the current solution than students had planned to (or time to) explain, which frustrated some students. With a few exceptions, the jurors were not experts in any of the projects' particular application area and therefore relied on their general knowledge about HCI and their personal experiences to make judgements about the projects and offer suggestions.

**Order of presentations.** Since each session spanned two class periods, the professor had to decide in advance which teams would present in which period. In the pin-ups, teams that had related projects were scheduled to present in the same session, most likely to facilitate comparison between those projects and to keep the conversation continuous. Within the sessions, teams either volunteered to present, were chosen because of their physical proximity to the previous team, or because a related project had just presented. The order of the teams was swapped for the two pin-ups for fairness—those who presented in the first class period for the first session presented in the second session for the second pin-up. For the jury review, there was no obvious pattern to the scheduling, and related groups presented on different days. In later discussions with the professor, she did not recall the reasoning behind the scheduling for the jury review, except that she was probably pairing projects that she thought would make for interesting comparisons. The jury, however, did not make many comparisons between the projects and instead tended to focus on one at a time.

## Presentation

**Amount of guidance.** Students were given guidelines about what their presentations should achieve, but little direct instruction about how to achieve it. For example, for the first presentation, students were told that their posters should show the current state of the project, present the work they had done to date, and be a stand-alone presentation. For a later presentation, teams were told to include the questions on which they would like input from the class. The professor's goal in giving relatively vague requirements was to give students the chance to "struggle" with how to communicate their ideas to the class. She wanted them to think about how to explain their project through the design of the poster rather than to simply produce a list of required items. She wanted them to think about what feedback they needed rather than having them defend the decisions they had already made. Students found this ambiguity frustrating and worrisome, especially early on. They were used to being told the exact requirements for something and then doing what they were told to do. They were concerned that they would do the wrong thing and repeatedly requested to be told "what she wanted." As the class progressed and students became more comfortable with her methods, they seemed less troubled by the ambiguity. They also began to learn from each other's presentations what worked well and what did not and to incorporate these ideas into their own presentations.

**Representations.** Designers use representations to communicate their ideas to others. Sketches, textual descriptions, mock-ups, and scenarios are all examples of design representations. Many fields have standard representations that fellow designers can quickly "read" to understand some part of the design: for example, a floor plan or a circuit diagram. There are fewer standard representations in HCI than in other design fields—perhaps because it is still relatively new and interdisciplinary—but there are a few (e.g. task models, screen shots). With a few exceptions, students were not required to use standard representations in their presentations. Again, the professor wanted students to struggle with the problem of how to represent the design and to develop representations that made sense to them. The professor's own research had previously shown that although students could produce standard representations when asked to, they did not always understand their use as tools in the design process [Newstetter, 1998]. The professor saw letting students develop their own representations as a way to address this problem. But design representations work in two ways: as a thinking tool for the designer and as a communication tool among teammates and between the team and others. Letting students create their own led to representations that were highly idiosyncratic and therefore were limited in their function as a communication tool. Teams instead relied on written and spoken language to explain their design and their representations. Using standard representations might have helped students in explaining their designs to one another.

## Interrelationship Between Parameters

Although the parameters identified in the previous sections are discussed individually, they are actually interrelated in a variety of ways. Table 5-3 lists some of the simple relationships between different parameters. For example, the more projects to discuss, the longer a full-class session will be if all the projects are given the same amount

**Table 5-3. Relationships among parameters**

- a **longer project** allows for a broader **process scope**
- a **longer project** allows for **more sessions**
- **more projects** require **longer sessions** or **fewer presentations** per team
- **fewer projects** can be discussed more easily in **full-class sessions**
- **less guidance** in preparing the presentation leads to more **diverse representations**
- **having clients** can lead to a broad **project scope**
- **using jurors** means they will be the **source of questions** during a session
- **less educator participation** allows students to be the main **source of questions**
- **presentations can be ordered** to highlight **commonality among projects**

of time. If there is only a limited amount of time available—which is the usual case—the educator can adjust a variety of parameters to accommodate this constraint: reducing the number of projects by having students work in teams, selecting only a few teams to present their work in each session, or using a combination of simultaneous small-group discussions followed by a shorter full-class session. In designing the learning environment, the educator iterates through a series of decisions, examining their implications and evaluating different trade-offs until a satisfactory solution is reached. This is not necessarily an explicit process, with the educator systematically considering each parameter and possible option. Instead, it might be implicit, with the educator making intuitive decisions based on his/her view of learning and particular goals for the class.

## Underlying Factors: Views on Learning and Goals

For parameters that were not dictated by logistics, many of the decisions made in creating this learning environment were fundamentally based on the professor's views on learning and her goals for the class. Many of the activities of this class, including the CDD sessions themselves, reflect the idea that students learn by participating in and then reflecting on different activities. The professor's role then becomes to set up the activity, guide students during it (making adjustments in the activity, if needed), and then guide their reflection afterward. This view on learning is also seen in some specific features of the CDD sessions, for example, in having the students ask most of the questions and do most of the talking. It also explains the importance of having a full-class session, which is where the professor can provide guidance and prompt students to consider new ideas.

Another factor was the professor's goals for the course as a whole. One of the most important goals was to have students understand what it means to design a system from the users' perspective. Another goal was to have students understand more about the process of design and how it is different from just implementing a solution. The professor aimed to accomplish this by having students work on realistic, complex problems, often with actual clients. By studying real-world users and situations, students would be able to recognize the difference between their own perspective and a user's or client's perspective and how this affected the design solution. The professor's goals are also reflected in the emphasis placed on the early phases of the design: information gathering and problem scoping. These parts of the design process are often overlooked by novice designers who want to immediately start working on a solution. The CDD sessions provided the class with a chance to talk about these activities as students undertook them and show their importance in developing a good solution.

In addition to the high-level course goals, the professor had particular goals for the CDD sessions. For example, in my later discussions with the professor she revealed that one of her goals was for students to achieve a metacognitive awareness—an awareness of their own cognitive processes. This goal prompted many of her comments and questions for students, especially those that challenged their rationale and assumptions. Another goal mentioned previously was that she wanted students to take on the problem of representation in creating their posters. For this reason, she gave students little guidance in choosing representations to use and then tested their choices by having students view the posters without a verbal explanation. Finally, she wanted the discussion to be relevant and useful for the students, not just in terms of learning but also for completing their projects. To do this, she adjusted the format of the sessions throughout the term and let students take the discussion into areas they were most concerned about.

It is important to note however, that students (and jurors) also have goals for the CDD sessions that may or may not align with the professor's goals. How students understand the goals of a CDD session seems likely to affect how they participate in and what they take from the discussion. Many students are genuinely interested in learning, but getting a good grade in the class is at least as important, if not more so. Usually, getting a good grade involves figuring out what the professor "wants" in addition to learning the material in the course. In terms of the CDD sessions, students may not have understood the learning goals that the professor had, especially in the first pin-up. Often in-class presentations are used for evaluative purposes without any clear benefit to learning (except to learn how the professor evaluates what the students have done).

Judging from the questions they asked other teams, students seemed to be thinking, “How can I help this team improve their project?” In other words, their main goal for the session was project improvement, not learning.

Jurors’ goals are more difficult to speculate about because their reasons for participating in and expectations for the session are much less clear. Jurors in this case participated in the jury review voluntarily, presumably out of a combination of interest and courtesy. Again, judging from the questions they asked and comments they made, at least some of the jurors had the goal of helping students improve their projects. This was most clear when they suggested changes or additions to the current design. Some jurors also had evaluating the project as one of their goals. Questioning teams’ rationale, pointing out strengths and weaknesses of the design, and asking about the teams’ research process all suggest an evaluation goal.

This analysis has explored many of the choices the professor made in creating this learning environment and the outcome of those choices. It has also shown how some of the choices interrelate and how they are related to the professor’s views on learning and goals for the class. The final section of this chapter describes another element of this learning environment, which was introduced in the middle of the class, the Electronic Pin-up Session (EPS). The EPS was created to allow the discussion during the pin-ups to continue online after the session was over. A variety of factors, however, prevented the EPS from fulfilling this goal.

## The Electronic Pin-up Session

After the first pin-up, I noticed that many students still had comments and questions for each group that we did not have time to discuss during the session. I found that I also had many more comments for the teams, particularly after I had had more time to think about them. The class already had a website that I used to post assignments, announcements, and other course information, so I thought it would be interesting to try to continue the discussion from the pin-ups on the web. I set up a Collaborative Website or CoWeb for the class to use. A CoWeb is a website like any other except that anyone can add to it using a standard web browser.[2] With the professor's permission, I announced the availability of the Electronic Pin-up Session (EPS) to the class. The professor encouraged students to use the website, but she herself did not visit it. I created a page for each team and posted the comments I had for them (or anyone) to read.

For the most part, the EPS saw little activity. In interviews with two students that took place a week after it was created, both said that they "really meant to" or "should have" looked at the EPS but did not. I asked them why they did not use it and they said that they just did not think about it and forgot about the site. One also said that he liked getting feedback on his own project, but honestly did not feel motivated to give feedback to others. There was a small burst of activity right around the second pin-up when some teams asked for feedback, linked in their current website, posted some of their work, and responded to some of my comments, but it was rarely used after that.

2. Using the CoWeb for CDD is discussed further in Chapter VI .

I think one factor in the failure of the EPS was that the class rapidly drifted away from using the regular website. Updates, assignments, and important information were generally distributed in class on paper or by email. Because little was being posted on it, students stopped visiting the regular website and rarely saw the EPS. Another problem was there was no way to know that anything had been posted on the EPS other than going and checking it from time to time. If students were not thinking about the EPS, they obviously were not checking it very often either. Even I found it too much trouble to enter many of my comments into the EPS. It took a deliberate effort to go visit the site and compose the comments. I was never sure if the team would read them, which made it even less motivating.

I am not sure how much the lack of professor participation in the EPS was a factor in its lack of use. In other classes where CoWebs have been successful, it was not always necessary for the professor to be an active participant, but it was important for the professor to encourage participation [Guzdial, personal communication]. The professor in this class did encourage students to use the EPS, but it was apparently not enough in this situation.

There were several lessons to take from the EPS experiment. The first was that the EPS did not work as an afterthought to an already busy class. Students and professors have limited time and choose to spend it on things that they feel they get the most value and/or enjoyment from. Participating in the EPS did not have any obvious relationship to students' grades (for better or for worse, the most critical value for them), and it never gained enough momentum to have value in itself as some other electronic discussions do (e.g. popular mailing lists, newsgroups, other CoWebs). Expecting students to put extra time into a voluntary activity, even if they recognize that it might have educational value, is probably not realistic in most cases. Some students may participate, but an online discussion relies on having many students participate to really be valuable. Alternatively, getting feedback from the professor might have been perceived as valuable enough for students to use the website, but in this case the professor was not an active participant in the EPS.

Another lesson was that “out of sight, out of mind” is a problem for infrequently used online environments. Unless there is some critical need to visit a website, students just forget about it because there is nothing reminding them to visit it. Frequently referring to the website in class or organizing the class in such a way that students need to visit the site regularly would be one way to keep the site “visible” and in students’ awareness. More thoroughly integrating the activity and the technology with the rest of the class might also help keep the website active.

The final lesson was that activities that do not fit into the way the professor conceives of the course are not likely to succeed. Even though the professor in this case was open to the idea and encouraged students to participate, the activity was still perceived as peripheral and optional, which, in fact, it was. It was not integral to the activities of the class and was not a part of students’ grades, so it became a low priority for them. Even though the EPS fell far short of our expectations, it provided a valuable first experience in using technology to support CDD.

## Summary

This chapter considered how the professor created this particular learning environment. Parameters related to the project and the critical design dialog were identified, and for each, the choice made by the professor, the rationale for that choice, and the outcome of that choice was examined. Some of the relationships between the choices and how they are connected to the professor's goals and views on learning was also presented. Finally, our first attempt at using technology to support CDD, the Electronic Pin-up Session, was described along with important lessons we took from the experience.

# CHAPTER VI

## USING TECHNOLOGY IN CRITICAL DESIGN DIALOG

This chapter documents a study that took place in a freshman architecture studio where an instructor was trying a new activity—having remote critics use the web to view and comment on students' design projects. This activity was modeled after the in-person jury reviews which are common in architecture education. Lessons from a previous effort are presented along with the design of this new activity and technology, called *Student-Curated Galleries*. This chapter has two goals. The first is to understand the affordances and shortcomings of this particular *technology* and *activity* for CDD. The second is to understand more about *CDD itself* and what is needed to support it. These two goals are addressed by comparing the online review with typical in-person reviews. Results showed that this learning environment supported CDD by allowing critics to participate remotely and by being similar enough to in-person reviews to be easily understood by the participants. The main shortcomings were that the slow pace and narrow communication channel limited the dialog and that the design did not take into account some important aspects of the in-person reviews. The analysis also revealed several insights about creating learning environments for CDD: the demands of a flexible pedagogy, the need to clarify participants' understanding, and the role of the educator in mediating dialog between students and critics.

## Introduction

This study took place in a freshman architecture studio where an instructor was trying a new activity—having remote critics use the web to view and comment on students' design projects. The instructor was very familiar with in-person design reviews, which are common throughout design education, but this was her first experience using remote critics. This change required her (and the researcher supporting the project) to reconceive the design review and change the activity to accommodate and take advantage of the online environment. At the same time, the online environment was customized to support the activities of the participants and correct some of the problems noted in previous online reviews. This chapter describes the activity, which we called *Student-Curated Galleries*, and the technology we created to carry it out. It then analyzes the outcome of this experiment—the ways in which it succeeded and failed and what it revealed about supporting critical design dialog (CDD).

This chapter has two goals. The first goal is to understand the affordances and shortcomings of this particular *technology* and *activity* for CDD. We created a new activity and online environment that we thought would support CDD: In what ways did we succeed? In what areas do we need improvement? Answering these questions can help us improve our learning environment and provide some general guidance to others. The second goal is to understand more about *CDD itself* and what is needed to support it. We believed that we had a good understanding of CDD and designed this learning environment accordingly. Carrying out the activity, however, revealed certain aspects of CDD—especially as it is practiced in architecture jury reviews—that we had not taken into account. These observations can inform our use of CDD in all situations, not just those that use technology.

These two goals are addressed by comparing the online review with typical in-person reviews. The reviews are first compared in terms of the *activity*—the things that the students, critics, and instructor had to do in order to participate in the review. Using the Student-Curated Galleries and the online environment meant that participants had to change the way they usually participated in the reviews. Some things were made easier, while others were made more difficult; some new things were made possible, while some old things were made nearly impossible. Examining these changes shows how well the Student-Curated Galleries activity and technology supported, and in some respects enhanced, the CDD found in jury reviews. It also reveals the ways in which the activity and technology failed to support, or required substantial changes in, other aspects of CDD.

Did having the jury review in an online environment change the patterns of interaction between participants? Did it change the things that got discussed? If so, in what ways? The second part of the chapter compares the dialog from the Student-Curated Galleries to the dialog from the in-person design reviews in which the class participated. For comparison, two in-person design reviews from the same class were audio taped and transcribed. First the *interaction* in each is examined: who spoke and how much. Then, a cursory comparison is made between the *content* of the dialogs. Two examples, one from the online review and one from the in-person jury review are compared to show some of the similarities and differences in the dialog between the two different reviews.

These analyses help us understand the outcomes of the choices we made in creating this technology-supported learning environment. This chapter begins by describing a typical in-person jury review and the setting for this study.

## A Typical Jury Review

Jury reviews generally occur at the end of a project or some other significant milestone, such as mid-term. A panel of approximately 3-5 jurors is invited to attend. Jurors may be other instructors and professors in the college, senior students, local

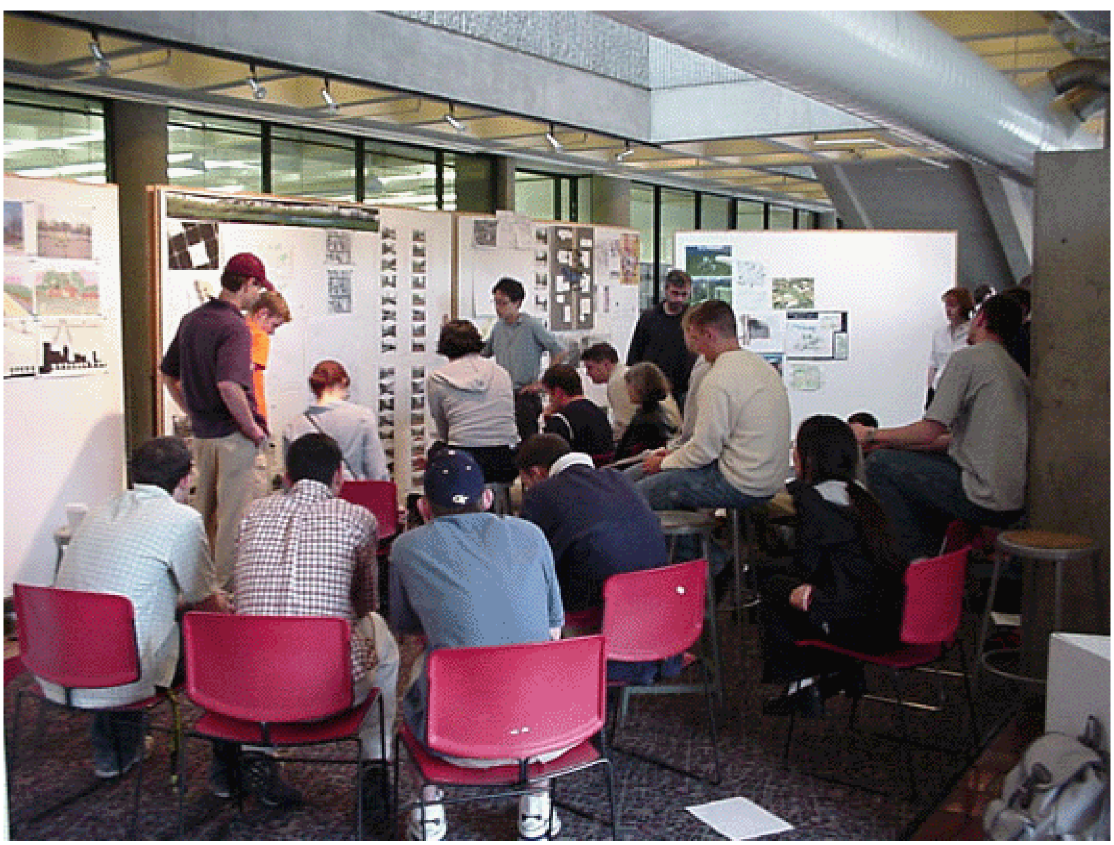


**Figure 6-1. A typical jury review**

working professionals, and in some cases, well-known academics or professionals who travel to attend the jury review. Jury reviews can last several hours depending on how many students and jurors there are. Many architecture schools (including Georgia Tech's) have specialized areas of the building for conducting reviews. These areas have large pin-up walls where students attach their drawings and images. They are also often in public or semi-public areas and passers-by may stop to listen to the conversation. Shortly before the review starts, students pin up their materials on the walls and arrange their models on the floor in front of them. When everyone is assembled, the review begins and each project is considered one at a time. Jurors are generally seated directly in front of the project and the student making the presentation stands near the wall facing the critics. The instructor may be seated or standing off to the side. The rest of the class sits or stands behind the critics. They may wander in and out (physically or mentally) as the reviews go on. Sometimes students take notes during other students' reviews either for themselves or as a favor to the student presenting. The student presents his/her project, making reference to the drawings and models available. Critics then ask questions and make comments, often discussing the project among themselves as well as with the student. Usually at the prompting of the instructor that it is time to "move on", they conclude their remarks and the group physically moves to the next project. Jury reviews serve a variety of purposes, most of which are never clearly articulated [Anthony, 1991]. Likewise, the kinds of comments made by jurors range over a wide variety of topics, but typical examples include: referring students to materials (books, paintings, buildings) they might find useful, pointing out the strengths or flaws in a project, reinterpreting what a student has done to provide new insights, making suggestions for what the student might do next, and suggesting ways the project could be improved. Figure 6-1 shows a typical jury review in progress.

## Setting

### The Freshman Common Core

In 1999, the College of Architecture at Georgia Tech revised its freshman year curriculum into a program called the Freshman Common Core. In this curriculum, all the freshmen were together for the first year regardless of which discipline they planned to pursue within the college (architecture, industrial design, or building construction). In the fall semester, a major part of the curriculum was a lecture course introducing students to the different disciplines and to design in general. Students spent this semester learning basic skills and concepts in design. In the spring semester, students were divided into nine studios of approximately 15 students, each with its own instructor. The spring studios met for 9 hours per week for 12 weeks. In these studios, students had their first real experience with design problems. The studios were organized around several design problems of increasing length and complexity (a 2-week, 3-week, then 6-week project). The 6-week project was an investigation of “The Picnic” and was situated in one of the largest and oldest parks in the city of Atlanta. Although all the studios began with the same assignment or *program*, developed by the course coordinator, individual instructors had considerable freedom in the way they ran their studios, the specific activities they had students undertake, the tools they had them use, and the issues they chose to focus on.

Instructors often made these choices based on their own interests, skills, and background. The set of activities created by the instructor in this study is shown in Appendix.

### Using 2CoOL

Along with the introduction of the Freshman Common Core was the introduction of a Collaborative Website (CoWeb) to support it. A CoWeb looks and acts like any other website with one important exception: anyone can add new pages to the site or edit the pages which are already there using a standard web browser. (For details of the CoWeb and its uses, see [Guzdial, Rick, & Kehoe, 2001]). The CoWeb used in this course was named Collaborative On-Line Studio 2, or 2CoOL. There were two goals for 2CoOL: 1) to expand opportunities for discussion about design, and 2) to help manage and coordinate course activities. In the fall semester, the site was used mainly to support the lecture course. It was used to implement several activities including design-related discussions [Craig, et al., 2000] and for administrative tasks including the distribution and collection of assignments and answering questions about the class. In the spring semester, the 2CoOL research team proposed several more speculative activities including: Fishbowls, which exhibited student work-in-progress; Market Reviews, where students could request help from a panel of critics; and Student-Curated Galleries, the activity in this study.

## Design of the Student-Curated Galleries Activity

The Student-Curated Galleries activity was strongly influenced by the original CoOL Studio project which had taken place the previous year and also used remote critics

[Zimring, et al., 2001]. This section first presents some background on that project and the lessons from it that most directly influenced the design of the new activity. This is followed by a description of the initial concept for the Student-Curated Galleries activity and a summary of the major design decisions made in creating it.

**Lessons from CoOL Studio**

Architectural education has sometimes been criticized for being inwardly focused, concerned more with formal, abstract ideas than with its responsibilities to society [Dutton, 1991]. CoOL Studio worked to address this problem by bringing a new set of “voices” into the design process, providing students with access to a wide range of expertise and perspectives. This took the form of interaction with remote critics, access to a case library of relevant designs, and pointers to a wide range of research information. The project sought to change the social space of the studio, encouraging collaboration and information exchange among students and other participants [Zimring, et al., 2001].

CoOL Studio took place in a graduate-level architecture studio that was designing four-room federal courthouses. The class planned to submit their final projects to an international competition at the end of the term. Since this is a very specialized and complex topic in architecture, six remote critics with relevant expertise were invited to periodically comment on student work. To do this, they used an early version of the CoWeb.

The project was successful in a variety of ways. It demonstrated that students and remote critics could interact successfully using the CoWeb. Students were able to represent their projects sufficiently so that they could be understood and commented on by the critics. Equally important, critics were able to participate with virtually no instruction and using only standard browser software. Critics enjoyed participating and reported that they found the comments of their colleagues as interesting as the projects themselves. Students found the most value in getting feedback on how well their presentation conveyed their design to the critics, information they then used to refine their submissions to the competition.

Even with these successes, CoOL Studio provided many lessons for future reviews with remote critics. Some of these were technology related:

- Most of the critics connected to the internet through modems, which made downloading large images and documents time consuming.
- Students had some problems creating their images. There were no computers in the studio, so they had to take their drawings to a computer lab down the hall to scan them. The drawings were often too large for the scanner, requiring multiple scans and then assembly with an image-processing program. Additionally, many were in pencil, which did not show up well in the final images. There were also a limited number of scanners, which everyone needed to use when the deadline approached. Because of these problems, students had to limit the number and kinds of images in their online presentations, which some found frustrating.

Other lessons had to do with the way the projects were presented:

- All students chose a linear presentation of their projects—a single, long page that interspersed images with text. Initially, the researchers thought students might use the hypertext capabilities of CoOL Studio to organize their presentation or use standard web techniques to ease download times (e.g. linking thumbnails to larger images for added detail). It is not clear whether students were unaware of these possibilities or if they chose linear presentations because they were the simplest to construct.
- In traditional in-person reviews, projects are posted around the room allowing for spontaneous comparison during the discussion. CoOL Studio allowed only one project to be viewed at a time (and only a portion of it, at that), requiring the viewer to rely on their memory in order to make comparisons. To overcome this, several critics reported printing out all of the projects and laying them side by side to compare them before making their comments.
- Even though some critics reported comparing the projects, rarely did they refer to the other projects in their critiques. This may have been related to the way many critics made their comments—by inserting them directly into a particular project page. Doing this allowed critics to read and build upon each other's comments, which they did, explicitly referring to what other critics had written. On the other hand, it may have encouraged them to address each project in isolation, since there was no easy way to refer to or “point at” something in another project.

- It was not clear if students read the comments the critics left for other projects. In traditional reviews, students are presumed to benefit from listening to other students' projects being critiqued. Displaying each project on its own page, with critics comments embedded within, might have given the impression that it was a private communication between the students and the critics, rather than the obviously public communication in a traditional in-person review.

More lessons came from the way the activity was organized:

- Originally, the plan was for students to keep an online journal of their design progress, updating it regularly with new images and text. Critics could then visit informally whenever they had time, commenting on students' work-to-date. It quickly became apparent that this was unrealistic because maintaining the online journals took too much effort. The researchers also were concerned that critics would waste their time commenting on out-of-date work or visiting when there was nothing new to see. Instead, several formal reviews by the critics were scheduled.
- Although students appreciated the critics commenting on their work, they did not always find the comments directly useful. By the time the project was put online and the critics made their comments, students had made many changes in their design or moved on to other parts of it. The time delay of the online review significantly decreased its utility.

In addition to the overall proof-of-concept, CoOL Studio provided many positive lessons:

- Having multiple reviews was useful. Students became more skilled at using the technology and presenting their projects clearly with each iteration.
- Critics' comments were clear and insightful, if not always directly useful to the students. Traditional reviews have sometimes been criticized for being overly negative and confrontational [Anthony, 1991], but the reviews in CoOL Studio did not seem to have this problem. Perhaps this was because the asynchronous style of interaction allowed both critics and students time to think and reflect before making a response.
- Critics made extensive use of the background information provided on CoOL Studio to familiarize themselves with the site and the city of Atlanta before making their comments on the projects. In a traditional review, critics may or may not have this kind of information and the time to study it before they are asked to make comments.
- Students found value in the reviews because it helped them in something they felt was important: preparing for the competition. It is difficult to present a design clearly, especially without any opportunity to discuss or clarify the drawings and images. The online reviews simulated the conditions of the competition in many ways and gave students a valuable opportunity to practice and develop their presentation skills.

The research team was encouraged by the success of CoOL Studio and planned to try another iteration of the remote critics activity the following year.

## Initial Concept

One of the ideas inspired by CoOL Studio was that rather than showing each student's work individually, as is usually the case in in-person reviews, students would group their work into thematic *galleries*. In these galleries students would be responsible for “curating” them—for deciding on a theme, selecting images that explore that theme, and writing about them. The same remote critics would review the work 2-3 times over the course of the project during scheduled review periods. The pedagogical goal was for students to reconceive their designs in terms of the themes and how they related to the other projects in the gallery. Simultaneously, they would have to take into account the strengths and limitations of an online presentation and decide how to convey their ideas clearly to the critics. One instructor agreed to try the activity in her studio, and so the research team worked with her over several months to develop the details and carry it out.

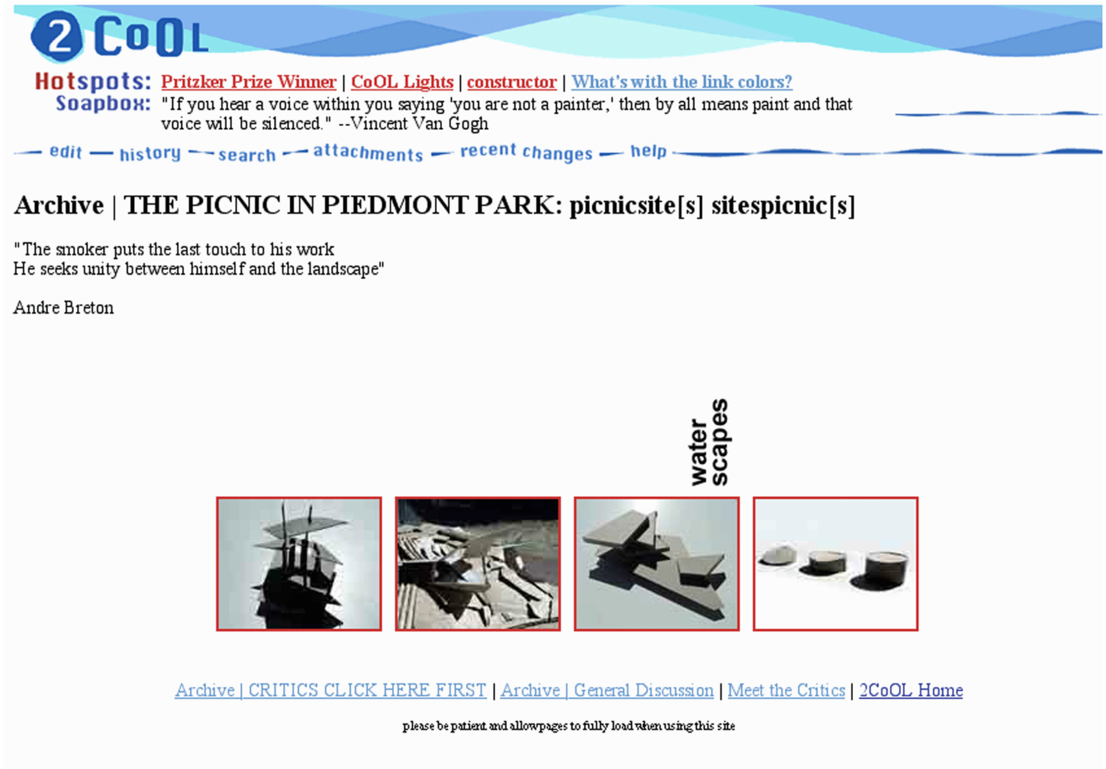
## Summary of Design Decisions

Designing the Student-Curated Galleries activity required many decisions to be made in creating the online environment and presentation format, addressing usability issues, and organizing and carrying out the activity. This section summarizes the major decisions made for each.

Online Environment and Presentation

Figure 6-2 shows the front page of the gallery website. This is the main page to which the critics were directed. From here they could access the four galleries (flat scapes, wooded scapes, water scapes, and sloped scapes), the General Discussion area, and an Introductory area. The General Discussion area was included as a place for critics, students, and the instructor to leave comments that were not related to any particular gallery or project. The Introductory area provided an explanation of the 2CoOL project, an explanation of the exercises students had done, brief instructions for using the CoWeb, and a sign-in page for each critic where he/she could introduce themselves and practice using the CoWeb.

Figure 6-3 shows a gallery from the first review. Up to three projects, related by a common theme, were displayed simultaneously on a single page, each with two images. The goal was to allow critics to compare projects side-by-side, so instead of using a long, scrolling page, we used a “fish-eye” [Furnas, 1986] scheme for laying out each gallery. This is a technique used in information visualization in which contextual information is displayed along with a more detailed view of some part of the information. Students' images were shown in thumbnail; clicking on one of the thumbnails brought it into focus. When an image was in focus, a larger version of it was displayed along with the text that the student had written to accompany the image. Each project in a gallery was given a unique number, so that critics would have some way to refer to them unambiguously in their comments. There was a single comment space for each gallery, shown at the bottom of the page. Within it, critics could comment on a specific project, compare projects, or




The four galleries are represented by images selected from each. The name of the gallery is revealed as the mouse moves over the image.

**Figure 6-2. Front page for the first review**

comment on the gallery and theme as a whole. Using a single comment space meant that critics could easily read what other critics had written. We also hoped that it would encourage students to read the comments for the whole gallery, not just those addressed to their project.

**Archive | sloped scapes**


```
I chose the lake as my location
for an intervention, more
specifically the dock, the
visitors? center and the
surrounding area.  I decided to
create an enclosure, a secluded
nook for adults to go, for
children, for whoever wanted a
bit of privacy from the city. I
have an overall view of what
will happen to the lake, but I
first started by exploring the
hill with the visitor?s center.
The building is not creating a
secluded area away from the
city but allowing the city into
the park. All of the concrete
and ?cityscape? needed to be
removed, thus causing the
problem of how to enter in to
my location.

 The models are of different
views of my first attempt at
approaching my site. I started
```

Please add your comments here:

[redacted] first of all, I'm a little disturbed by how quickly you seem to take up and abandon ideas. You need to define the parameters of your project and stick to the general structure you set for yourself.
You gave up the hill for the dock, why?
I'm intrigued by your artistic urge to symbolically introduce the home into the park, but I'm not certain how this idea will play out. Why are you drawn to this idea? It cannot be nostalgia as picnickers will return to their own homes by sunset. Is it enigmatic?
The idea of domestic memory is a very strong one. The picnic is pretty faithfully transcribed from the kitchen table to a patch of grass complete with tablecloth, but are there other aspects of domestic life you might consider airing in the park? Laundry, for example?
[redacted]

[redacted] If you are going to use the house as a point of departure for your proposal, a more careful analysis of the relationship between the outdoor picnic and the indoor activities of preparing and eating meals, and or recreating, is crucial. To begin with, you might want to diagram indoor activities as you have done with outdoor picnic activites. Secondly, instead of treating house as image or symbol, consider the specific functions and (I say reluctantly) equipment that organize indoor domestic life. Turn the tables -an indoor picnic for instance, or an outdoor garden kitchen, and so on.
[redacted]

Detail of one gallery with an image from Project 2 in focus. Text to the right of the image is from the student; text below is from the critics.

**Figure 6-3. Sloped scapes gallery from the first review**

Based on feedback from the critics, some adjustments were made to the galleries for the second review. The number of images per project was increased to six so that students could show more of their projects' development. We still needed to keep the number of images in each gallery page small, so we reduced the number of projects per page from three to two and created more gallery pages. There were then six galleries with popular gallery themes having more than one page (e.g. sloped scapes I & sloped scapes II). The size of thumbnails was also increased slightly to make the images easier to interpret at this small scale. Critics also requested some way to refer to individual images in the gallery, so each image was given a unique number. The front page for the second review is shown in Figure 6-4. The updated gallery design is shown in Figure 6-5.

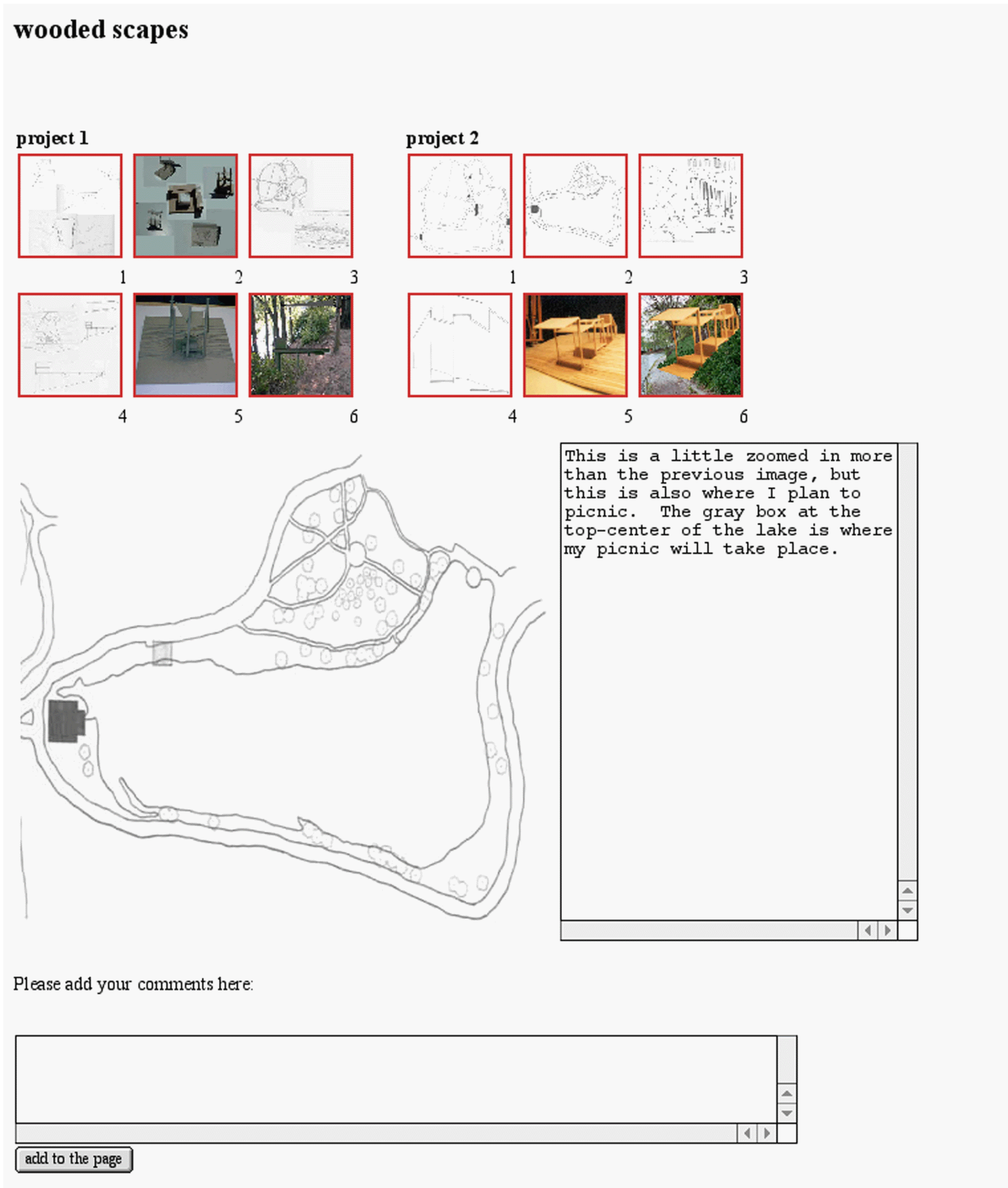
### Addressing Usability Issues

Usability refers to the ease (or difficulty) with which someone can carry out a task. Although it may be possible to complete the task, poor usability means that it will be difficult or require a concerted effort to do so. There were several usability issues that needed to be addressed in the design of the Student-Curated Galleries activity. One resulted directly from the design of the galleries; the others were revealed in the original CoOL Studio study.

The fish-eye design that we chose required some sophisticated web page scripting to accomplish. Usually, when someone needs to add something to a CoWeb page (e.g. an image or some text), they simply click the Edit button, find the appropriate place in the text, and type their addition. In this case, however, someone clicking the Edit button


There were six galleries for the second review. The rollover effect was eliminated.

**Figure 6-4. Front page from the second review**




For the second review, each project was allowed six images. Critics would use the type-in box at the bottom of the page to add their comments, as in the first review.

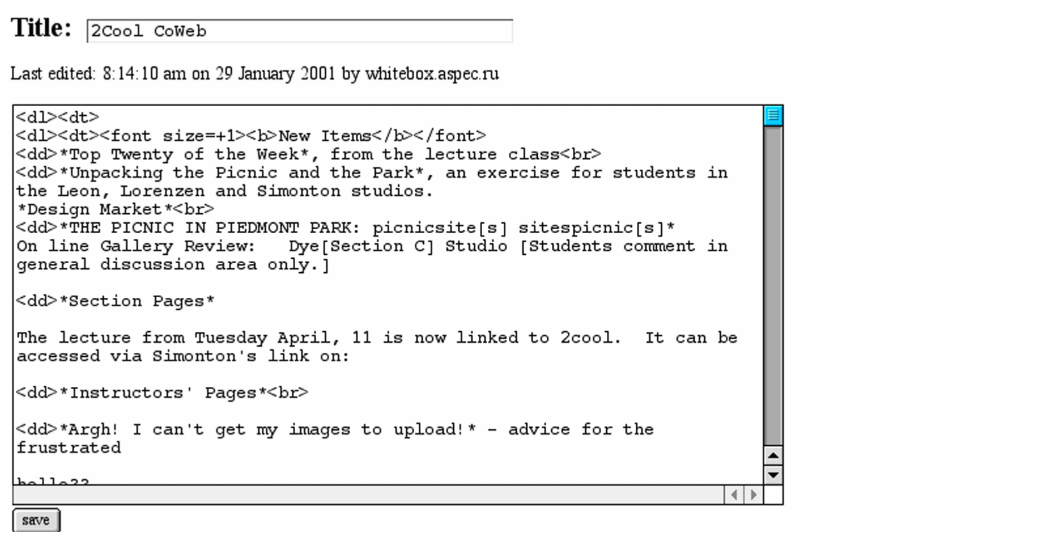
**Figure 6-5. Wooded scapes gallery from the second review**

would encounter a very complex page full of web-scripting code. If even one character was accidentally removed or changed while a student was adding to the gallery, the whole page would stop working. To address this, we decided to use the *template* feature of the CoWeb which allowed the complexity of the page to be hidden from the students. Students were presented with a series of “slots” to fill in with their information. When the page was displayed, the information from the slots was combined with the web-scripting code to produce the fish-eye interaction. An added benefit of this approach was that the editing page could be scaffolded, providing guidance to students as they filled it in. The result was that students could very easily add their information into one of the galleries, which could then be used in a very complex presentation. Figure 6-6 shows a normal CoWeb page being edited in contrast with our gallery editing template.

During CoOL Studio, critics reported that it took a long time to download the projects because of the large images and documents they sometimes contained. Since students create their web pages using fast on-campus connections, it can be difficult for them to judge how long it will take to download with a slower connection. To address this issue, the gallery format was designed to strictly limit the number and size of the images. Students were also shown how to change the compression and resolution of their images to make the file sizes smaller.

Another difficulty in CoOL Studio was in scanning images to make them available online. To make the creation of images more manageable, students this time worked on smaller format paper which could be scanned in a single pass. Arrangements were also made to use a digital camera to photograph their three-dimensional models, eliminating

**Normal Edit Screen**



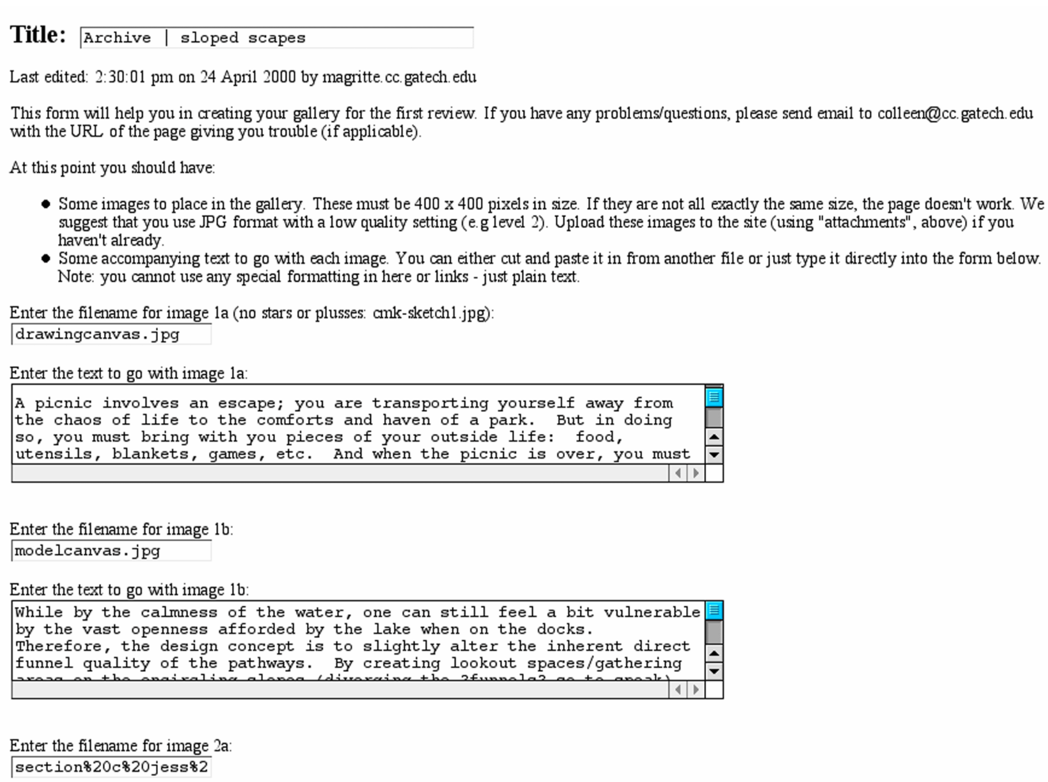
**Title:** 2Cool CoWeb

Last edited: 8:14:10 am on 29 January 2001 by whitebox.aspec.ru

```
<dl><dt>
<dl><dt><font size=+1><b>New Items</b></font>
<dd>*Top Twenty of the Week*, from the lecture class<br>
<dd>*Unpacking the Picnic and the Park*, an exercise for students in
the Leon, Lorenzen and Simonton studios.
*Design Market*<br>
<dd>*THE PICNIC IN PIEDMONT PARK: picnicsite[s] sitespicnic[s]*
On line Gallery Review:   Dye[Section C] Studio [Students comment in
general discussion area only.]

<dd>*Section Pages*

The lecture from Tuesday April, 11 is now linked to 2cool.  It can be
accessed via Simonton's link on:

<dd>*Instructors' Pages*<br>

<dd>*Argh! I can't get my images to upload!* - advice for the
frustrated
```

save

**Gallery Edit Screen**



**Title:** Archive | sloped scapes

Last edited: 2:30:01 pm on 24 April 2000 by magritte.cc.gatech.edu

This form will help you in creating your gallery for the first review. If you have any problems/questions, please send email to colleen@cc.gatech.edu with the URL of the page giving you trouble (if applicable).

At this point you should have:

- Some images to place in the gallery. These must be 400 x 400 pixels in size. If they are not all exactly the same size, the page doesn't work. We suggest that you use JPG format with a low quality setting (e.g level 2). Upload these images to the site (using "attachments", above) if you haven't already.
- Some accompanying text to go with each image. You can either cut and paste it in from another file or just type it directly into the form below. Note: you cannot use any special formatting in here or links - just plain text.

Enter the filename for image 1a (no stars or plusses: cmk-sketch1.jpg):
drawingcanvas.jpg

Enter the text to go with image 1a:

```
A picnic involves an escape; you are transporting yourself away from
the chaos of life to the comforts and haven of a park.  But in doing
so, you must bring with you pieces of your outside life:  food,
utensils, blankets, games, etc.  And when the picnic is over, you must
```

Enter the filename for image 1b:
modelcanvas.jpg

Enter the text to go with image 1b:

```
While by the calmness of the water, one can still feel a bit vulnerable
by the vast openness afforded by the lake when on the docks.
Therefore, the design concept is to slightly alter the inherent direct
funnel quality of the pathways.  By creating lookout spaces/gathering
```

Enter the filename for image 2a:
section%20c%20jess%2

**Figure 6-6. Comparing the normal CoWeb edit screen to the gallery editing template**

the intermediate steps of developing and scanning regular photos. For the second review, students did some of their work in digital media which made it easier to incorporate into the galleries.

Organizing and Carrying Out the Activity

Because the project was only six weeks long, on-line reviews were scheduled to replace, rather than duplicate or supplement, in-person reviews. In other words, there would not be both kinds of reviews for the same stage in the project. We felt doing both would be redundant, so we developed a schedule of alternating reviews, three in-person and two online over the six week project.

Students were scheduled to spend about three days (Friday-Sunday) preparing their on-line presentations from the drawings and models they had previously created. Digital photographs of their models would be taken on Friday and they would spend the weekend putting their work into the gallery. Critics were given a five-day window (Monday-Friday) in which to visit the galleries and leave their comments. The aim was to allow critics a reasonable amount of time to participate, but to make the window small enough that the comments would still be relevant to the students' projects. We requested that all the critics visit all of the galleries.

The instructor had the responsibility for recruiting the critics. She had several colleagues in mind and planned to contact them via email to ask them to participate. She would also provide them with background information and an explanation of the exercises the class had done before the review.

These design decisions were made by considering many factors: students' needs; critics' needs and expectations; the instructor's comfort level with the technology; the tools, time, and resources available; the directions of students' projects; the other activities in the class and other studios; and the pedagogical goals for the activity. Previous experience with design reviews, website design, and the CoOL Studio experiment in particular provided a basis for making many of these decisions.

## Results and Discussion

The first online design review was completed successfully. Students were able to put their work into the online galleries and critics were able to view them and leave comments. Six of the ten students who participated completed a survey about the experience, with most reporting that they found the activity interesting, worthwhile, and somewhat influential on their designs. They also reported reading the comments left for other students and reviewing their own comments more than once. Several critics also commented that they enjoyed the experience, and it was clear that they did read and respond to each other's comments.

Even with this success, there were several setbacks. Not everything was carried out as we had initially planned, and some new problems were encountered. Furthermore, the second design review never took place. Near the end of the semester, the instructor became very busy helping students finish up their projects and acting as a critic for other studios' final jury reviews. Even though the students had prepared the second galleries, she did not have time to contact the remote critics before the students had left for the summer. We decided that it was not worthwhile for the critics to spend time writing comments that the students might never read.

The rest of this section discusses the results of this study in more detail and makes comparisons between the online review and in-person reviews. First, it reviews the intentional changes we made in turning the traditional in-person review into an online activity. Then, it presents the unanticipated outcomes of making those changes. Finally, it presents the positive outcomes we observed.

**Intentional Changes**

There were two major intentional differences between this online review activity and a typical in-person design review. The first was a pedagogical change—the explicit presentation of student work as a themed group, rather than as individual projects. This required that the instructor, the students, and the critics all take a somewhat different approach to this design review and deal more explicitly with the relationships between projects. In in-person reviews, critics sometimes spontaneously compare projects, but the projects are not usually presented as having any particular relationship to one another. The other major change was that critics would participate remotely in the review. Specifically, they would use an asynchronous, web-based environment to view the student work and then leave comments in writing. Together, these two changes required more work of students: converting their work into electronic form, writing captions for the images, coordinating their work with other students, and learning how to use new technology in the process. We expected, however, that the benefit students would gain would make the extra work worthwhile. The main difference we expected for the critics was that they would be viewing the student work in a restricted way (e.g. small images) and would be writing rather than speaking their comments. This might have required more effort than usual on the part of the critics in conveying their ideas, but the trade-off was the convenience of being able to participate remotely and asynchronously.

## Unanticipated Outcomes

As every designer knows, however, intentional changes almost always have unanticipated outcomes. This section reviews some of the problems we encountered that resulted from the changes we made in this learning environment—adding technology and making changes to the pedagogy.

### Making a Familiar Activity Unfamiliar

We expected that the instructor would actually face the fewest differences in the new activity since her participation in either an online or in-person review would be minimal. In fact, she actually dealt with the most. The changes we made in the design review introduced a high degree of unfamiliarity into what is normally a routine activity in the design studio. She had plenty of experience with design reviews and was enthusiastic about experimenting with remote critics. However, she was not very familiar with the CoWeb technology or issues of web site design. Having only a partial understanding of how web pages worked made it hard for her to judge what would be easy or difficult to do with the CoWeb and to understand the range of possibilities it offered.

Our plan to change the pedagogy to use groups instead of individual presentations also made the activity unfamiliar. This change was probably even more radical than the introduction of the technology because it affected the fundamental concept of the design review. In the end, the instructor chose to develop the themes for the galleries herself, instead of having students develop them, as we had originally planned. Instead, students simply chose the theme they felt suited their project and placed their work in that gallery. Within each gallery, student projects were still presented essentially independently, requiring no interaction among the students. When the critics reviewed the projects, they generally responded to each one independently, as well. Critics were not given any explicit instruction about how to review the galleries, so they responded as they would in an in-person review, addressing a few paragraphs to each student.

All of our early planning for the activity had dealt with the needs of the students and critics and had overlooked the important role that the instructor would play in shaping the activity as it actually occurred. Design reviews not only represent students' work to a panel of critics—they are also a representation of the instructor to his or her colleagues [Anthony, 1991]. The instructor was the person who would have the most interaction with the students and critics and would ultimately be responsible for making the activity happen. Perhaps the introduction of the technology and the change in the pedagogy was introducing too much unfamiliarity into the situation for her to comfortably manage. She wanted to make the experience a good one for both students and critics, and one way for her to do that was to use a more familiar approach. As the activity began to be carried out, it became clear that it was changing from the research team's initial concept to more of a traditional design review pedagogy. Because we felt it was necessary for the instructor to have full confidence in the activity for it to be successful, we deferred to her judgement in making this change.

Flexible Pedagogy, Inflexible Software

Before a design review, students typically work late into the night preparing their materials for the next day. Although some students take this to the extreme, it is necessary to do at least some of the work at the last minute so that the presentation can represent the students' most current thinking on the project. It makes little sense to have critics spend time commenting on ideas that have been abandoned or issues that have already been resolved. Students are expected to put some amount of planning into what they will pin up for the critics, but they can continue to make last minute adjustments nearly until the review starts. Their oral presentations may also be planned to an extent, but they easily allow for improvisation when needed. Finally, the ordering of the presentations is sometimes decided on-the-fly, allowing the instructor to skip over students who do not meet presentation requirements or jump to a project that relates to the current discussion.

Studio pedagogy is very flexible and reactive, and as a result, the details of a design review may not be decided until the last minute. This style of teaching has both benefits and drawbacks, but the significant observation here is that the Student-Curated Galleries could not easily accommodate this kind of flexibility. This difficulty was manifested in several ways. The galleries contained secondary representations of students' work: photos of models and scans of drawings. If a student wanted to make a change to any of these, he/

she had to change the primary representation (the model or drawing) and then make a new secondary representation (the photo or scan). This required students either to do double work to make a change or to stop updating their designs earlier than they might have otherwise. Another difficulty was that the themes the instructor chose changed at the last minute based on how the students' projects had evolved. As a result, the galleries then needed to accommodate different numbers of students, whereas the initial plan was to always have three students per gallery. There were also a few students who did not attend class the last day before the review, so we were unsure whether they would participate in the review or not. It would have been trivial to allow these kinds of changes in an in-person review. For example, students could just pin their work up in any size group, regardless of the size of other groups. Changing these things in the CoWeb environment was not as simple given the design we had created. New graphics needed to be created for the new themes, new galleries allowing for more or less than three projects had to be programmed, and empty slots had to be removed at the last minute if some students did not participate. Our design for the galleries took what might be abstract concepts in an in-person review (e.g. *themes*, *groups*, *slots*) and turned them into concrete "objects", removing much of their flexibility and creating a new set of tasks and skills needed to carry out the review.

Finding Time to Participate in the Online Review

Five remote critics, who were colleagues of the instructor, agreed to participate in the review. The review was scheduled to take place over four days (Tuesday - Friday)[1] and critics were notified that the class would be meeting to discuss their comments on Friday afternoon. Mid-week the instructor noted that some of the critics were dragging their feet, and she sent them an email to remind them to participate. She also asked the other studio instructors to participate to make sure that all projects got enough comments. Three remote critics left comments in a timely way, one responded at the last minute, and one was never able to participate. Most critics did visit all of the galleries, but they did not necessarily leave comments for each project. Finding the time to participate during the short commenting window was likely part of the problem. Even critics who did participate noted that they wished they had more time. One suggested that having the comment period over the weekend would be easier.

In a sense, the virtual world of the review had to compete for attention with the “real” world that the critics lived and worked in. Unlike an in-person review, critics had to find time on their own to view the galleries, an activity which could be preempted at any time with more pressing real-world concerns. In contrast, an in-person review, especially one that involves travel for the critics, is a captive event—all of the participants are there for a scheduled period, reviews are given, and the event is over. The fact that everyone has to be there in the same place at the same time means that agreeing to be there is a significant commitment. The irony is, that what makes it convenient to participate in a virtual, asynchronous design review also makes it easy to ignore. All of the remote critics

1. Originally scheduled for Monday, the start was delayed until Tuesday to allow time to resolve some last minute technical issues.

may have fully intended to participate in the review, but the virtual event did not seem to demand the attention and commitment of an in-person event.

Limitations of Gallery Images

We expected that communication between the critics and students would be adversely affected in some ways by the limitations of the technology. Critics confirmed this in their comments, noting that the small images lacked impact and that the three-dimensional models were hard to interpret without being able to handle and inspect them. One critic asked if there was a way to interact with and annotate the images. Another requested more images which were bigger and had captions that explained them. Because of these limitations, critics said that they felt they reacted more to the text that students had written than the images it accompanied. This was a surprise because usually the images in an in-person review are key to the critics understanding the students' project.

No Opportunity to Clarify Students' Projects

Jury reviews are not noted for their interactivity between student and the jury—after a students' initial presentation, the jurors do most of the talking. However, there is usually a phase just after the presentation in which jurors ask questions of the student, clarifying what was presented or asking for more information. This phase was absent from our design, requiring that students try to explain in advance what they thought jurors would want to know. Jurors were also left guessing about students' intentions when they were unclear or when information was missing. Jurors expressed their uncertainty throughout their comments and questions (e.g. "I'm not sure I entirely understand...", "Am

I missing something?”, “What is it made of?”). The single iteration (students post, critics respond) without a chance to clarify and build a shared understanding of the project might have limited the usefulness of the comments. Critics were working from a partial understanding of the projects, either filling in the gaps with their assumptions or asking students questions directly. Students on the other hand, were never required to really answer the questions, as they would have been if they were asked in person. Interestingly, a majority of students who completed the survey said that they wanted to respond to the critics’ comments, so perhaps this should be incorporated in future online design reviews.

No Way for Instructor to Mediate Discussion

Another subtlety of the jury review which was overlooked by this design was the role that the instructor plays in mediating the discussion between the students and critics. Of all the people involved in a jury review, it is the instructor who actually knows the most about the situation. She is intimately familiar with the students’ projects, having worked with them over the course of several weeks. She also has far more experience in design (and with juries) than the students and is probably better able to understand and interpret the critics’ comments than they are. Even though her participation in a jury review is small, it is very important in helping students and critics bridge the gaps in their understanding. For example, she might rephrase a critic’s question for a student who seems confused or further explain the assignment for critics questioning a student’s choices. The online review did not take into account this mediating role or even the fact that the conversation between students and critics might need mediation. To partially address this, a debriefing session was held at the end of the online review. During this session, the instructor read the comments for each project aloud, elaborating on them and explaining how she interpreted the critics' comments, what she thought was important and what was no longer relevant. She asked what the students thought about the comments and made sure each student understood them. Being an experienced jury member and a colleague of the remote critics, she could, in a sense, hear the intonation and intention in the critics' comments that was inaccessible to the students.[2]

To summarize, the following unanticipated outcomes were identified:

- The instructor had more unfamiliarity to deal with than usual with the new technology and pedagogy; this might have led to backing off of the new pedagogy as a way to keep the activity manageable and successful.
- Studio pedagogy is flexible; the design of software did not take this into account and required many unexpected changes at the last minute. Complex software is not easy to change, however, which meant that the instructor could not make the changes herself.
- The online reviews required that critics find time during their work week to participate. In contrast to an in-person review, which is a captive event, the online review did not seem to demand the same level of attention and commitment.

2. Another instructor reported the same phenomenon the following year. He found that he needed to provide the "voice" to the comments left by the critics. He felt that students had a tendency to interpret them more harshly than they were intended.

- Limitations in the display of images and 3-D models resulted in critics relying more on students' written text than they usually would.
- The format of the review, a single iteration of students posting and critics reviewing, did not allow a clarification phase found in most in-person reviews. As a result, critics had to make assumptions or ask questions in their comments.
- There was no easy way for the instructor to mediate the discussion between the students and critics online; instead she debriefed students afterwards to help students interpret the critics' comments.

Many of these unanticipated outcomes were the result of our not taking into account how our changes would impact the design review. It revealed several weaknesses in the design of the software and the activity. Perhaps even more significantly, this study revealed some of the subtle features of design reviews that participants often take for granted but that are important for making them work.

## Positive Outcomes

All of the outcomes discussed so far have been negative outcomes—problems caused by not taking into account ways in which the online activity would differ from the more familiar in-person activity. However, there were several positive outcomes that came from using this technology.

The asynchronous, online review was convenient for the jurors. Even though it was difficult for some to find time to participate, it was still much more convenient than taking the time and expense to travel from New York to Atlanta. Jurors could also spend as much or as little time as they had available, instead of committing to a day-long event. Scheduling the review period to include a weekend and helping set jurors' expectations about how much time they should allocate may help alleviate the problems encountered in this study.

The fact that the review was written and asynchronous may have given participants a chance to be more reflective in their comments. Instead of having to speak spontaneously about a project to which they had just been introduced, critics had the option to compose and review their comments before committing them to the website. One critic even revised his comments after they appeared on the site. Similarly, students were able to read critics' comments carefully, without the need to respond to them immediately. Some students reported reviewing the critics' comments several times—something that is nearly impossible in in-person reviews.

Jury reviews are notoriously stressful for students, who sometimes view them as confrontational, unpleasant, and unhelpful. According to [Anthony, 1991], there is often legitimacy to these complaints. The online review may have helped remove some of the factors that contribute to this problem: the long duration of most reviews, the need for jurors to respond to projects with little time to prepare, and the problem of students remembering and understanding jurors' comments. Interestingly, most of these problems could also be addressed without using technology. [Anthony, 1991] presents numerous suggestions along these lines.

## **Differences in Interaction & Content**

Given the differences in the online and the in-person activities, it is natural to wonder if the participants interacted differently or if the content of the discussion was also different. In some ways, it is difficult to compare an in-person to this online review because of their fundamental differences: a single iteration between students and critics versus freeflowing conversation; a written instead of oral communication mode; asynchronous rather than synchronous discussion. In this case, the identity and number of critics who participate in each session are also different, and the projects are at different phases of completion. But even with these difficulties, some useful comparisons can be made that uncover some similarities and differences between the two reviews.

Two of the regular in-person reviews for this class were audio taped. The first one (ARCH-1) occurred fairly early in the project, when students had just finished their investigation phase and were beginning to form their intervention. The second one (ARCH-3) was the final jury review held after work on the project was completed. These were transcribed so that they could be compared to the online review. Unlike in the online review, where words can be counted exactly and no two people "talk" simultaneously, a transcript of a real-time discussion is only an approximation of what was said. A best effort was made to transcribe the discussion as accurately as possible but there were some cases where it could not be understood because of recording limitations or because several people were talking at the same time. Also, speaking is not as clean as written text—there are more false starts, incomplete sentences, repetition and non-words ("um", "er", "hmm"). Non-words were omitted from the transcript as were repeated phrases when they did not add to the discussion ("when I, when I went back to the..."). Due to a recording error, the ARCH-3 session was not recorded in its entirety. Of the 11 presentations made, 6 were recorded in their entirety, 3 were truncated, and 2 were not recorded. However an inspection of the transcript suggests that what was recorded is reasonably representative of the entire session. The online session (ARCH-2) includes only the text from the online environment (the galleries and the general discussion), not any peripheral (in-person or email) discussion. For these reasons, the following should only be considered very rough comparisons between the sessions.

## Patterns of Interaction

One of the simplest comparisons that can be made between the sessions is the number of words written/spoken by each group of participants. The transcripts were divided up by speaker and a word processing program was used to count the number of words for each group. The results are shown in Table 6-1.

**TABLE 6-1 Words for each set of participants**

| **Session** | **ARCH-1 Pin-up** | | **ARCH-2 Online** | | **ARCH-3 Final Jury** | |
|---|---|---|---|---|---|---|
| Student Words | 7596 | 37% | 4078 | 39% | 6493 | 34% |
| Instructor Words | 1246 | 6% | 354 | 3% | 1780 | 9% |
| Juror Words | 11, 587 | 57% | 6133 | 58% | 10,738 | 56% |
| Total | 20,429 | | 10,565 | | 19,011 | |
| Number of Jurors | 1 | | 7 | | 5 | |

The first thing to note is that the two in-person sessions have approximately twice as many words as the online session. There are several possible explanations for this. It could be because written communication is more economical in terms of the number of words needed to communicate an idea. Or it could be that because writing takes longer than speaking, participants were not able to write as much in the time they had available. Finally, it could be that the single iteration style of the online session limited the discussion—it could proceed no further without some feedback from the student.

Interestingly, though, the percentage of the words spoken by each group are roughly equal across the sessions. In fact, if the email the instructor sent to the jurors or the introductory page she wrote for the site were included, the percentages would be even more similar. This suggests that the online format did not inhibit the participation of any of the groups unnecessarily. On the other hand, it did not encourage any more interaction between critics and students; it looked very much like a typical review, which is sometimes criticized as being very one-sided [Anthony, 1991]. Although the differences are small, it is interesting to note that the instructor participated more in ARCH-3 than in the other sessions. This reinforces the earlier observation that the instructor has a small but important role in interacting with the jurors.

The number of turns for each group of speakers was also compared across sessions, similar to the analysis done in Chapter III. For ARCH-1 and ARCH-3, a *turn* of dialog is an uninterrupted segment of speaking by a single speaker. For ARCH-2, the text students created for their images is considered a single turn. A turn for a juror was an uninterrupted

**TABLE 6-2 Turns for each set of participants**

| Session | ARCH-1 Pin-up | | ARCH-2 Online | | ARCH-3 Final Jury | |
|---|---|---|---|---|---|---|
| Student Turns | 144 | 42% | 10 | 22% | 83 | 23% |
| Instructor Turns | 71 | 20% | 3 | 7% | 88 | 25% |
| Juror Turns | 131 | 38% | 32 | 71% | 188 | 52% |
| Total | 346 | | 45 | | 359 | |
| Number of Jurors | 1 | | 7 | | 5 | |

segment of text, usually addressing a single student—although some jurors addressed more than one student in a single turn. This analysis is shown in Table 6-2.

Even though some of ARCH-3 is omitted from the transcript, the number of turns in the in-person sessions are more similar to each other than to the online session. This is not surprising given that the single iteration format limited the number of turns in the online review. A difference between ARCH-1 and ARCH-3, however, is in the percentage of turns taken by the students. In ARCH-1, the students actually had more turns than the juror. This suggests that there was more interaction between the juror and the students in this session than in ARCH-3. While this is true, a further examination of the transcript shows that many of the student turns were quite short compared to the juror’s turns. So even though the number of turns was more balanced in this session, the juror still did the vast majority of the talking (e.g. recall the number of words for each participant from Table 6-1). In ARCH-3, the jurors have the majority of the turns. Although their comments are intended for the student presenting, the student only occasionally has to (or gets to) respond. There are many cases where jurors speak one after another, sometimes in response to each other, before the student is required to respond.

Some of these differences in turn taking are probably stylistic differences between the jurors. For example, the juror in ARCH-1 frequently asked students if they understood what he was saying or whether his interpretation was fair. He also addressed the whole class occasionally, bringing more students into the conversation. Another factor, however, seems to be the number of jurors participating in the review. With five jurors in ARCH-3, giving each a chance to respond to every project already sets up a 5:1 ratio for juror to student turns. The fact that the session actually achieves a 2.3:1 ratio shows that it is more interactive for the student than it first seems. The apparent imbalance between student and juror turns is a result of the large number of jurors, who all want to give their comments on each project.

There is a dramatic difference in the percentage of instructor's turns in the online versus the in-person reviews. As noted previously, the instructor plays a much more active role in the design review than was initially anticipated, and this was not taken into account in the design of the online activity. The instructor might have participated less in ARCH-1 because the single juror was also already very familiar with the project and the students.

## Content

It is beyond the scope of this project to compare in detail the content of the online review with the content of the in-person reviews. Instead, this section gives only a high-level comparison of the discussion of one project from the online review with one from the final jury review. The goal, then, is to bring out some of the apparent differences and similarities between the two reviews. The two examples were chosen because they seemed typical for each review: they were of average length with an average number of reviewers, and the projects were neither the most exemplary nor most problematic in the class.

Figure 6-7 presents a transcript of the comments for one student's project from the online review.[3] (The student's text and images that the critics are responding to are not included here.) Three separate critics comment on the project, which is concerned with designing a new dock structure for picnicking at the edge of the lake.

All three of the critics ask the student questions—a feature of virtually every comment left by the online critics. Critics knew that students would not be responding directly to their questions, so in this sense they were all rhetorical. Still, some questions seemed to be *clarifying* questions, intended to represent the critic's uncertainty or a deficiency in the work presented. These are the kinds of questions that would probably require an answer if asked in person. Other questions seemed to be *guiding* questions, intended to influence students' thinking about their project rather than provide information for the critic.

In this example, all of the critics point out a similar kind of problem with the project, a contradiction or disconnect between the student's written intention for the project and the model she has built. Even though they all identify the same kind of problem, they are not identical, and each critic points out a slightly different issue. Critics

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3. Spelling, typing, and grammatical errors in the transcripts have not been corrected.

| | |
|---|---|
| [Student],<br><br>Interesting. I think I have more questions than recommendations at this point, but perhaps my questions will be helpful to you. In your redesign of the dock as it relates to the paths around the lake, how do the fragmented forms that I see stacking upon each other, or breaking away from one another...how did they evolve? How, and why, do these pieces combine to create the new dock? If the intention is to "bring together the paths, the dock, the hill and the lake" why is the accumulation of elements in your model somewhat discontinuous? I like the intentions in the text, but I am still looking for the paths and dock as they merge in your models. I trust that they will show up as you continue.<br><br>[Critic 1] | **Clarifying question** about the evolution of the pieces and how they combine. Also asks **why** (rationale).<br><br>Critic points out **contradiction/problem** in stated intention and current model. |
| [Student],<br><br>While reading your text I got interested into two notions you bring up which are highly interdependent. You talk about "sequence of events" end "snapshots" as determining factors for "Picnic". I like this a lot since it sets up the field for a dynamic rather than static approach to architectural intervention. A sequence is always time-related and therefore subject to change. A snapshot is a captured moment which stands out because of what? Could you think about your architecture as one of these moments? Or would you suggest that through your intervention "snapshot-moments" are encouraged or initiated? Look up(if you haven't already) "Manhattan Transcripts" by Bernard Tschumi. It's a great example how time, space and event become one construct and are actually following a particular logic.<br><br>Having said all this I feel that you abandon these ideas when you start to approach the "real" building. You emphasize on location, views, paths and docks. But there is no apparent connection to your initial observation. How do you initiate events? Is one space capable of taking on different events in different times? If yes, how so? | Critic **expands** on stated ideas. Asks **questions** to further students' thinking.<br><br>**Reference** to an author and why it would be useful.<br><br>Critic points out **problem** of disconnection between ideas and model. Asks **questions** for student to consider that highlight the problem. |

**Figure 6-7. Transcript of online comments for one student's project**

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|---|---|
| You talk about "understanding" the paths and traffic flow. I would recommend to "read" these according to your notion of "snapshots". Remember, you are the architect and you will read this and any other space different than any one else. There is no "objectivity" involved in design. I think you have a strong premise. Now you need to develop a way to carry it into architecture. Don't rush into form-finding, try to verify each step you take with your ideas.<br><br>[Critic 2] | Critic **suggests** a **way to approach** the problem.<br><br>Gives some **general advice** about design. |
| [Student], Your analysis is sharp and thoughtful as usual. My questions are more to do with what you are up to now. If you are, as you say " attempting to bring together the paths, the dock, the hill and the lake into one structure and experience," I just wonder what means are you employing to explore this? Your model seems to suggest some kind of paving. But what about visual elements (foliage, screens, railings etc.)? Do you feel that your model might be constraining you a little?<br><br>I'm running out of time, but, at the most cursory level, I would question why your 'dock' still runs perpendicular to the water? If you are bringing different paths together from different 'planes' of movement (a very provocative) idea, why is your structures still basically a line made up of pieces? And why the triangular pieces? I would like to see your study models starts to acknowledge the different paths, feed off of them, attach to them, subvert them, etc. I think that will help you to give the model the clarity of your language.<br><br>[Critic 3] | Critic asks **how** the student is exploring the stated intent. Asks **questions** to further the students' thinking.<br><br>Asks questions about **rationale** for the design. Points out **contradictions/ problems** between the ideas and the model. **Suggests** a **way to approach** the problem. |

**Figure 6-7. Transcript of online comments for one student's project (Continued)**

identified more diverse problems in other projects, but the disconnect between intention and model was a common one.

The second critic suggests the student look up a certain author he thinks she would find useful. Referring students to authors, artists, films, books, architects, etc. was very common in the online reviews.

Two of the critics offer suggestions about how the student might proceed. In this example, the suggestions are quite vague, but in some other online reviews they are more specific. Offering some suggestion on what to do next was also fairly common in the online reviews.

The second critic ends with some general advice on the design process and what it means to be a designer. This particular critic gave this type of advice in several of his comments, including a long comment in the General Discussion area. One other critic also gave this kind of advice, but to a lesser extent.

Figure 6-8 is a transcript of the final jury review for one student, a different one than in the previous example. This transcript begins immediately after the student has finished explaining his project. His final design is two large forms that resemble a couch and table from a distance. Four critics, the instructor, the student presenting, and another student participate in the discussion.

The discussion begins with the critics asking the student several clarifying questions. This is very typical of a review that begins with a student making a presentation. Unlike in the online review, these questions are clearly meant to be answered immediately.

Also unlike the online review, the discussion flows through a series of topics. The fact that the student is undecided about the material for his object sets off a chain of discussion topics: why the material/making matters, the choice of stone versus concrete and their properties, different styles of stonework. Another critic changes the topic to another problem he sees with the design: that the design moves the student makes are not

| | |
|---|---|
| R4: It's up on the hillside?<br><br>S8: Yeah, you walk up the slope...<br><br>R4: On the fields?<br><br>S8:...and it's right here like on the crest of the hill. So that like when you're up here you get the whole view of the part of the lake and the trails that are around. You can almost see the other side, you can see that on the city line, the trees so it is concerned with the view. | **Clarification questions** about the **location** for the project; student provides further rationale for choice of location |
| R4: What is it made of?<br><br>S8: I'm thinking first thing I was thinking would be kind of neat is like grass planes along with the grass slope. I also kind of tossed around concrete but pressed with wood so that it kind of had a grainy effect with age and get dirty and nasty, kind of like an interesting aging effect. | Question about **materials**; student has ideas but no firm choice. |
| R4: That's really a question of how much you want this thing to blend in or stick out.<br><br>S8: Yeah, I know. But I'm not sure. | Critic offers a **criteria** for choosing. |
| R1: But it's solid, right.<br><br>S8: Yes it's solid. | Further **clarification** of material quality and, construction method.. |
| R1: Because there's something about how you make it that could give more resonance to the project. I find it the most appealing when I don't know what it is, you know when it's enigmatic. You know, because it could be furniture forms, it could also be sitting forms. It could be any number of scales and what who'd give it a certain logic in how it's made and you determine it's proportions and sizes, might be if you were say, making it up out of stack materials, I don't know pieces of stone or something. Or if it's concrete it has to do with the kinds of form work that's used and what those dimensions are of the forms. But that would be the next step I think for me it would be either concrete or stone or virtually both of those as they are about their mass. And they're about the heaviness that they are. The two of them would actually be very different because the concrete would actually be one, probably one pour would be one thing.<br><br>R4: Monolithic. | Critic discusses **why** construction method matters. Contrasts choice of stone with choice of concrete. Suggests this choice as a **next step**. |

**Figure 6-8. Transcript of one student's final jury review**

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|---|---|
| R1: Monolithic. The stone would be likely stacked and then you would start to get the kinds of cracks that you're building here here but you would start to get the multiples all the way through. | |
| S8: Throughout the park they do use like the stone walls, the big stone planters but near the main playground...<br><br>R1: But the use them in a rustic fashion and this has a potential to be much more machined and planed.<br><br>IN: Crisp.<br><br>S8: That's why I was thinking the concrete.<br><br>R1: Yeah but stone can also be that way. Stone doesn't have to be like the "Flintstones." It can also be very refined and very urban. Very urbane. | Student notes that stone is used in the rest of the park. Critic makes **distinction** between different styles/uses of stone. |
| IN: Are you talking about like ____, ____-style?<br><br>R1: No I mean, you know, stones that are planed into cube and blocks. Like this sculpture say of Carl Andre, he takes granite slabs and pieces.<br><br>IN: So you're thinking like slabs and not?<br><br>R1: Or solids, like rectangles and stuff. | **Clarification** of critic's suggestion by **instructor**. **Reference** to a sculptor. |
| R4: When it's cut really carefully you could even lay it up without mortar. So you would end up with this jointless or totally minimal __ joints. | Another critic **adds** to the idea. |
| R1: Like Machu Picchu where you can't even stick knives in between the stones because it was so tightly put together. | **Reference** to a famous site. |
| R5: I'm just going to read back what I heard you say, because you know it's really interesting you guys have four weeks to lose your way and then four weeks also to make your own way depending where ever you end up. So here you start off with a very interesting diagram of how a picnic is a zero sum game. You know it's there, nothing's there, something happens and it goes away. And then [the instructor] suggested the Rachel Whitetree and all the sudden you were looking at Whitetree. And so in a way for all of us the challenge in these kinds of projects is to make our proposition out of things that we find along the way. And somehow integrate them. And I | Another critic **summarizes** the students' project and process. Points out a **problem** he sees with the design and when the problem occurs in the **process**. |

**Figure 6-8. Transcript of one student's final jury review (Continued)**

| | |
|---|---|
| think you were perhaps on to something when you were looking at this sort of zero sum game because Rachel Whitetree is a sort of zero sum game too, you can think of it in that way. And I think that these are some of your most evocative ones. It doesn't matter whether they're molds of chairs or city blocks. The fact that they are positive and negative, the fact that they are always working themselves as positives if you will, increases and negatives as depressions. And I think where you sort of lost your way and it's sort of unfortunate is in this model. Because everything here is a positive for all of these things after a first move which was a negative cut. But this move of cutting into the slope of the hill, and this move of pouring it or stacking it are not complimentary. They're not in dialog the way this stuff is. | |
| S8: So like then if it had been like a flat-scape...<br><br>R5: Well whether if were a flat scape of digging and of making up form work out of what you just dug to become dependent on the next floor, or whether it were on a slope would be similar operations just playing themselves out on two different contexts. | **Student** tries to **clarify** source of the problem as the scape. Critic says the problem exists regardless of scape. |
| R1: Well you could set yourself say a rule that the amount of dirt that comes out is the amount of dirt that you'll put out in front of it say you know it's cut fill. Or the amount you make per mass is the amount that you also describe as void. I don't see that he's so far off from it. I don't think it's as explicit in that one as it is in this one. | Another critic **suggests** a **way to solve** the problem. **Disagrees** with the severity of the first critic's assessment. |
| R4: Part of what's missing in this model is the retaining wall that has to be here. [agreement] | Third critic points out another problem with which the others **agree**. |
| R5: Well [other reviewer], what I'm saying though is the that the first move to do that is a radical cut into the hillside. And then the second move is to fill it in with boxes whether they're stacked or poured. As opposed to an operation which worked back and forth constantly. One of the nice things about that is that it gives you a certain rigor right, it goes back to Whitetree which you were looking at and it goes back to your first drawing. But also then, this is something that helps all of us is it gives us a measure, it gives us a register. So you can make some as dumb a statement as 50 cubic feet dug, 50 cubic feet put there. But you know just poured it differently so | First critic **addresses** second critic directly, **restating and clarifying** his view of the problem. Offers some other **ways to solve** the problem. |

**Figure 6-8. Transcript of one student's final jury review (Continued)**

| | |
|---|---|
| you get these wonderful scapes, whether they're landscapes or den-scapes. | |
| IN: Well, I was going to say... | |
| R5: But the model action is very, very explicit but the first thing is a cut slapping the ground and then places boxes on it. | |
| IN: Another thing is I thought this was a flat-scape from the beginning and he says, when we were talking about Whitetree in these, he says, "Oh, I'm on a slope." I'm like, "But then what do you do?" I mean I think that this would be much better on a flat surface. I think it would read much... | **Instructor** agrees with the student that the scape is part of the problem, having discussed it with him previously. |
| S8: Rip that off, drop it down. | |
| IN: Well... | |
| R1: It would be easier. I don't think that it is necessary. | Critics and instructor further discuss what the **source** of the problem is and how it can be **resolved**. |
| IN: I would like to see it cantilever out. | |
| R1: The thing is, is that you have to, if you don't want to build a wall which you don't, but you're going to make it out of solids but you have to be sure that all the parts where you start to cut are higher than __. So that's the _____. And that you're also explicit about quantities, the amount that you take out you put back, and the way that you concentrate the masses is also how you begin thinking about voids. So that there's a kind of an equivalence going back and forth between them. But even if he puts it on the ground the same issues of the relationship between this and the dirt would still... | |
| IN: Would be the same. | |
| R2: I agree, I mean just the flat makes it easier but the slopes, I mean there's so much opportunity there to play with these blocks that something's emerging and something's pushing to the ___. | Another critic **agrees** with the current idea. |
| S8: Okay. | |
| R5: Yeah if you were to take this down to the shop right now and get your saw and cut it out you'd have a lot more fun. That's how I was thinking _________. And I think [the instructor] actually pointed out another one that you | Critic suggests **another approach** to the problem. |

**Figure 6-8. Transcript of one student's final jury review (Continued)**

| | |
|---|---|
| could [do another] way, which is we're on a slope. That's my datum now right? I'm not digging but I will carve in this way horizontally and cantilever out this way. So you're working up the slope datum and going and this way or you could work on a sloping datum going this way. | |
| R1: That sort of depends a little bit on imagery how much you want to keep to sort of the safe mass or how much you want to keep, have the things that sort of dig in and stick out. | First critic provides a **criteria** for choosing between options given by previous critic. |
| S3: What would happen like, this might be kind of a dumb question but what if he made his model differently instead of like superficially putting that block in with the vertical planes and just made it all out of horizontal planes so it all looked like one surface you know? Like getting back to his thing about making it out of grass like making it out of boxes of grass? | **Another student** asks if making the model differently would help. |
| R1: That's what I would suggest the next time you make a model is you make it out of, if it's going to be poured concrete I would make it out of plaster and I would build the molds and I'd pour it. And if I was going to make it out of stone then I would switch to wood. | Critic **agrees**, suggests model be more related to proposed material. |
| IN: I suggested that but I thought it would be too complicated. | Instructor **questions** suggestion. |
| R1: No, it's easy to make a plaster model. You just use foam core that's the thing it's good for is to make a plaster model. Or else it could be out of stone then I would suggest that you carve or make wood into wood boxes and look at how they stack. If you want to look at a project that's very good about being very stereometric like this, Peter _____ baths in Switzerland at __ are sort of reconstituted quarry in a sense. That's a different set of imagery then what you're used to and he's, what you're using, and he actually, it's really a concrete building with just stone facing and but it looks very massive. You could look at that more for how does he make these stone pieces go together and how does he shape spaces and masses and voids with those stone pieces. It a different set-up because it's a ___ system, but I think it might help you get a sense of what stone can do other than looking like the "Flintstones". | Critic **disagrees**, **explains** how to make models.<br><br>**Reference** to another building and why it would be useful. |

**Figure 6-8. Transcript of one student's final jury review (Continued)**

| | |
|---|---|
| R5: I think one of the lessons which all of us can learn from your process right now is the kind of exploration you're doing and the kind, or way which you're making the model actually you're running in tandem. Not only because of your drawing but because of Rachel Whitetree and so you started from that beetlejuice cutting template shapes and you went to this one, but you're trying to see it as blocks up and down. But it was still made up of planes made out of chipboard like this one and the third one is.... Well, it could be out of a uniform material, like clay or plaster or as [the other reviewer] was saying, out of wood. Whereas, [the other student] was saying, if you were to simply make it out of layers of chipboard, you know, layer by layer so that sort of village sitting on the hillside was not made out another block, but it was made out of, almost as if this were a quartz ____, some kind of you know shale, something that was coming through cross and then you cut and added. Every time you cut a piece you put it somewhere else and it added up somewhere else. So the model, the inquiry through which the model is proceeding, through which the project is proceeding are calibrated to each other. And that in a way makes a nice kind of curve between the way you started and what you went through and the difficulties with where you ____.<br><br>S8: Okay.<br><br>IN: Thanks, [student]. | Critic **generalizes** the student's process. **Restates** why choosing different model materials could have helped and changed the process. **Draws a connection** between the design activities of model making and inquiry. |

**Figure 6-8. Transcript of one student's final jury review (Continued)**

complimentary. A discussion follows about whether this really is a problem, how severe it is, what the source of the problem is, and how it might be corrected. Finally, another student suggests that a different form of model making might be useful. The discussion then moves to different kinds of models, the difficulty (or not) in making plaster models, and the connection between model making and inquiry.

The discussion is not directly between the critics and the student. The critics and instructor often discuss the project among themselves, but for the benefit of the student(s) listening. They ask each other questions, clarifying what was said, building on it, agreeing or disagreeing. This kind of interaction not only allows the student to observe a kind of design thinking in action, but also may allow for a better discussion as critics feed off one another's ideas. When the student does participate in the discussion, it is a small but important signal to the critics about whether or not the student understands the points being made.

A few times, the instructor subtly takes responsibility for choices in the project with which the critics disagree. Much of the student's design has been developed under her guidance and represents her choices as much as his. For example, when she agrees with the student that the flat scape is part of the problem, or when she says the plaster model was too difficult, she is defending the student and deflecting some of the criticism to herself.

Table 6-3 and Table 6-4 summarize the differences and similarities found in these two examples. Since this is only a preliminary analysis, it is difficult to say what caused these differences. For example, if the online review was conducted synchronously (e.g. as a chat), would critics question each other as in the in-person review, even though they were typing instead of speaking? Did critics ask guiding questions in the online reviews because students could not respond or was it because they were still in the formative stages of their ideas? Did they focus on model-building in the in-person review because it was at the end of the project, because the problems with this project were with the model, or because of the particular interests of these jurors? If students were given the chance to respond in the online review, would the discussion be more or less like the in-person review? Further research is needed to answer these questions, which are important for understanding how the learning environment shapes the dialog that takes place within it.

It is a bit easier to speculate about why some similarities were observed between the two kinds of reviews. A likely reason is that the jury review is a well-understood ritual in design education, and the jurors applied their expectations and understandings of the ritual to this online version as much as possible.

**TABLE 6-3 Observed differences between the two kinds of reviews**

| Online Review | In-Person Jury Review |
|---|---|
| • some questions are intended to guide thinking<br>• critics make a small number of points<br>• no student feedback<br>• no intervention from instructor | • questions require immediate answers<br>• discussion flows through many topics<br>• student observes discussion among critics<br>• critics question, explain to each other<br>• small amount of student feedback<br>• instructor deflects some criticism during discussion<br>• instructor guides student, interprets critics' questions (not in this example) |

**TABLE 6-4 Observed similarities in the two kinds of reviews**

| Similarities |
|---|
| • critics identify problems with projects<br>• critics offer solutions or approaches to solving<br>• critics suggest references students might find useful<br>• some critics offer general advice on design<br>• critics explicitly agree or disagree with each other (not in this online example) |

## Discussion

One goal of this analysis was to understand the affordances and shortcomings of this technology-supported learning environment for CDD. It is worth differentiating, however, between the *technology* itself and the *activity* in which it was used. The affordances and shortcomings of this technology will be the same for a variety of activities. Likewise, the affordances and shortcomings of the activity will remain even if the technology is changed or improved.

In terms of the technology, the major affordance of the Student-Curated Galleries was that it allowed critics to participate remotely in the dialog. The expense of traveling and busy schedules of the critics would have made their participation difficult or impossible otherwise. Because it was asynchronous, critics could visit at their convenience (within the review period). Because it was simply a website, critics did not need any special software or instruction to participate. This online environment also seemed to afford a more reflective style of interaction between critics and students. Critics could take time to review the projects carefully and could add their comments to the site when they were ready. Because comments were written, students automatically had a record of the critics' comments, which they could review as needed for their own project and for others'. This environment also seemed to remove some of the stress associated with in-person reviews.

The main affordance of the online review as an *activity* was that it closely paralleled the familiar in-person activity. Participants could rely on their past experiences to know what to expect, what was expected of them, what topics were appropriate to discuss, etc. This was especially important for the critics who were interacting with the class for only a short time and in such a limited way. It probably would have been difficult for the critics to participate as effectively in an unfamiliar activity. The similarity was also important for the instructor because it gave her a comfortable way to incorporate technology into the design review.

The shortcomings of using this technology for CDD are the same as the strengths of an in-person discussion. A major affordance of an in-person discussion is the rapid, synchronous, freeflowing dialog. The dialog in the online review moved quite slowly in comparison, both because it was asynchronous and because it was written. The effect was that it limited the interaction among the participants which seemed to also limit the range of topics discussed. The interaction was limited even further by the decision to not have students respond online to critics' comments. The other major affordance of an in-person review is the richness of communication it allows. Participants can handle 3-D models, point at drawings, read each other's body language, and hear the intonation in each other's voices. This online environment did not allow any of these to be used in the dialog, which meant that communication required more effort and perhaps was less clear.

The shortcomings of the online review activity came from not taking into account important but subtle aspects of the in-person review. This study provided three important insights about CDD itself. The first is that design pedagogy, and studio pedagogy in particular, are flexible and fluid. Design projects and participants' understanding of them are constantly evolving, and the activities and tools designed to support them need to take this into account. The second insight is that good CDD builds upon a foundation of clear communication. Providing an opportunity for participants to clarify their understanding by asking and answering questions is especially important. The final insight is that the instructor has a special role to play in mediating the CDD between critics and students. She acts as a bridge between the two groups, helping each understand the goals and ideas of the other.

## Summary

This chapter documented the process of creating and using this particular online environment for CDD and analyzed its affordances and shortcomings. The results shed light not only on this particular technology and activity, but also on some of the more subtle aspects of CDD itself.

There were two intentional differences in the design of the activity: the use of a new pedagogy, where students presented their work in groups exploring a common theme rather than as individuals, and the use of the CoWeb so that critics could participate asynchronously over the web during a specified review period. Several unanticipated differences were uncovered, which prevented the activity from fulfilling all of our intentions. Still, the review was successful overall and even demonstrated some advantages to using this online environment.

A comparison between the dialog in the online review and the in-person reviews revealed differences and similarities in the interaction and content. The percentage of writing/speaking by each group was similar in all the reviews, but the design of the online activity limited the turn-taking interaction. The instructor’s interaction was also different in the two kinds of reviews. The content of the dialog was similar in both reviews with critics identifying problems and offering suggestions. Differences were noted, however, in the kinds of questions asked, the need to respond to questions, and the interaction among critics and the instructor.

One goal of this analysis was to understand the affordances and shortcomings of this technology-supported learning environment for CDD. The main affordances of this learning environment for CDD were that it allowed critics to participate remotely and was similar enough to in-person reviews to be easily understood by participants. The main shortcomings were that the slow pace and narrow communication channel limited the dialog and that the design did not take into account some important aspects of the in-person reviews.

The other goal was to understand more about CDD itself. The analysis showed that all learning environments that use CDD need to accommodate: the demands of a flexible pedagogy, the need to clarify participants' understanding, and the role of the educator in mediating dialog between students and critics.

# CHAPTER VII

# DISCUSSION: PARAMETERS, OPTIONS AND MAJOR CONSIDERATIONS

This chapter continues the discussion started in Chapter V which looked at how the educator in the human-computer interaction (HCI) class created a learning environment that supported critical design dialog. The learning environment considered in this chapter is the design studio—in particular, the design studio that was the setting for the study in the previous chapter. The same set of parameters developed in Chapter V is used here to examine the choices the educator made in creating this learning environment. Using the same set of parameters facilitates comparing the two class settings. For each parameter, the choice made in the design studio is discussed and compared to the HCI class when interesting differences occur. Comparing the two settings provides a starting point for thinking about these parameters more generally. Therefore, some more options and some things the educator should consider in choosing between them are also discussed.

## Introduction

This chapter continues the discussion started in Chapter V (*Discussion: Creating a Learning Environment for Critical Design Dialog*) which looked at how the educator in the human-computer interaction (HCI) class created a learning environment that supported critical design dialog (CDD). The learning environment considered in this chapter is the design studio—in particular, the design studio that was the setting for the study in the previous chapter (Chapter VI). An interesting difference between the two class settings is that in the architecture studio, CDD is already an established practice. The educator can rely on the traditions of the studio to guide the decisions she makes. She does not need to consider each parameter individually because having a typical “pin-up” or a “jury review” already implies a certain set of choices. Relying on these traditions, however, has drawbacks as well as benefits. The benefit is that it is a familiar and well-understood event for most of the people involved, which means that they know what to expect and how to participate. On the other hand, critics of studio pedagogy point out that poor aspects of the studio are perpetuated along with the good when familiar practices are simply repeated (e.g. [Anthony, 1991], [Dutton, 1991]). They suggest that educators reevaluate studio traditions, and they present a variety of ways in which they could be improved.

The same set of parameters developed in Chapter V is used here to examine the choices the educator made in creating this learning environment. Using the same set of parameters facilitates comparing the two class settings. For each parameter, the choice made in the design studio is discussed and compared to the HCI class when interesting differences occur. Comparing the two settings provides a starting point for thinking about these parameters more generally. Therefore, some more options and some things the educator should consider in choosing between them are also discussed. A table summarizing the choice made in the architecture study, some other options, and the major considerations accompanies each discussion.

There are two considerations, however, that underlie virtually every decision: the educators' learning goals and the resources available, with time being one of the most precious. It would be wonderful if a class could cover every facet of a domain, but this is an impossible goal. Educators therefore must prioritize their learning goals. The priority given to different goals is an important factor in making decisions regarding CDD. Unfortunately, the range of learning goals is limitless and their priority is highly dependent on the particular context, so it is difficult to make very specific recommendations. Where possible, the different choices that might support different learning goals are discussed. The other pervasive factor in planning for virtually all classroom activity is time. CDD and design projects in general are time-intensive. The amount of time the class has available and the amount of time the educator is willing to dedicate to CDD will influence many of the decisions that are made.

As with the previous discussion, this chapter represents my understanding of how this learning environment was created. These insights are a result of my attending numerous design reviews and working with different educators in architecture over the course of several years. My personal experiences are supplemented with information from other researchers in design education.

## Choices about the Projects

This section presents the six project-related parameters that educators need to consider when using CDD. The choice made in the architecture studio is discussed first, followed by a more general discussion of that parameter.

### Project Groups

Students worked individually on their projects, which is typical in an architectural design studio. Even though students work side-by-side and may help each other informally, each is ultimately responsible for his/her own design. This is made possible by keeping studio classes small (around 15 students), which requires a large number of instructors to maintain this ratio. More than other disciplines, the design fields recognize that knowledge and skills are something that each student must develop within themselves, not something they can be told or shown. Therefore, the goal of the design project is not just to produce a solution, but to develop one's own way of working and to learn to evaluate one's own ideas. An advantage to working alone is that the student does not have to compromise with teammates who may have differing ideas and work ethics. On the other hand, individual work can be frustrating and intimidating. It involves making a significant intellectual and emotional commitment to an idea, and then accepting the praise or criticism it generates.

Educators should consider using project teams in several situations. When there are a large number of students in the class, having students work in teams reduces the number of projects that need to be discussed, making CDD more feasible. It may also be useful for

**Table 7-1. Project Groups**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| students worked individually | • individual projects<br>• team projects<br>• combination of team and individual work | • student to instructor ratio<br>• complexity of project<br>• importance of developing individual competencies<br>• mix of students' back-grounds & skills |

students to work in teams when projects are complex or require a mix of backgrounds and skills. However, if it is important that each student develop individual competencies, having students work independently might better accomplish this. When there is a combination of these factors, a combination of teamwork and individual work may be useful. Students might individually research a problem and then combine their efforts in developing a design. Or, they might each propose an initial design and then form groups to develop a few ideas further.

## Having Clients

In this architecture studio, students did not work with clients. Instead, the project was developed by the instructors and course coordinator. This choice was likely both pedagogical and practical. The pedagogical goals of this project were not about solving the needs of clients, but about learning new ways of seeing and representing. Both of the major elements of the project, the "picnic" and "Piedmont Park", were familiar and accessible to students but were more complex than they first appeared. Instead of learning about a brand new situation that they needed to understand, students had to learn to see a familiar situation in a new way—an important skill for designers. The project also allowed investigation at a variety of scales (e.g. a picnic basket vs. a picnic pavilion), which the educators felt was important because of the mix of majors taking the course. Although there was no client, students did have to observe people picnicking and using the park, introducing an element of authenticity to the project. In their designs, students had to address the practical needs of the situation in addition to working with more abstract ideas.

**Table 7-2. Having Clients**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| no clients, but students did have to observe the proposed site and potential users | • use clients<br>• do not use clients<br>• used for proposing projects only<br>• all students work with a single client | • availability<br>• accessibility<br>• appropriateness of pro-posed projects<br>• way to mediate expecta-tions & requirements<br>• need for authenticity |

Real problems, the kinds proposed by clients, are complex. Interacting with clients is also complex, and introduces a new set of communication and coordination issues into the design problem. Educators may need to play a role in this process, helping mediate the interaction between students and clients to set reasonable expectations and goals. Therefore, it is important for educators to consider whether this added complexity enhances or interferes with the main learning goals of the class. In addition, educators need to consider whether or not there are clients available who have appropriate projects and how accessible they will be to students. The main attraction to having clients, of course, is that they bring an air of authenticity to the projects. Students may be motivated by knowing that they are working on “real” problems of interest to other people. Clients also bring a rich context to a problem that students must learn about and take into account in their solution. One way to maintain the benefits of having clients without the drawbacks might be to have the educator work with a single client to develop a project that is realistic but simplified. Instead of having students interacting with clients on their own, the client might visit the class, join an electronic discussion, or provide other information through the educator.

## Commonality Among Projects

Another interesting feature of the design studio is that students work on projects that have a great deal in common. In the architecture class, all students worked from the same starting point, which provided certain benefits—especially in the early stages. For the research phase, students were studying Piedmont Park: photographing different parts of it, making drawings, etc. They were also developing different ways of looking at picnics and examining different details of picnic scenarios. For example, one student sketched the positions of people during a romantic picnic. Another represented the sensory experiences of different picnic participants: an adult, a child, a pet, and an ant. The instructor and critic used some of the early in-person pin-ups to draw together these diverse activities in a way that benefited all the students. They led the students in comparing and contrasting what each had done, illustrating the way certain kinds of investigations revealed different things than others and how different representations communicated ideas differently. As the discussion progressed, they verbally wove these different ideas together into a more complex and multilayered understanding of the picnic, the park, and the process of design. All of the students could benefit from each other's work because it enabled them to develop a richer understanding of the problem as they began to create their designs. In later phases, the projects diverged as students chose different issues and sites within the park on which to focus.

**Table 7-3. Commonality Among Projects**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| all projects had the same starting point but became differentiated after research phase | range from identical to completely distinct<br><br>Examples:<br>• same starting point<br>• same domain<br>• some related projects<br>• interconnected projects | • learning goal of depth or breadth<br>• desire to accommodate interests of students<br>• ability to manage diverse projects<br>• need for common ground for discussion |

Educators might choose to have more diverse projects when they want students to encounter a wide range of issues, for example in a survey or introductory course. In contrast, having students all work on the same project may afford exploring fewer issues but in more depth. Another consideration is to what degree the educator wants to accommodate the interests of students. Allowing students to choose their own projects will likely lead to a wide range. The educator may also want to consider his/her own ability to manage a diverse set of projects. The more diverse the set of projects, the wider the range of knowledge and resources the class will need.

**Length of Project**

The main project in the architecture study lasted six weeks with 12 hours per week of scheduled studio time (although students did not always work during scheduled hours). Before this project, students had worked on a 2-week and 3-week project. As students become more experienced, it is typical for them to undertake longer and more complex projects.

**Table 7-4. Length of Project**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| six weeks of focused work; 12 hours per week of scheduled studio time | range from a few days to a full-term or more | • need to iterate<br>• time available<br>• student courseload<br>• complexity of project<br>• scope of project |

An important part of learning through design is iteration—the ability to try something, evaluate it, learn more about it, and try again. It is important to make sure that the length of a project allows some time for iteration. The length of a project will, of course, be limited by the length of the class (e.g. a semester). The length of time available then dictates other parameters of the project. For example, a longer project can generally be more complex and broader in scope than a shorter project. As important as the number of weeks spent, however, is the actual amount of time students are expected to work on the project. In architecture, the studio project is the centerpiece of the curriculum, and students are expected to devote substantial time to it each week. In other disciplines, the project may be one of many the student works on during the semester.

## Process Scope

The architecture class started with a very abstract goal (see the project documents in the Appendix on page 272). The instructor for this studio then interpreted this goal into a set of phases and more specific activities for students to undertake. Students ended with a set of drawings, images, and models that demonstrated their process and the "intervention" they created.

**Table 7-5. Process Scope**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| from design brief through conceptual drawings and models | Starting points:<br>• find own project<br>• design brief<br>• detailed specification<br>Ending points:<br>• concept<br>• detailed design<br>• prototype<br>• evaluation/testing<br>• implementation | • time available<br>• desire to accommodate students' interests<br>• students' background and skills<br>• evaluation of design |

As with most of the parameters educators need to consider, the time available for the project is a factor; more time available can allow for a longer process. Less obvious considerations are how students' interests and skills related to the project scope. Having students seek out projects that they find interesting requires that they spend more time spent finding and defining the project. At the other end of the process, modeling, prototyping, and implementation will require additional learning for students who do not already have the necessary skills. The benefit though, is that actually trying to instantiate a design can be an important way to learn more about its strengths and weaknesses.

**Project Scope**

The pedagogical goals of the architecture project were to have students work with particular concepts and develop certain skills. Part of the rationale for choosing this picnic project, for having all of the students working on from the same starting point, and for limiting it in certain ways, was because it is part of a long educational sequence—the first of many projects students would undertake. It is not necessary to experience a wide variety of projects in a single semester during freshman year. Instead, design skills are developed and a depth of understanding is achieved by working on many projects over the whole degree program. In the HCI class, the situation was quite different. Many of the students in the class were juniors and seniors, and this would be their only exposure to issues in design and HCI. Here, the goal is not necessarily to develop skilled designers, but instead to sensitize students to the idea of user-centered design. Exposing students to a wide variety of projects that are broad in scope might be one way to achieve this.

There are several different ways to think about project scope and the ways to limit or expand it. Projects may be limited to a single component (e.g. a chair or a scrollbar) or they may deal with a system (e.g. an apartment complex or the use of a kiosk in a department store). Projects may involve designing something from scratch (original), improving upon something that already exists (re-design), or creating an original design

**Table 7-6. Project Scope**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| focused on particular concepts and skills; examples of both original and re-design | • narrow - component level<br>• broad - system level<br><br>• original<br>• re-design<br>• configuration/parameter-ization<br><br>• emulate practice<br>• learn particular skill/con-cept | • time available<br>• appropriateness for domain<br>• skill levels of students |

from a fixed set of components (configuration). Another way to define the project scope is to consider whether the project is designed to emulate practice or to focus on certain topics and skills. Educators should to take into account that more experienced students may be able to handle broader and more open-ended projects with less guidance than novice students. Educators may also find that some types of problems are more typical or appropriate for different domains.

## Choices about the Critical Design Dialog

This section presents the eleven dialog-related parameters that educators need to make choices about when using CDD. Closely related parameters are grouped and discussed together. For each parameter or group of parameters, the choice(s) made in the architecture study is discussed, followed by a more general discussion.

## Scheduling

### Number, Frequency, and Timing; Length of Sessions

In the architecture class, the reviews were more frequent and lasted longer than in the HCI class. They were scheduled evenly throughout the project duration, and the phases of the project were coordinated with the review schedule—each phase ended with a review. The reviews could be more frequent because students were expected to devote a large amount of time to working on their projects each week, much more than in the HCI class. They could last longer because they were scheduled during studio hours, which were already 3 hour time slots. Having sessions this long may not be beneficial from a learning perspective, as this is a very long time for anyone to pay attention. On the other hand, reviewing all the projects at once might have facilitated comparison between them and the building of a common understanding. A benefit to the long sessions was that the review could be completed in a single day instead of consuming a whole week of class time, as in the HCI class.

Since one of the premises behind CDD is that students need guidance while they are working on their design projects, scheduling sessions periodically throughout the length of the project is a reasonable strategy. Make them too frequent and students may spend too much time preparing for the discussions instead of making progress on their design. The danger of having them too far apart is that projects may stray off course without any supervision. The pace at which the projects proceed should also be taken into account, with faster paced projects allowing for more frequent discussions. The studio model of CDD suggests that sessions will always be long because time is needed to

**Table 7-7. Number, Frequency, and Timing; Length of Sessions**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| four reviews were scheduled, spread throughout the project duration plus one final jury review; the two online and two in-person reviews were scheduled in alternating weeks | combinations are unlimited, for example:<br>• spaced evenly throughout project duration<br>• once per design phase<br>• once per week; teams take turns presenting | • duration of project<br>• pace of progress on projects |
| 2 or more hours | options are unlimited but will probably be constrained by logistical factors | • number of projects to discuss<br>• number and frequency of sessions<br>• length of class periods<br>• availability of critics<br>• availability of location<br>• complexity of projects |

discuss each project. Another option that may fit more easily into some classes is to not have every project presented every time. For example, some small number of teams may present their projects each week, rotating through the teams so that each gets several opportunities for feedback.

Location

Many architecture schools, including Georgia Tech’s, have specialized areas for conducting CDD sessions. They allow work to be easily attached to the walls so that participants can gather around it during the discussion. They also tend to be fairly open, so that passers-by can stop and observe the discussion if they find it interesting. Most of the pin-ups and the final jury review for this class were held in these areas. One was held in in a more private classroom so that I could record the session more easily.

**Table 7-8. Location**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| reviews took place in special pin-up areas (although one was in a classroom with a pin-up wall) | • regular classroom<br>• specialized pin-up area<br>• any open space (e.g. hall-way, common area, large conference room) | • availability<br>• ease of gathering around design artifacts<br>• changing normal class-room dynamic |

Using a specialized area, or any open area where students can move around freely, makes the logistics of CDD much easier. When possible, educators should choose locations that allow participants to comfortably interact with one another. They should also be able to easily examine the artifacts being presented. For students who are not familiar with CDD, the educator might consider using a location outside the normal classroom to foster a different dynamic and encourage students to interact with one another.

## Procedure

### Project Preview

Most of the jurors that participated in these design reviews were other instructors and professors in the College of Architecture. Therefore, they were already familiar with the general project and needed only to be introduced to the activities of that particular studio. The instructor provided this introduction at the beginning of the session. In some cases, jurors are provided with some background information before the session begins; in other cases they are not. If not, the educator may introduce the goals and methods of the studio before the first students' work is discussed.

**Table 7-9. Project Preview**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| no previews of projects, but jurors were given background information on the assignment and process students had used | • no previews<br>• background information available to jurors in advance<br>• project descriptions available in advance<br>• jurors view project materials individually at the beginning of the session<br>• jurors interact informally with students before session | • length of session<br>• number of projects<br>• familiarity of jurors with projects and subject matter |

Including some form of project preview may be especially worthwhile when time is short or when jurors are unfamiliar with the projects. It may allow the discussion to move more quickly to important issues, because less time has to be spent up front explaining each project. It may also allow jurors to do some advanced preparation for the session: coming up with questions, making preliminary comparisons between projects, and looking for common themes. One way to provide a preview would be to distribute background information about the class or assignments to jurors in advance. Alternatively, they could also be given descriptions of each project. Even if given these materials, jurors may not have time to read them in advance, so another option would be to have an in-person preview at the beginning of the session. Jurors might have a few minutes to review students' posters or interact with them informally before the discussion begins.

Full-class Sessions

All of the CDD sessions in this studio were held as full-class discussion, as is typical. The idea behind this practice is that students can benefit from hearing jurors discuss all the projects, not just their own.

**Table 7-10. Full-class Session**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| all reviews were held as full-class discussions, meaning that all participants focused on the same project at the same time | • full-class sessions<br>• small group discussion<br>• combination of small group and full-class discussion<br>• "poster session" - participants move independently forming spontaneous groups | • number of projects, students and critics<br>• time available<br>• goal of building shared understanding or individual feedback |

It is especially important to include some amount of full-class discussion if the goal is to have students learning from one another and building common concepts. It is also an important opportunity for the educator to model the use of language and ways of thinking that students are expected to adopt. With large classes and limited time it may not be possible to discuss every project in a full-class session. Instead, educators might have projects discussed simultaneously in small groups, perhaps with one juror in each group. At the end of the session, the full class could come together to share the insights from each group. Another option would be use a poster session format, where jurors and students view the projects at their own pace, forming spontaneous discussion groups. Again, insights might be shared by ending with a short full-class discussion.

Amount of Educator Participation

In neither the architecture class nor the HCI class did the educators participate a large amount in the discussions. The reasons were somewhat different, however. In the HCI class, the educator wanted the students to be interacting with one another in the pin-ups, so she purposely limited her own participation. In this case she was acting more as a guide to the conversation among the students rather than as a full participant. During the jury review, she mainly played the role of host, allowing jurors to set the direction of the discussion. In the architecture class, the educator met weekly with each of the students, so she had plenty of opportunities to give them feedback. The goal of the CDD sessions was to let them get feedback from other sources.

**Table 7-11. Amount of Educator Participation**

| **In Architecture study** | **Some Options** | **Major Considerations** |
|---|---|---|
| the instructor did not participate in the discussion a large amount, but it was mainly to allow the critics to speak, not the students | • none/minimal<br>• educator as host<br>• educator as guide<br>• educator as critic | • presence of other participants<br>• need for guidance<br>• other opportunities for educator feedback |

When deciding how much to participate in a discussion, educators need to first assess how much guidance students need. Participants who are unsure about CDD may need more guidance as to what are appropriate topics. Also, if the educator has certain goals in mind for the dialog he/she may need to help guide the discussion in those directions. The educator should be wary about participating too much, however.

Participants who are hesitant about speaking in class will gladly let the educator do most of the talking. In addition, one of the reasons for using CDD is to encourage a variety of viewpoints to be brought to the discussion. This means that it will almost surely go in directions that the educator had not anticipated but which should still be explored.

Source of Questions; Using Jurors

The more formalized design reviews in the architecture studio (i.e. midterm and final) followed the tradition of using jurors and allowing them to direct the discussion. There was a time when jury reviews were closed to students [Anthony, 1991]. Jurors reviewed projects in private and students received simply a grade with little additional feedback. At some point, jury reviews were opened, perhaps because it was thought that students would benefit from observing jurors discuss their projects. It is tempting to criticize the design studio as putting students in a passive role, because they are mainly expected to listen as the jurors comment during a review. But unlike other educational traditions where students are supposedly “absorbing” the material throughout the course and then “performing/producing” at the end to demonstrate their knowledge (e.g. a final exam or term paper), the design studio has it reversed. Students are constantly producing throughout the term, and the reviews are the time for them to get feedback and reflect on what they have done.

Students also spend a great deal time together in the studio. They have plenty of opportunity to discuss projects together and to see what others are doing. The HCI students, in contrast, rarely knew what the other teams were doing until they presented their projects in class. Reviews with external critics have the specific purpose of having students hear what the critics have to say. It is an opportunity for them to share their ideas, opinions, expertise, and knowledge with the students. That is not to say that students should not also be participants in the discussion—they certainly should.

**Table 7-12. Source of Questions; Using Jurors**

| In Architecture study | Some Options | Major Considerations |
|---|---|---|
| the jurors and instructor were the main source of questions in all of the reviews | • jurors<br>• instructor<br>• other students<br>• presenter of project | • phase of design<br>• participants<br>• goal of session to broaden viewpoint or focus on certain topics<br>• other opportunities for peer discussion |
| all reviews had some external visitor; the last one was a more formalized jury review | • none<br>• use jurors for some discussions and not others<br>• use jurors for part of discussion<br>• always have jurors | • goal to bring in new viewpoints or focus on student concerns<br>• level of formality desired<br>• availability |

It is notable that every CDD session in the architecture course involved some sort of external critic. One of the premises of design education is that the quality of a design and what students learn from it is directly related to the extent to which the problem is explored [Schön, 1987]. The external critic is very important in studio education because he/she brings an objective distance to a project that the student (and also the instructor) has a very intimate relationship with. Discussions with external critics are a way to continually expand the problem space by introducing new ideas and interpretations that help students see their projects with a fresh view. In the HCI class, students could act as external critics for one another because they were often working on very different projects, giving them a similar sort of distance. Of course, students do not have the depth of knowledge and experience of a more senior critic, but they do have their experiences and their own projects to draw from. Although their projects may be quite different, it can be useful to search for the parallels between them. When students act as critics for one another, they can learn not only by getting feedback, but by giving it as well.

Order of Presentations

In the early phases of this architecture studio, students were all working on similar projects, so there was no obvious ordering for presentations. Students chose their own locations on the pin-up boards and as a result, the order in which they were discussed, since the group worked its way along the board sequentially. Students who were well-prepared and happy with their work were more willing to present it, so they tended to make the earlier presentations. Earlier presentations, however, also tended to have the longest discussions. Whether this was because of time management issues, because participants were getting tired by the end, or because topics were becoming redundant, it is hard to say. However, the result was that the longer a student could avoid presenting his/her work, the shorter the resulting discussion was likely to be.

Educators should order presentations to facilitate comparison between them when possible. They should also encourage reluctant presenters to go early and not wait until the end of the session when they are likely to get less feedback. Finally, when sessions span

**Table 7-13. Order of Presentations**

| **In Architecture study** | **Some Options** | **Major Considerations** |
|---|---|---|
| in most reviews, students chose their own order or were chosen by the instructor; in the final jury review, projects were roughly grouped by theme | • let students choose<br>• random<br>• grouped by theme or relationship | • relationships between projects or useful comparisons<br>• encourage reluctant presenters<br>• fairness |

multiple days or when only a few teams present at a time, the educator should make sure that projects take turns going first or last in the discussion since the tendency is to run out of time.

## <u>Presentations</u>

### <u>Amount of Guidance; Use of Representations</u>

One goal for the first-year architecture students was to introduce them to the rituals and language of the field, part of which is using standard representations to communicate their designs. As mentioned before, standard representations provide another language that practitioners in the same domain can use to communicate their ideas to one another. It is worthwhile for students to spend the time to learn these representations, because this is only the beginning of a much longer educational sequence for most of them. Students are not only using CDD as a way to learn from their designing, it is one way they learn to use the language (verbal and visual) of the field they are training to join.

Educators should use standard representations when it is important for students to learn them or when they can facilitate discussion. If students do not understand the use of the representations and their utility, then creating them becomes merely an exercise and

**Table 7-14. Amount of Guidance; Use of Representations**

| **In Architecture study** | **Some Options** | **Major Considerations** |
|---|---|---|
| the instructor worked closely with students on their projects, talking individually with each student at least once per week; she gave guidelines for what should be in presentations | can range from close guidance, describing in detail what should be presented and helping students prepare materials, to very little guidance, describing only the high-level goals for the presentation | • skill levels of students; need for guidance<br>• desire for uniform presentations<br>• goal of making sure presentations cover important topics vs. letting students struggle with decisions |
| early representations, especially of research/investigations, were idiosyncratic and varied between projects; standard representations and models were used for later presentations | • students develop their own representations<br>• use standard representations<br>• use a combination<br>• have students experiment with individual representations before introducing standards | • importance of learning to use and create standard representations<br>• utility of standards for academic projects<br>• goal of learning standards vs. thinking about how to represent information |

not a useful exploration of the design. If the learning goal is to think about representation itself, then having students create their own representations might be a useful activity. Other studies have shown that idiosyncratic representations created by students can also be a basis for understanding the affordances of standard representations (e.g. [diSessa, 2000]).

## Summary

This chapter discussed more generally the choices to be made when creating a learning environment for CDD, some of the options available to educators, and some of the major considerations for making these decisions. The discussion was based on examining the choices that were made in the architecture study, many of which were typical of design studio traditions. Comparing the choices made in the two class settings, HCI and architecture, demonstrates more clearly how different choices lead to different outcomes and why educators make different choices under different circumstances.

# CHAPTER VIII

# CONCLUSION

The goal of this research was to understand how to support critical design dialog among peers and experts in different learning environments. Critical design dialog (CDD) is a pedagogical technique aimed at helping students learn through their design activities by discussing them with others. Research from several different fields provides evidence that dialog can be a useful pedagogical technique in general. For example, dialog can be a way for both educators and students to identify and repair misconceptions in their knowledge. During dialog, educators can demonstrate their thought processes for students to understand and emulate. It is a particularly appropriate technique for students working on design projects. Because design projects often develop in unexpected ways, critical design dialog provides a way for educators to monitor and guide students' design processes. It also provides students with the opportunity to articulate what they are doing and why—a process necessary to turn their activities into learning.

Traditional design education, in fields such as architecture and industrial design, has used CDD as an integral part of their educational process for most of their history. These fields are organized around a curriculum of learning-by-doing. They recognize the importance of dialog in helping students learn from the projects they undertake and have embodied this idea in the tradition of the design studio. More recently, design projects are being used in other fields, sometimes to more explicitly address the design aspect of the field (as in engineering and human-computer interaction), and other times to contextualize and motivate learning of other subjects (for example, in math and science). In some cases, educators who are teaching in these fields model the learning environments they create after the design studio. However, little research has been done to guide educators in creating learning environments that use CDD, especially ones that differ from the design studio in important ways. This research has been aimed at helping educators navigate this process and makes the following contributions:

- An articulation of some of the choices to be made when using critical design dialog and a rationale for making those choices.
- A demonstration of the viability and benefit to using critical design dialog outside traditional studio settings.
- A description of critical design dialog as it occurs in a real classroom.
- An example of how technology can be used to support critical design dialog and an analysis of its design and use.

## Supporting Critical Design Dialog

To support an activity requires two things. First, it requires understanding the goals participants have, the tasks they must undertake, and the needs they have in completing those tasks and reaching those goals. Second, it requires finding ways to make those tasks easier and make sure needs get met, especially those that are the most critical or most difficult for the participants. This research has shown that it is important to support four things for CDD:

**Clear communication of the design idea.** If participants do not understand what the design is or what problem it was intended to solve, then the subsequent dialog has limited usefulness. Results from this research showed that participants spent a great deal of time and effort on this task in all the CDD sessions. Because time was limited, this meant that there was less time to discuss other topics, such as the strengths and weaknesses of the design. The issue was especially obvious in the HCI class when jurors were being introduced to the projects during the discussion. Some ways to support clear communication of the design idea are:

- Include a *clarification phase*, where participants can ask questions to clear up any confusion and fill in gaps in their understanding. This phase may occur without prompting, as it did in most of the in-person CDD sessions, but it may need to be specifically included in online environments.
- Use *common representations* when they exist. Especially where interaction among the participants is limited, using common representations may be a way to help them communicate their design more clearly. Common representations support communication because they provide a standardized language for talking about important parts of the domain.
- Provide a way for participants to *preview projects* in advance. If participants are already somewhat familiar with the projects before the session begins, less time needs to be spent explaining them. Additionally, the dialog may benefit

from participants having had some time to think about the projects and formulate questions before the session. An online environment might be used to allow critics to preview the projects and leave questions for students which get discussed further during the in-person review.

- Have *several sessions* with the same participants. As with the project preview, having participants who are already familiar with the projects requires less time spent explaining them during the session. Being able to see how the project develops and incorporates ideas from previous sessions may also enable a different kind of dialog.

**A balance of diversity and commonality in student projects.** When students' projects are extremely diverse, it may be difficult for them to understand how their own experiences might be useful lessons for someone else. Additionally, without some common ground and appreciation for the problems other teams are facing, it seems difficult for them to make reasonable comments and suggestions for each other. On the other hand, when there is not some sort of diversity—if they all come to the same solution or conclusion—there is nothing to discuss. Both of the classes used in this research achieved this balance, but through different means. Additionally, the combination of diversity and commonality stimulated discussion. Educators prompted students to consider how two projects were different or what new ideas a project brought to the discussion. Students in the HCI class also made spontaneous comparisons, offering suggestions based on how their team had handled a "similar" problem. Some ways to balance the diversity and commonality are:

- Exploring a *range of solutions* to the same problem. Design problems almost by definition afford a wide range of solutions. In this scenario, students can share resources and have a great deal of common knowledge about the problem. Diversity is provided by the different solutions that students propose.
- Exploring a *range of problems or interpretations*. Students need not all work on the exact same problem. They may be given a more general situation that they are required to interpret or in which they find their own problem. Alternatively, they may work on problems that are only related to a very general theme, such as “mobile computing”. In this scenario, projects will have both a common and unique component. Students may need help finding the commonalities in projects with little obvious connection.
- Involve a *range of participants*. Even for a single design, every participant in the dialog brings a unique perspective. Inviting participants with varied backgrounds and experiences—novices, experts, professionals, academics, theoreticians, builders, colleagues, visitors—is a way to bring diversity to the dialog around one particular design.

**Publicness of the dialog.** Having CDD take place in a public forum is important for several reasons. One reason is that it allows the class to share their experiences and knowledge with one another. For example, in the architecture class students shared their research and ideas to build up a more complex and elaborated concept of a picnic. Publicness is also important because it gives the educator a chance to direct the attention of the class to certain issues, to model ways of thinking and speaking in the domain, to help students reflect on larger, more conceptual issues, and to monitor the progress teams are making. This research showed evidence of all of these occurring during CDD. Finally, public dialog allows participants to play a variety of roles: presenting work, answering questions, asking questions, observing the interaction between the educator and other students, listening to discussion among critics, etc. These roles place a wide range of demands on students, but also provide a wide array of opportunities for learning. Some ways to support publicness are:

- Use *full-class* discussion, even if only for a portion of the session. This technique was used in both of the classes in this research. It is also extremely common in other projects where students are learning through design.
- Use an *open online communication forum*. The CoWeb used in this research allowed all the participants to read each other's comments, which students and critics both reported doing. The publicness of the comments was further emphasized by the educator reviewing the comments in a full-class debriefing. In a closed communication system, such as email, participants cannot benefit from discussions they are not directly involved in, nor can the educator monitor and influence the discussion.

**The role of the educator in mediating and guiding the dialog.** One of the features of CDD is that the educator is not the main focus of the dialog—it often occurs between students or among students and critics. The educator, however, still plays an important and unique role in mediating and guiding the dialog and the rest of the class activities. This research has documented several aspects of this role:

- Maintaining a *focus on learning*. Students can get caught up in the low-level details solving the design problem. It is the role of the educator to help students step back and reflect on what they are learning from the process. He/she should show how the students' activities connect to the subject matter of the class.
- Mediating the dialog *between critics and students.* The educator is knowledgeable about students' projects and, to some extent, about critics' expectations. It is his/her role to put the students' work in a context for the critics and help them understand the pedagogical goals of the project, the methods the class used, the expected outcome of the projects, and the evaluation criteria by which projects should be judged. Additionally, the educator may aid communication between between critics and students during the dialog by offering explanations and suggestions.
- Mediating *clients' expectations*. In projects that use clients, the educator may need to work with clients and students to help set reasonable expectations for the project. Clients may have only a limited knowledge of the goals of the class and the capabilities of the students. Likewise, students may be too eager to meet clients' requests or too inexperienced to judge whether or not they are reasonable. The educator is in the best position to help the two set reasonable expectations, making sure that project requirements and constraints are not in conflict with learning goals.

Unlike the first three factors, this research does not offer any specific suggestions on ways to support the educators' role in CDD. Identifying these multiple roles, however, is a first step toward helping educators become aware of them and their importance in CDD.

This research has provided evidence that each of these four factors is important in creating a learning environment that supports CDD. The next section considers the use of technology in supporting CDD, both in the specific use studied in this research and its potential more generally.

## Using Technology to Support CDD

It makes almost no sense to talk about technology in the general sense—as if technology were a single thing with a single set of properties. Technology can refer to a wide range of thing: from conference calls, to video phones, to web pages, to overhead projectors, to 3-D virtual environments. All of these have different affordances for supporting critical design dialog. The way to understand how technology can support CDD is to understand the tasks and needs of participants during CDD—for example, the four identified above—and then to think about how any proposed technology supports these tasks. This section discusses the advantages and challenges in using technology for CDD.

### Advantages to Using Technology

The Student-Curated Galleries study showed that a CoWeb used in this way could be successful in allowing remote critics to participate in design reviews. There were several advantages that this technology provided over a traditional in-person review. The main advantage was that it allowed critics to participate in the dialog who otherwise might not be able to because of time and distance limitations. It also created a record of the critics' comments that students could carefully review and refer to as needed. The fact that the critics' comments were well received by the students—that they did not interpret the comments as overly negative or the activity as very stressful (common reactions to in-person reviews)—suggests that the asynchronous, written format might have been beneficial. Perhaps by allowing both students and critics more time to reflect on and react to each other's responses, the review was made less confrontational.

Beyond what the CoWeb offered, other kinds of technology have the potential to support CDD in other ways. One way would be to more actively scaffold the dialog. The technology could provide guidance to students as they prepared their presentations, helping them focus on important issues and giving them ways to judge whether their presentation communicated their ideas well. It might also guide participants during the dialog, suggesting topics to be discussed or questions to consider when viewing the projects. Finally, it might scaffold students after the dialog, helping them draw together the lessons they learned and refine their ideas. Several research projects are investigating this scaffolding role that technology could play in CDD and the challenges of making it work (e.g. [Kolodner & Nagel, 1999], [Conanan & Pinkard, 2001]). Presently, the responsibility for scaffolding these CDD activities usually falls to the educator, but providing the scaffolding through technology has several advantages. An educator can only work with one student or set of students at a time; technology can potentially be used by many students at the same time. Inexperienced educators may not know when or what kind of scaffolding to provide; while it helps the students, the technology might also act as a model for the educator, helping them develop their own scaffolding skills. Finally, an educator can usually only provide direct scaffolding for a limited amount of time, after which students must continue work on their own; technology can allow the scaffolding to be always available and tightly integrated with the students' work.

Technology might also allow more students to participate in CDD. Not every student gets a chance to participate during in-class discussions, especially when classes are large. Even when given the chance, some students are intimidated by speaking in front of the class. Other times, in-class discussion can be dominated by a few aggressive speakers. Using an online environment, especially an asynchronous one, can alleviate some of these problems. Students no longer have to vie for speaking time or worry about being put on the spot. Instead, every student has the opportunity to compose their thoughts and add them to the unfolding discussion. Other researchers have also reported this advantage to using technology for discussions (e.g. [Hsi & Hoadley, 1997]).

Another way in which technology might support CDD is by making new kinds of representations and new ways of interacting with them possible. Many representations are a "frozen" view of the design, but technology has the potential to allow representations to be manipulated and to keep a record of the changes made to them. For example, when reviewing a software prototype, critics could not only suggest changes, but actually make them and immediately examine the results. A record could be kept of each variation along with the original. This could support not only the exploration of different ideas but it might also make it easier to communicate the idea, by showing it rather than describing it. Technology can also allow representations to be connected to one another, known as having *multiple linked representations* [Kaput, 1989], [Kozma, et al., 1996]. This would allow representations to be used in a more integrated way during the dialog. For example, when a question is raised about a certain interface feature, the feature might be linked to the task model it supports, which in turn might be linked to the data from which the task model was derived. Linking the representations together allows the current issue to be investigated easily from multiple viewpoints. Linked representations might also allow changes to be automatically propagated between them. For example, a change made in a 3-D model of a building could be immediately reflected in other representations, showing how the change affects the floor plan or electrical plan. The technologies that allow representations to be manipulated and linked already exist in many cases, but it is still quite difficult to create, manipulate, share, and have a dialog around them. The major challenge is not in coming up with new technologies, but in finding ways to realize their full potential.

## Challenges in Using Technology

The Student-Curated Galleries also shed light on many of the challenges of using technology to support CDD. At its most basic, CDD is a process of communication. While the CoWeb helped overcome some communication issues (e.g. distance), it introduced others. For example, the CoWeb did not allow for the free flow of ideas found in in-person dialog. This was in part because of the way the CoWeb was used, allowing only a single iteration of comments by the critics. But, it may also be related to the slow-moving, asynchronous, written interaction that the CoWeb supports. Another way in which communication was hampered was that the representations—scans of drawings and photos of 3-D models—were inferior to those used in the in-person reviews in terms of the amount of detail they showed and the ways participants could interact with them. Human-to-human communication is a complex process involving not only words, but gestures, other objects, intonation, body language, etc. which is only partially supported by current technologies. Other means must be found to compensate where the technology is lacking in supporting communication.

Another challenge in using technology is integrating it into the class environment. The CoWeb was used not because it was the ideal environment for CDD, but in part because it was already integrated with the class. Students were familiar with the CoWeb and used it regularly for other class activities, so it was easy for them to use it for this additional activity. The fact that critics, students, and the educator could use the CoWeb with only their regular web browser was also important for integrating the technology with the CDD activity. It eliminated the technical and motivational obstacle of having to install special software to participate in the review.

Design learning requires a flexible pedagogy, which is an interesting challenge when using technology, which tends to be inflexible. The CoWeb itself is a very general and flexible technology, but customizing it for this particular activity removed some of its flexibility. This became problematic when the activity changed at the last minute in response to the educator's new understanding of the students' projects. Additionally, customizing the CoWeb required technical skill far beyond what was needed to use it, which meant that the educator herself could not make the changes needed. The dilemma in creating technology is one of specificity versus generality. The more customized the technology is to a task or situation, the more help it can provide and the simpler the interaction will be. The more general it is, however, the more successful it will be for a variety of tasks in a changing environment. The drawback is that it can not provide much support for any given task. This dilemma is sometimes addressed by allowing technology to be highly customizable, but in practice, customizations are beyond the skill or interest of many users. Given the flexibility inherent in the pedagogy of design learning, flexibility of the technology is an important property.

Finally, there are several challenges unique to asynchronous technologies. One is that participants need to schedule time to participate. Unlike an in-person review, where participants are “captive” for a certain period, an asynchronous review lacks a similar forcing function. Critics may instead be inclined to put off participation until the last minute because of other more pressing demands. Another challenge is that an asynchronous review takes longer than an in-person one. One of the advantages of using an asynchronous medium is that participants can contribute when it is convenient for them rather than at a fixed time. However, allowing an extended comment period means that students get feedback days after they post their work, rather than within hours. A counterintuitive way to address both of these issues might be to schedule a relatively brief comment period (2-3 days) during a time when critics are likely to be available (e.g. a weekend). If critics are likely to comment near the end of the period anyway, making it short will have little negative impact. It may actually benefit students, who will receive their feedback more quickly.

## **Future Work**

There are a variety of directions for future work on this topic. This research has primarily focused on CDD from the educator's perspective, but what are the perspectives of critics and students? How do they interpret their participation in CDD? What are they trying to achieve and how to they go about it? How do they interpret the educator's and each other's comments? The educator may be responsible for officially creating the learning environment, but the dialog that takes place is shaped by all of the participants. Understanding their points of view is important to interpreting what occurs during and as a result of CDD.

As mentioned previously, human communication is a complex and multifaceted process. This research has investigated only one aspect of communication, the *words* that participants used. How are other aspects of human communication (e.g. gestures, facial expression, intonation, etc.) used in CDD? What implications does this have for supporting CDD in other learning environments? Or with technology? How does using different modalities of communication affect CDD?

Along similar lines, what role does the physical environment and the media embedded within it play in shaping and supporting CDD? What features or properties are most important? How can they be incorporated into virtual environments or other technologies? In-person interaction has numerous properties that seem to support discussion: the ability to see many different things simultaneously; the ability to point at and manipulate objects; the ability for many people to view the same object at the same time; the ability to view large objects or images, etc. Research has not yet determined how the absence of these properties might affect CDD.

Representations are an important part of design. Not only are they tools to help the designer think about the problem, but they are also critical to communicating design ideas to others. How do different representations interact with the CDD that takes place around them? What features of these representations are most important during CDD?

## **Epilogue**

> [T]he teacher's part in the unfolding dialogue involves speaking with the student in such a way that the content (and the answer) of the discussion is not entirely determined in advance. Confirmation of the student as a person, the careful listening to what the student says (both verbally and non verbally), responses that take account of the legitimacy of the student's comments, and the continual respect of the student as a bearer of convictions and knowledge—even when these become the focus of the educational moment—are all essential to the openness and mutuality that characterizes dialogue. [Bowers & Flinders, 1990], p.191.

This quote serves as a reminder that the essence of dialog—openness and mutuality—is not a matter of choosing the right projects, scheduling the right number of sessions, or using a specialized room. These are important and can be useful in supporting dialog when good choices are made. Equally critical, however, is the stance that participants bring to the dialog.

# APPENDIX

## PROJECT DOCUMENTS FROM ARCHITECTURE STUDIO

***Georgia Institute of Technology / College of Architecture***
***COA 1012 / Fundamentals of Design and The Built Environment II / Spring 2000***

***THE PICNIC IN PIEDMONT PARK: PICNICSITE[S] SITESPICNIC[S]***

*"The smoker puts the last touch to his work*
*He seeks unity between himself and the landscape."*

*Andre Breton*

*"Truth cannot be out there – cannot exist independently of the human mind – because sentences cannot so exist, or be out there. The world is out there, but descriptions of the world are not. Only descriptions of the world can be true or false. The world on its own – unaided by the describing activities of human beings - cannot."*

*Richard Rorty*

***PROCESS***

*The point of departure was to investigate via re-descriptive diagramming, drawing and modeling the spatial parameters of the picnic[s] and site[s] within piedmont park, and how these parameters may inform each other as a set of relationships rather that a set of intrinsic elements. In other words, seeing the picnic not as a dialectical, an 'either/or' event, confined to the stasis of the picnic table, blanket and/or pavilion, but is more of an 'and' event that's oscillates between multiple programs, scales, sites, bodies and spaces.*

***PHASE I: Re-describing the Picnic through Mappings***

*This phase was to map the sequential and non sequential moves of the picnic [i.e. the interactions between the object[s] and the occupant[s] within the spatial parameters of the blanket[s] and/or table[s].*

***PHASE II: Re-describing the Site through Mappings***

*This phase was to map the qualities of the site[s] chosen in piedmont park. These qualities were primarily topographic and/or landscape contingent.*

***PHASE III: Interplays: picnicsite[s] sitespicnic[s]***

*This phase was to interplay the mappings of the picnic and site. How does the space of the site change with the picnic now grafted onto it and how does the space of the picnic change once the site is grafted onto the picnic. How do they begin to negotiate each other through a set of relationships rather that a set of isolated intrinsic elements?*

***PHASE IV: Spatialization of Interplays***

*This phase was to begin to spatializing the picnicsite[s] interplays via diagram modeling and drawing. Materially thinking, begin to construct the "spatial parameters" of the interplaying of the picnicsite[s] explored in the previous exercises.*

***PHASE V: Articulation of Picnic Intervention***

*This phase was to begin to articulate through detailed modeling and drawing the spatializations of the picnic interventions.*

***PHASE VI: Final Presentation***

*This phase was to construct final models, drawings and photo collages; as well as edit/curate process diagrams, models and drawings.*

***PHASE I: RE-DESCRIBING THE PICNIC THROUGH MAPPINGS***

***Images + Mappings***

*Collect images of the activities/objects of the "picnic". These should be 8 1/2" x 11" xeroxes, prints, and/or photographs.*

*Do hard-line mappings of the sequential moves of the picnic two dimensionally as well as three dimensionally on white trace trimmed @ 14" x20" in size.*

***Final "Play by Play" Mappings***

*With the images and mappings that you have gathered and drawn, compose a final drawing on 14"x20" water color paper. The drawing should be centered on the page and not exceed the dimensions of 8-1/2" in height and 14" in width.*

*Represent the **images** of the picnic through **mapping** to give one degree of abstraction or removal from the literalness of the images. This method of mapping will also graphically not out weigh the line drawing.*

*Think about the line weights and patterns, dashes, dots etc. as notational devices for your "play by play".*

***PHASE II: RE-DESCRIBING THE SITE[S] THROUGH MAPPINGS***

***Images + Mappings***

*Go to Piedmont Park, photograph it, sketch it, listen to it, smell it, SEE IT, and [re] describe it through your own abstractions and perceptions. Investigate different sites and the activities inflected upon it. Look at certain areas of concentration that interest you, perhaps the circulation patterns, the uses of the site and how they might transform through out the day, perhaps the topographical qualities of the site and how they vary quite drastically though out the park. Perhaps look at the lake or bridges, dilapidated structures, graffiti and how they might create different territories.*

*Do hard-line mappings of your site[s] two dimensionally as well as three dimensionally on white trace trimmed @ 14"x20" in size.*

*Hard-line mappings, site sketches and photographs are all to be included in the pin-up.*

***Final "Play by Play" Mappings***

*With the photographs and sketches that you have taken and drawn, compose a final drawing on 14"x20" water color paper. The drawing should be centered on the page and not exceed the dimensions of 8-1/2" in height and 14" in width. Represent the **images** of the site through **mappings** to give one degree of abstraction or removal from the literalness of the images. This method of mapping will also graphically not out weigh the line drawing.*

*Think about the line weights and patterns, dashes, dots etc. as notational devices for your "play by play".*

*Make sure the lightest lines are not too light…. Remember we will be scanning these drawings for the on-line galleries/reviews.*

***Required Pinup Material for Review:***

*Images, Sketches, Photographs, Tracings, all Process "stuff" that influenced the "play by plays".*

*Final "play by play" drawings on "picnic" and "site".*

*Two concise paragraphs typed that explain each of the "play by play" drawings, i.e. picnic version and site version.*

***PHASE III: INTERPLAY: picnicsite[s] / sitespicnic[s]***

***Thinking***

*Required reading: Excerpts from* ***InsideOutside: Between Architecture and Landscape***

*Attempt to situate your thoughts, processes and design approach through of the operations in the InsideOutside reading, i.e.* ***RECIPROCITY, MATERIALITY, THRESHOLD, INSERTION, INFRASTRUCTURE****. It may be only one of these operations and/or a hybrid of two or three.*

***Making***

*Using your [re]describing diagrams and mappings of the picnic and site as "underlays" begin to interplay the two. How does the site change with "picnic" now "grafted" on to it and how does the picnic change once the site is "grafted" onto the picnic? How do they begin to negotiate each other through a set of relationships rather than set of isolated intrinsic elements? The relationships being, but not limited to, program, space, ergonomics, site, user, material etc.*

***INTERPLAY Drawings***

*Same requirements as previous drawings.*

***INTERPLAY Diagram Models***

*Using xeroxs of your interplay drawings mounted on thin white board or paper begin to spatialize [via cutting, folding, collaging] the relationships that you are proposing.*

***PHASE IV: SPATIALIZATION OF INTERPLAYS***

***MODELS:***

***Topography Model:***

*Using the folding and faceting technique of 1 ply or “flimsy” chipboard or corrugated cardboard produce your site model. Estimate via pictures and/or measuring the site the approximate slopes and heights of the ground. Use straight wood dowels and/or bent wire to represent trees. Carve and or peel the surface to represent paths.*

***Diagram Models:***

*Through diagrammatic modeling one can begin to conceptualize and create the spatial and material effects you desire for your picnic intervention. Through spatializing the interplay of picnicsite[s] sitespicnic[s] explored in phases I-III produce three diagram models of your picnic intervention.*

***DRAWINGS:***

***Plan, Section, Elevation and Axonometric Studies:***

*Draw the plan, section, elevation and axonometric of your all of your models on trace: Remember do not exceed the scannable area “8.5 x 11”. Scale: 1/2” = 1’-0”*

***ON LINE REVIEW:***

***MONDAY 04.10.99***

*Prepare to take photographs of most recent models and scan most recent drawings and upload them over the weekend for the online review. You should provide some sort of text along with your material. I will get Colleen to stop by Friday to answer any questions you might have.*

***PHASE V: ARTICULATION OF PICNIC INTERVENTIONS***

*Keep working on refining your picnic interventions and how it is inserted into the site:*

*Do more diagram models @ 1/2" =1'-0" and/or smaller/larger depending on your design.*

*Continue drawing sections and plans, including the site @ 1/2" = 1'-0" and or smaller/larger depending on your design.*

***PROCESS + IN PROGRESS DRAWINGS:***

*Scan your picnic mappings, site mappings and most current section drawings and arrange them on one "canvas" in photoshop. Save this file, this is your "process + in-progress drawings" image. Write a corresponding piece of text that describes the drawings on the "canvas" and the ideas behind them.*

***PROCESS + DIAGRAM MODELS:***

*With the digital camera take pictures of process and in progress models and arrange them on one "canvas" in photoshop. Save this file, this is your "process + in-progress models" Write a corresponding piece of text that describes the drawings on the "canvas" and the ideas behind them.*
*We will be taking pictures of them today in studio.*

***GALLERIES:***

*WATER SCAPES*
*SLOPED SCAPES*
*FLAT SCAPES*
*WOODED SCAPES*

*Which gallery you choose to occupy is up to you, maybe you will occupy two.*

***NOTE:***

*Save scanned images @ 75 DPI and the photoshop files as "low quality" JPEG and the sizes of your images cannot exceed 400 x 400 points.*

*The work should be posted by 3 pm Monday 04.10.00 for the On line Review.*

***THE ONLINE REVIEW IS SCHEDULED FOR MONDAY 04.10.00***

*Over the weekend photograph your most recent model and scan your most recent drawing and upload them to your designated gallery space for review. Colleen will be coming in Friday to answer any questions so be prepared to ask.*

***PHASE VI: FINAL PRESENTATION***

***DRAWINGS: 6 TOTAL***

*OLD LINE DRAWINGS [TO BE CLEANED UP]*
*MAPPING OF PICNIC*
*MAPPING OF SITE*

*NEW LINE DRAWINGS: FIRST ON TRACE [FOR PRACTICE & CRITIQUE] AND THEN FINAL DRAWING ON WATERCOLOR PAPER.*

*SITE PLAN*
*PLAN @ 1/4" = 1'-0"*
*SECTIONS @ 1/4" = 1'-0"*
*SECTION DETAIL @ 3/4" = 1'-0"*

***COLLAGE: 1 MINIMUM 2 MAXIMUM***

*PHOTOCOLLAGE OF YOUR MODEL AT THE SITE PRODUCED IN PHOTOSHOP INCLUDE PEOPLE, PETS PROGRAM!!! SHOW HOW YOUR SPACE OPERATES AND PERFORMS!!! AND PRINTED IN COLOR ON 11 X 17 BOND.*

***MODEL: 1 TOTAL***

*@ **1/4" = 1'-0"***

***ALL** MODELS TO BE OUT OF **ONE** MATERIAL: CHIPBOARD**,** MUSEUM BOARD OR BASS WOOD. THIS INCLUDES THE SITE [LANDSCAPE] YOUR INTERVENTION AND THE TREES. REMEMBER THIS IS A **MODEL** OF SOMETHING THAT IS REAL, NOT A **REPLICA**, THUS WE MUST **ABSTRACT** AND NOT **SIMULATE**. SIMULATION CAN OCCUR VIA YOUR PHOTOSHOP COLLAGE.*

***PROCESS SKETCH MODELS / PROCESS SKETCHES***

*CHOOSE ALL SKETCH MODELS THAT ARTICULATES YOUR PROCESS AND YOUR INTERVENTION.*

*CHOOSE ALL PROCESS SKETCHES AND MAKE 2 11 X 17 XEROX COLLAGES THAT ARTICULATE YOUR PROCESS AND INTERVENTION.*

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# VITA

## COLLEEN MARY KEHOE

## Education

**Doctor of Philosophy**, Learning Sciences and Technology, December 2001

College of Computing, Georgia Institute of Technology, Atlanta, GA
Thesis: Supporting Critical Design Dialog
Advisor: Dr. Mark Guzdial
Minor: Information Design and Technology

**Master of Science**, Computer Science, 2000

College of Computing, Georgia Institute of Technology, Atlanta, GA

**Bachelor of Science**, Computer Science, with High Honors & Thesis, 1994

Stevens Institute of Technology, Hoboken, NJ
Thesis: Adding Application-Level Authentication Mechanisms
to Existing Applications
Advisors: Dr. Derek Morris (Stevens) & Dr. Chandra Kintala (AT&T Bell Labs)

## Research

**Supporting Critical Design Dialog**

Analyzed the use of critical design dialog (CDD) in two different learning environments. CDD is a pedagogical technique to help students learn through discussing their design projects with peers and experts. Methods included transcript analysis, examination of student-created artifacts, interviews, and surveys. Results shed light on the strengths and weaknesses of CDD and provide guidance for educators implementing CDD in their own classes.

**Publications:** Kehoe (2001); doctoral dissertation.

**Collaborative Online Studio (2CoOL/TresCoOL Studio)**

Member of the research team for CoOL Studio, a project which explored ways in which technology could expand students' opportunities for discussion about design and support a team of faculty and teaching assistants in managing a large class. It used a flexible and highly customizable online environment called a CoWeb (Collaborative Website) to implement a variety of activities. I worked with researchers, faculty and students to plan and implement many of the activities, customize the CoWeb environment, and study its use.

**Publications:** Kehoe (2002); Guzdial, Rick, & Kehoe (2001); Craig, et al. (2000).

**GVU's WWW User Surveys**

Member of the research team for GVU's WWW User Surveys, a series of ten surveys over the course of five years that documented the early growth of the web and pioneered the use of web-based surveys as a research tool. I participated in all aspects of the project including software development, questionnaire development, survey execution, analysis and presentation of results, advertising, fund-raising, and responding to media inquiries. The team was invited to present survey results at the 1997 Federal Trade Commission Workshop on Consumer Information Privacy, held in Washington, D.C. The project was also featured in the PBS series "Life on the Internet".

**Publications:** Pitkow & Kehoe (1995); Kehoe & Pitkow (1996a); Kehoe & Pitkow (1996b); Pitkow & Kehoe (1997).

**Cognitive Media Types**

Member of a research team that aimed to develop a mechanism for separating presentation from content in an educational multimedia environment. The team developed a formalism for organizing multimedia elements based on their cognitive role (e.g. definition, example) rather than their physical media type (e.g. text, audio). I developed a markup language (PML) in XML to instantiate the formalism and a generator to translate PML documents into HTML allowing the team to experiment with different presentations of the same underlying content.

**Publications:** Ram, et al. (1999).

**Algorithm Animations for Learning**

Member of a research team that investigated how expert learners used animations to learn about computer algorithms. I designed and conducted the pilot study which observed how expert learners used animations alone and in conjunction with other media to answer questions about a complex algorithm. Results showed that learners used the animations in unique ways only used them in answering certain kinds of questions.

**Publications:** Kehoe, Stasko, & Taylor (2001).

**Apprenticeship-Based Learning Environments**

Used log-file analysis to study how students were using STABLE, a case library of student projects designed using the principles of apprenticeship-based learning. Found that student use was strongly tied to assignment due dates and that students examined multiple cases in each session of use.

**Publications:** Guzdial & Kehoe (1998).

## Employment

**Georgia Institute of Technology, Atlanta, GA**

**Graduate Research Assistant**
- 2CoOL/TresCoOL Studio Project (8/99-5/01)
- Redesign of College of Computing Website (6/99-8/99)
- Cognitive Media Types (4/97-7/97)

**Graduate Teaching Assistant**
- CS6752: Qualitative Methods for HCI Research (3/99-6/99)
- CS6751: Human Computer Interaction (1/99-3/99)
- CS4753: Human Factors in Software Design (9/98-12/98)
- CS6751: Human Computer Interaction (6/98-8/98)
- CS2390: Modeling and Design (10/96-3/97)
- CS7100: Introduction to Graduate Studies (10/96-12/96)

TA responsibilities: developing and grading assignments, projects, exams; maintaining class website; assisting students during office hours; guest lecturer on empirical evaluation techniques, GOMS modeling, and Java programming

**SunSoft, Sun Microsystems, Mountain View, CA**

**Summer Research Intern** (6/96-10/96)
Designed and implemented an adaptive questionnaire applet in Java to solicit user feedback on Sun's web site. Designed a mechanism for randomly inserting the applet into pages on the site. Conducted laboratory usability studies and a field test on the live site. Supervisor: Jakob Nielsen.

**AT&T Bell Laboratories, Murray Hill, NJ**

**Summer Intern**, Interactive Systems (5/94-8/94)
Implemented an algorithm for handwriting recognition. Collected handwriting samples to test the algorithm.

**Part-time Contractor**, Distributed Software (8/93-5/94)
Rewrote several fault-tolerance software packages to use RPC with encryption instead of sockets. Analyzed the impact this change made on system performance.

**Summer Intern**, Electroacoustics (6/92-8/92)
Rewrote software used by researchers for visualizing the frequency response of microphones to use a standard graphics library. Developed a graphical user interface in Motif.

**Dialogic Corporation, Parsippany, NJ**

**Co-Op Student** (1/93-8/93)
Developed PBX tone collection system and database for researchers to test call-processing and detection algorithms.

**IBM, Poughkeepsie, NY**

**Co-Op Student** (5/91-12/91)
Wrote test cases for TSO/E. Automated existing test cases into a nightly testing suite that was used to rapidly identify changes to the code base which had introduced new bugs into the system.

## Publications

### Journal Publications

Guzdial, M., Rick, J., Kehoe, C. (2001). Beyond Adoption to Invention: Teacher-Created Collaborative Activities in Higher Education, **Journal of the Learning Sciences**, Vol. 10, No. 3, p.265-279.

Kehoe, C., Stasko, J., Taylor, A. (2001). Rethinking the Evaluation of Algorithm Animations as Learning Aids: An Observational Study, **International Journal of Human-Computer Studies**, Vol. 54, No. 2, p. 265-284.

Ram, A., Catrambone, R., Guzdial, M., Kehoe, C., McCrickard, D.S., Stasko, J. (1999). PML: Adding Flexibility to Multimedia Presentations, **IEEE Multimedia**, Vol. 6, No. 2, p. 40-52.

Guzdial, M., Kehoe, C. (1998). Apprenticeship-based learning environments: A principled approach to providing software-realized scaffolding through hypermedia. **Journal of Interactive Learning Research**, Vol. 9, No. 3/4, p. 289-336.

Kehoe, C., Pitkow, J., (1996). Surveying the Territory: GVU's Five WWW User Surveys, **The World Wide Web Journal**, Vol. 1, No. 3, p. 77-84.

Kehoe, C., Pitkow, J., (1996). Emerging Trends in the WWW User Population, **Communications of the ACM**, Vol. 39, No. 6, p. 106-108.

Pitkow, J., Kehoe, C., (1995). Results from the Third WWW User Survey, **The World Wide Web Journal**, Vol. 1, No. 1, p. 1-14.

### Conference and Workshop Publications

Kehoe, C. (2002). Design Reviews with Remote Critics in an Asynchronous Environment, to be presented as a short paper at *Computer Supported Collaborative Learning 2002*, Boulder, CO.

Kehoe, C. (2001). Bringing Design Dialog to HCI Education, Poster presented at *ACM Conference on Human Factors in Computing Systems (CHI 2001) Extended Abstracts*, Seattle, WA, p. 473-474.

Craig, D., ul-Haq, S., Khan, S., Zimring, C., Kehoe, C., Rick, J., Guzdial, M. (2000). Using an Unstructured Collaboration Tool to Support Peer Interaction in Large College Classes, *Proceedings of the International Conference on the Learning Sciences 2000*, Ann Arbor, MI, p. 178-184.

Kehoe C., Guzdial M., Turns J. (1997). What We Know About Technological Support for Project-Based Learning, *Proceedings of the 1997 IEEE Frontiers in Engineering Education Conference*, Pittsburgh, PA, p. 918-922.

Pitkow, J., Kehoe, C. (1997). Initial Comments (Project: P954807 Document: 18), *Federal Trade Commission Workshop on Consumer Information Privacy*, Washington, D.C. (http://www.ftc.gov/bcp/privacy/wkshp97/)

Pitkow, J. Kehoe, C. (1997). Supplemental Comments (Project: P954807 Document: 18), *Federal Trade Commission Workshop on Consumer Information Privacy*, Washington, D.C.

Carlson, D., Guzdial, M., Kehoe, C., Shah, V., Stasko, J. (1996). WWW Interactive Learning Environments for Computer Science Education, *Proceedings of the ACM SIGCSE'96 Technical Symposium on Computer Science Education*, p. 290-294.

### Other conference participation

Kehoe, C., Guzdial, M., (1997). Case Libraries for Learning Object-Oriented Design, Poster presented at the *Seventh Workshop on Empirical Studies of Programmers (ESP)*, Alexandria, VA.

McCrickard, D.S., Kehoe, C., (1997). Visualizing Search Results using SQWID, Poster presented at *The Sixth International World Wide Web Conference*, Santa Clara, CA.

## Invited Presentations

Pitkow, J., Kehoe, C., Federal Trade Commission Workshop on Electronic Privacy, Washington, D.C., June 1997.

Kehoe, C., Pitkow, J., Results from the Sixth WWW User Survey, University Continuing Ed. Association. 5th Annual Marketing Conference, New Orleans, LA, February 1997.

Kehoe, C., GVU's WWW User Surveys, SunSoft, Mountain View, CA, October 1996.

Pitkow, J., Kehoe, C., Presentation of Longitudinal Analysis of WWW User Survey Results, Workshop on Internet Survey Methodology and Web Demographics, Cambridge, MA. January 29-30, 1995.

## Professional Activities

Paper Reviewer for

- CHI Special Interest Group Proposals, 2001
- Computer Supported Collaborative Learning (CSCL), 1999
- International Conference on Computers in Education (ICCE), 1998
- User Interface Software and Technology (UIST), 1998
- International Conference of the Learning Sciences (ICLS), 1998, 2000
- Journal of Computer Mediated Communication

Demonstrations Co-Chair for the International Conference of the Learning Sciences, 1998

Student Volunteer for CHI 1996

Mentor for NSF/HCI Traineeship Program, 2 yrs.

Mentor for incoming PhD students, 3 yrs.

Graduate representative to College of Computing Honors & Awards Committee

Member of Association for Computing Machinery

## Honors & Awards

NSF Graduate Research Fellowship recipient, 3 yrs.

Winner of 1997 GVU Leadership Award

Member of Gamma Beta Phi Honor Fraternity

Participant in Doctoral Consortium at the International Conference of the Learning Sciences, 2000

## Personal History

Ms. Kehoe was born in 1971 in Passaic, NJ to Edward J. Kehoe, Jr. and Valerie C. Kehoe (née Vaszkis). She lived in Belleville, NJ until 1977 when the family moved to St. Simons Island, GA. She graduated in 1989 from Glynn Academy high school in Brunswick, GA and moved to Hoboken, NJ to major in computer science at Stevens Institute of Technology. While at Stevens, she was a co-op student and spent semesters working at IBM, Dialogic, and AT&T Bell Labs. In 1994, she returned to Georgia to attend graduate school at the Georgia Institute of Technology in Atlanta. Ms. Kehoe married Mr. Kevin M. Behrens of Saddle Brook, NJ in 2000. She has two siblings, Nancy M. Scholten of Brunswick, GA and Michael P. Kehoe of Atlanta, GA.