The Design and Use of Internet-Mediated Communication
Applications in Education: An Ethnographic Study

by

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THE DESIGN AND USE OF INTERNET-MEDIATED COMMUNICATION APPLICATIONS IN EDUCATION: AN ETHNOGRAPHIC STUDY

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(ABSTRACT)

This dissertation presents a study of the design and use of computer-mediated communication (CMC) in education. It concentrates on a specific type of Internet-based CMC called asynchronous structured discourse (ASD). Using ethnographic methods and data from real-word case studies, this research focuses on three related problems. First, the effective application of any technology (like ASD) within any domain of complex practice (like education) requires collaboration between technology specialists and domain practitioners. This research studies both the techniques of collaborative design and the relationship between collaborators within the process. Second, while the use of computer networks in education offers obvious benefits (e.g., allowing the separation of students in time and space) much remains to be learned about the more subtle possibilities and effects of ASD (and CMC, in general) in education. This study focusses on the social, motivational, and organizational possibilities and effects of ASD applications. Finally, a meta-level focus of this research is assessing the utility of ethnography for computer application design and research.

Design process results include the following argument for effective collaborative design: 1) The object of collaborative design should include the pedagogical activity, as well as the technological system; 2) Scenarios are particularly useful as activity design representations (but must be augmented with other representations of system design); 3) Collaborative design includes an inherent power asymmetry insofar as technologists define and orchestrate the methodology; 4) But, educators and technologists can and should design together in direct collaboration. Results regarding ASD applications include the following argument for effective use: 1) ASD applications provide an effective means to transcend the traditional classroom social structure; 2) But, they should be used as a complementary medium within educational activities (not as a replacement for face-to-face interaction); 3) They can inject writing into instruction in an unobtrusive and authentic form; 4) And, they help shift the paradigm of learning from individual apprehension of knowledge to social construction of knowledge. Finally, this dissertation demonstrates that ethnographic methods can be effective for application design and research. In particular, it defines and demonstrates a specific methodology for ethnography-based collaborative design.
I dedicate this dissertation to my wife, Wendy. Without her unwavering faith and selfless support, I simply could not have done it.
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1. INTRODUCTION

1.1 A Study of Internet-Mediated Communication in Education

My interest in this research is the design and use of computer-mediated communication (CMC) applications in education. This dissertation presents case studies that applied a specific type of these applications within real-world teaching situations. These applications were based on an Internet mechanism I call asynchronous structured discourse (ASD). I use ethnographic methods and the data from these case studies to focus on three distinct but related problems. First, the effective application of any technology (like CMC) within any domain of complex practice (like education) requires collaboration between technology specialists and domain practitioners. Each of these parties possesses different sets of skills and knowledge that must come together in the application design process. Here, the contribution of this research is to increase our understanding of collaborative design: both of the techniques for integrating this disparate knowledge and of the social roles and relationships between these parties within the process. Second, the use of computer networks in education is becoming increasingly common (see Harasim, et al. 95 for a comprehensive survey). While this technology offers obvious benefits, e.g., allowing educators and learners to be separated in time and space (so called “distance learning”), much remains to be learned about the more subtle possibilities and effects that CMC holds for education. The contribution of this research, in this case, is to increase our understanding of the social, motivational, and organizational possibilities and effects of CMC in pedagogy. Finally, a meta-level focus of this research is assessing the utility of ethnography for computer application design and research.

1.1.1 Focus 1: The Utility of Ethnography in Application Design and Research

Throughout this dissertation I will demonstrate the utility of taking a broad approach to application design and show how ethnographic methods are particularly well suited to such an approach. I employed ethnographic methods at two levels in this research. First, I used them as a design technique within the individual design processes of the case studies. In conjunction with other techniques (scenario-based design, in particular), I employed ethnographic inquiry to better understand the practices and goals of the educators who worked with me to design CMC applications for their teaching. Second, I used ethnography as a research method, both to study the collaborative design process and to study the possibilities and effects of the applications in use. At the first level, the products of ethnography as a design method were the applications themselves. At the second level, the product of ethnographic research is this document: the following case studies and the generalized conclusions that came from
them. But, this document can also inform future design of Internet-mediated applications for education. Hence, even at the broader level, ethnography provides a useful design technique.

1.1.2 Focus 2: The Utility and Methods of Collaborative Design

A second major objective in this research is to support the following four-point argument (hypothesis) for the utility of direct practitioner/technologist collaboration in application design. As part of this objective, I explore and test several specific methods for collaboration, including ethnographic study and the use of scenario-based design representations.

1) The object of collaborative design should be conceptualized as an application that consists of both a pedagogical activity and a technological system. This approach is broader than that traditionally taken in design. Designers usually focus on the computer system or, at best, on narrow “tasks”—sequences of direct “user” interactions with the system. The term activity indicates a much broader context of system use, including social interactions and constraints independent detached from the system itself. The following case studies will show how this context can be important to system design.

2) Scenarios are particularly useful in design collaboration as representations of hypothesized activity design. Including activity as a new object of design calls for a new type of design representation. Scenarios (narrative, textual descriptions of activities—i.e., stories) work well for this purpose. In the following case studies, I show how scenarios can facilitate effective design conversation between technologists and practitioners, despite their different backgrounds and expertise. I will also show how scenarios integrate well with ethnographic analysis methods. On the other hand, I will also demonstrate why scenarios should be augmented with other devices, such as abstract structural diagrams, which better represent aspects of system design and activity structure.

3) Educators and technologists can and should design together in direct collaboration. The following case studies will demonstrate how technologists and practitioners can communicate effectively in design. Furthermore, I will demonstrate how, in many cases, a technologist will only obtain an adequate understanding of a specific teaching practice by designing directly with the educators, long-term and within their workplace. Likewise, educators can only appreciate the full range of technological possibilities and constraints through direct engagement with technologists and the technology itself. In particular, I will show how educators may not achieve a full sense of ownership of the application design unless they are able to shape its implementation directly.

4) Finally, I will show how, even though it is an effective approach, collaborative design is typically asymmetric in terms of design power. The importance and complexity of the expertise that practitioners
and technologists bring into the collaboration (activity and technology expertise, respectively) is symmetric. Nevertheless, in the collaborative design processes that I studied, the technologist had more power to affect the trajectory of design than the practitioner. This asymmetry occurs because technologists typically create and control both the design representations (e.g., scenarios) and the design process itself (e.g., the fact that scenarios are used in the first place). It is important that technologists conducting collaborative design processes are aware of this asymmetry so they can employ techniques (and adopt a sensitive and responsive attitude) that will reduce this inequity.

I will provide evidence for the points of this argument throughout the following case studies. In this case, most of the evidence comes from my ethnographic study of the design processes, rather than the applications in use.

1.1.3 Focus 3: The Effective Use of ASD in Education

The third, and final, objective of this research is to support the following four point argument (hypothesis) for how ASD applications will be most effective in education.

1) ASD educational applications are more important in their potential for transcending the traditional classroom social structure, as opposed to, supporting the efficient maintenance of this structure. By social structure I mean the roles of students and teachers in relation to each other. Traditionally, teachers play the authority role within the classroom: they bear the knowledge; they author the course instructional materials; they judge correctness of student apprehension (assign grades); and, they (or the school institution they represent) define the classroom activities, including the time and place in which these occur. Students, on the other hand, play the role of knowledge assimilators—they receive knowledge transmitted to them by the teacher—with little or no role in constructing the course. I will show how ASD applications can shift some classroom authority from the teacher to the students and how this can promote greater student engagement in the educational activities.

2) While ASD applications can effect profound changes in the classroom social structure, they will be most effective as a complementary medium within educational activities. In other words, I will show why ASD should not replace face-to-face interaction and, in some cases, should be combined with or supplanted by other types of CMC. If learning activities are merely transposed from the face-to-face to ASD medium, in entirety, students will view the ASD activity as artificial, not experience a real change in social structure, and hence, be less engaged. Rather, an ASD activity will be most effective when connected to other, independent, student concerns (for example, other assignments). In this way the activity can provide an authentic resource (for students pursuing external goals) rather than simply another detached, contrived assignment. Likewise, the communicational effects of ASD (e.g., increased
formality and reduced interactivity) will not be optimal for all students in all situations; in many cases other CMC mechanisms will be more effective. (See the section *ASD within a Taxonomy of CMC Applications*, page 8, for a comparison of several CMC mechanisms.)

3) Another important effect of ASD applications is that they inject writing into learning activities unobtrusively. I will show how, even though the ASD medium is text-based, many students do not perceive their communicative actions within it as writing (in the sense of traditional individual writing) because these actions are embedded in social discourse. Insofar as the ASD activity is authentic (see point 2, above), this unobtrusive effect becomes stronger. This, of course, is important whenever writing practice itself is the primary pedagogical goal. But, insofar as transcribing an utterance into text requires deeper or more precise analysis of the ideas contained within it, this result has utility in all learning activities. Furthermore, by reifying social discourse in a shared, structured, textual object, ASD facilitates the social construction of knowledge.

4) Finally, ASD applications can shift the paradigm of learning from individual apprehension of knowledge to social construction of knowledge. I will demonstrate in the case studies how the above points facilitate this shift. By placing students in an authorial role, whereby their utterances are recorded as part of a publicly accessible record, students become knowledge constructors, rather than knowledge consumers. Furthermore, because discourse within ASD is interactive (between students), students create this objectified knowledge though a social process. This can radically change what learning activities mean to students and teachers: rather than simply fulfilling an individual task they are constructing a public good (a resource) within a community of peers. The accumulation of knowledge itself becomes the focus (as in the idealized process of science) rather than individual performance (see the discussion of CSILE, below, page 25).

I will provide evidence for this four point argument throughout the case studies of the following chapters. This evidence comes from my ethnographic study of the pedagogical goals and practices of the teachers I designed with and, even more so, from the reaction of the students to their experience with the application in use. I did not attempt to measure and compare the rote efficacy of teaching with these applications versus alternative techniques; for example, I did not compare test scores across instructional methods, as an education researcher might. Rather, I my goal was to uncover the meaning that these applications had for both the educators and the students who used them.

1.2 A Model for Applications
Throughout this research I worked with and developed an informal qualitative model for computer applications, which I found to be useful in collaborative design. My specific conception of the generic term *application* reflects my broad approach to HCI and systems design, which includes social, motivational, and organizational (institutional, cultural, etc.) context in the study of how people use computer systems. I believe that this broader perspective is the appropriate one for design.

### 1.2.1 Activities + Systems = Applications

I define a computer application as the act (or a plan for action) of putting a system to use within an activity for a purpose (i.e., to achieve some goals).\(^1\) By system I mean the computer hardware and software that comprise a physical, functional artifact that people can interact with. By activity I mean the procedures or sequences of actions that people perform in pursing the application’s purpose. Some actions will be directed at the system but, in most interesting applications, many will not. Rather, my conception of activity (within an application) includes the surrounding context of social interactions and actions on artifacts other than the computer system that all contribute to the application’s purpose. Furthermore, the actions that are directed toward the system are done so with the intention of affecting some other object, in pursuit of the application’s purpose (hence, repairing a computer is not a computer application, unless one uses a computer to do it; see [Bodker 91] for a more thorough discussion of similar concepts).

The point of this activity/system distinction is that the computer system is not the only object of design in application development—the activity is also. The level of design I am concerned with here stops at the external functionality and user interface of the system; i.e., I do not address the internal system design—the structure of software modules, etc. At this level, and for systems with relatively simple functionality (like those I study in this research) designing the activity may in fact be the hardest and the most complex part of the process. The activity/system distinction is not absolute, however. For example, both the activity and the system design may include structural aspects and these two structures will usually determine each other. But it is useful to think of some aspects of design as belonging to one component of this application model or the other. Presentational aspects (colors, windows size and positions, etc.), for example, belong to system design, while social aspects, like scheduling when people come together, may

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\(^1\) I present equation metaphorically. I use this intentional oversimplification to distinguish these two interrelated concepts (activity and system) for the sake of discussion. I also use it to place activities on an equal footing with systems in design. Finally, it is an homage to Niklaus Wirth [Wirth 76].

\(^2\) Here, the terms system and activity roughly correspond to Floyd’s distinction between the *software system* ("programs and their interfaces") and the *reference system* ("the part of the real world [software designer’s] take into account") in system design [Floyd 1987]. Casting both the system and activity as the product of design is also consistent with her *process-oriented view* of software development.
be considered independently of the system. Again, my main point is that this later aspect, an aspect of activity, is still a part of the application’s design.

1.2.2 Asynchronous Structured Discourse

Three of the four applications that I (in collaboration with educators) developed in the case studies of this research fit a more specific application model that I call asynchronous structured discourse (ASD). Below, I will illustrate this model by instantiating one of these specific applications within it. A discussion of the general characteristics of this application type follows.

![Diagram](image)

**Figure 1-1: Application Visualization for the On-line Debates**

1.2.2.1 An Example Application

Figure 1 illustrates the overall design of the On-line Debates application, which was used in an undergraduate Computer Science ethics class. (The design and use of this application is the subject of the first case study, presented in Chapter 2. Similar visualizations appear within the case study chapters for each application, see Figures, 2-6, 3-3, 4-1, and 5-1.) In the On-line Debates activity, a group of students state pro or con positions that respond to an ethical issue in computing. The issues are represented as scenarios, for example, a brief story about a situation of software pirating. The entire class then debates these positions by attaching arguments (agreements and disagreements) to these positions and to preceding arguments. The educator specifies the scenario, which is the initial focus of discussion; as the debate goes on, however, the positions and arguments contributed by the students become part of the referent of the continued discourse. Besides the structure imposed on the discourse, this application
structures the debate activity in two ways. First, the activity consists of *phases*: the scenario goes on-line for inspection; a group of students post positions; all the students debate; and finally, the group prepares a live presentation of the results. Second, participants have specific *roles* within the debate, e.g., a small group of students post positions, but all the students are debaters. Also, because this application is implemented within the Internet, it can be open to the Internet community at large, which plays a spectator role, in this case.

The On-line Debates system design enforced the discourse structure in the activity design; it also added presentation, interaction sequence, and other aspects of the implementation technology. In this case, the system was implemented as a set of World-Wide Web (WWW) pages. Each scenario and each utterance (position or argument) was represented as a single WWW page and the speech acts allowed in response to each of these were presented as buttons on the page. This selection of technology implied/allowed that the discourse was textual and persistent (recorded as shared artifact) and that it was structured hierarchically via hypertext links.

### 1.2.2.2 *ASD* within a Taxonomy of CMC Applications

**Table 1-1: A Faceted Classification Model for CMC Applications**

<table>
<thead>
<tr>
<th>Facet</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication Type</td>
<td>broadcast: one-to-many</td>
</tr>
<tr>
<td></td>
<td>information retrieval: many-to-one</td>
</tr>
<tr>
<td></td>
<td>discourse: one-to-one or many-to-many</td>
</tr>
<tr>
<td>Discourse Record</td>
<td>persistent/ephemeral</td>
</tr>
<tr>
<td></td>
<td>shared/copied</td>
</tr>
<tr>
<td>Scope</td>
<td>public/private (read/write)</td>
</tr>
<tr>
<td>Structure</td>
<td>phases, roles, threads, speech acts</td>
</tr>
<tr>
<td>Distribution</td>
<td>same-time/different-time</td>
</tr>
<tr>
<td></td>
<td>(synchronous/asynchronous)</td>
</tr>
<tr>
<td></td>
<td>same-place/different-place</td>
</tr>
<tr>
<td>Media</td>
<td>text, graphics, sound, video, etc.</td>
</tr>
</tbody>
</table>

The On-line Debates is an instance of the class of CMC applications that I call ASD. I define a taxonomic space for CMC applications and mechanisms\(^3\) according to six facets (attributes) that represent dimensions of variation between them. Table 1-1 presents these facets and the range of values each can

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\(^3\) I use the term mechanism to refer to abstract system features independent of any specific application.
assume. This taxonomy is neither precise nor complete: the facets and their values are not orthogonal, mutually exclusive, or collectively exhaustive and, there are many other ways to define this space. Nonetheless, this particular faceted classification illustrates several important distinctions for understanding the possibilities and effects of ASD applications. Table 1-2 classifies several CMC applications or mechanisms according to these facets. I contrast these with ASD in the discussion below.

Table 1-2: Classification of Several CMC Applications or Systems

<table>
<thead>
<tr>
<th>Appl. or Mechanism</th>
<th>Communication Type</th>
<th>Discourse Record</th>
<th>Scope</th>
<th>Structure</th>
<th>Distribution</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycos</td>
<td>info. retrieval</td>
<td>n/a</td>
<td>public (read)</td>
<td>n/a</td>
<td>n/a</td>
<td>multi</td>
</tr>
<tr>
<td>e-mail</td>
<td>discourse: one-to-one</td>
<td>persistent copied</td>
<td>private</td>
<td>little: msg/reply</td>
<td>different time, place; asynchronous</td>
<td>text</td>
</tr>
<tr>
<td>ListProc</td>
<td>discourse: many-to-many</td>
<td>persistent copied</td>
<td>private</td>
<td>little: msg/reply</td>
<td>different time, place; asynchronous</td>
<td>text</td>
</tr>
<tr>
<td>USENET</td>
<td>discourse: many-to-many</td>
<td>persistent shared</td>
<td>public (read/write)</td>
<td>thread, msg/reply</td>
<td>different time, place; asynchronous</td>
<td>text</td>
</tr>
<tr>
<td>IRC</td>
<td>discourse: many-to-many</td>
<td>ephemeral</td>
<td>public (read/write)</td>
<td>none</td>
<td>same-time, diff-place; synchronous</td>
<td>text</td>
</tr>
<tr>
<td>Daedalus Interchange</td>
<td>discourse: many-to-many</td>
<td>ephemeral</td>
<td>private</td>
<td>none</td>
<td>same-time, same-place; synchronous</td>
<td>text</td>
</tr>
<tr>
<td>ASD</td>
<td>discourse: many-to-many</td>
<td>persistent shared</td>
<td>public (read-only)</td>
<td>phase, role, thread, speech act</td>
<td>different time, place; synchronous</td>
<td>text</td>
</tr>
</tbody>
</table>

The most general attribute of CMC applications is the type of communication they mediate. Possible values for this facet include broadcast, information retrieval, and two types of discourse. Broadcast involves one-way transmission of information from a single source to multiple receivers (e.g., a video stream broadcast to many receivers, or an e-mail list used by an individual for mass-mailing). Information retrieval differs from broadcast in that a single individual receives information from multiple sources (the various WWW search engines, e.g., Lycos [Lycos Inc. 96], are typical). Discourse differs from both of these in that communication is bi-directional: participants in discourse activities both

4 See [Frakes 92] for an example of a faceted classification of Information Storage and Retrieval systems.
transmit and receive information. Some mechanisms used in CMC discourse activities support one-to-one communication (e.g., e-mail exchanged between individuals); others support many-to-many communication (e.g., e-mail list servers, which define a group of individuals as a single e-mail address). ASD is a many-to-many discourse mechanism—information transmitted in an ASD application is received by many participants and many participants can transmit. The remaining facets in the classification of Table 1-1 are most relevant to the discourse communication type, which is also the focus of this research.

Another distinguishing facet of ASD is that participants in the discourse activity collaboratively construct a persistent, shared artifact—the cumulating record of discourse—which becomes additional referent for subsequent discourse. The persistence property of ASD contrasts with ephemeral communication modes such as speech and some synchronous CMC mechanisms (e.g., Internet Relay Chat (IRC) [Reid 91][Shirky 95. chapter 7]) where there is no discourse record. The shared property distinguishes this model from message-based mechanisms: In ASD, a single instance of the discourse record is simultaneously accessible to all participants; on the other hand, an e-mail list server (e.g., ListProc [CREN 93] ) gives each participant a private copy of the discourse record. I will argue that a shared, persistent discourse record facilitates learning through the social construction of external knowledge.

Since the ASD applications in this research are Internet-based (compared to LAN-based, e.g., Daedalus Interchange, see chapter 2, Networks for Writing Communities), their scope of participation can include the entire Internet community. While all the applications in the case studies of this research were public, they limited public participation to read-only access—only the students and teachers were able to contribute to the discourse. A CMC system that produces a shared, persistent discourse record facilitates opening the activity to the general public. This contrasts with e-mail list servers where the participants (because they receive copies of the discourse utterances) must be explicitly defined; furthermore there is no external representation of the discourse history, which newcomers can “happen upon” and review. A persistent record of discourse is not required for public access, however. The IRC mechanism is also accessible to public participation through a set of well-known servers and channels, even though they do not record the discourse history. The critical factor is the extent to which the CMC mechanism creates a sense of “place” that the public can “go to” (see [Curtis 94][Shirky 95. p.60]). ASD creates a place in the form of a discourse archive; IRC creates a live conversation “room.” List servers, on the other hand, merely propagate messages—they do not create a sense of place. (Of course it is also technically possible to prevent public access in both the ASD and IRC mechanisms.)

Structure also distinguishes ASD from other CMC application classes. The On-line Debates example (above) illustrates several kinds of structure: discourse structure, activity phases, and participant roles. A
significant feature of discourse structure within ASD applications is that they prescribe a discrete and explicit set of discourse actions. Using the vocabulary of Searle’s taxonomy of speech acts [Searle 79], these applications make the illocutionary point (e.g., to assert vs. request) and other aspects of illocutionary force explicit (e.g., agreement and disagreement are both assertives that differ in their relationship to the prior discourse). This contrasts with discussion systems like threaded USENET news groups (see [Shirky 95], chapter 6) that structure discourse as a hierarchy of messages and replies (each top-level message and the “tree” of replies beneath it is called a thread), but do not represent illocutionary force explicitly.

The extent of distribution in time and space also distinguishes CMC application classes. First, during the discourse activity, participants may or may not be located in the same place. Second, participants may or may not engage in the discourse activity at the same time. Because the ASD applications in this research were Internet-based they facilitated different-place activities: because they produced an persistent discourse record, they facilitated different-time discourse. Nonetheless, in the ASD application of case study 2, contextual factors (lack of Internet access within the school) caused us to design a same-time, same-place ASD activity, despite the different-time, different-place capabilities of the ASD mechanism. The synchronous/asynchronous dimension is similar to but distinct form time and place. I define synchronous mechanisms to be those where participants automatically and simultaneously receive new utterances as they are entered into the discourse. Even within the same-time, same-place ASD activity of case study 2, the application was asynchronous—students scanned the discourse record and individually selected which utterances they would receive. Asynchrony leads to different expectations among the discourse participants; in particular, there is less pressure to respond quickly to the utterances of others.

Finally, CMC applications include various combinations of media. In the ASD applications studied here, text was the only medium.\(^5\) Besides allowing a persistent discourse record, this supports the pedagogical goal of teaching writing. It also has several social psychological effects compared to other face-to-face communication (see the section A Two-level Perspective, page 23, below). Other media possibilities include graphics, sound, and video.

1.3 Ethnographic Study of Application Design and Use

1.3.1 Objectives and Methods

\(^5\) The underlying WWW technology of these applications makes the introduction of other media, such as graphics, sound, etc., a possibility, however.
Internet-based asynchronous structured discourse as applied to education is the primary object of study in this research. I have taken a broad approach in this study, however, which includes two foci: the applications themselves—the learning activities in which these systems are used (the product of design); and, the way educators and I collaborated to conceive and implement these applications (the process of design). The product of this research lies in the four case studies of the following chapters. These are ethnographies of design and use—rich textual descriptions of what happened and analyses of why it happened the way it did. These case studies consider multiple viewpoints including, the educators’ goals, my own goals, the history of the design process, the resulting applications themselves (both their design and the result of using them), and the students’ conceptualizations of the applications. The purpose of these ethnographic descriptions is to inform the design of future applications and tools to create them. As such, these reports will serve as a sort of requirements document, although much broader in scope and less formal than traditional, single application requirements specifications.

1.3.1.1 Action Science, Validity and Generality

My approach in this research was like the action science described by Carroll and Rosson as “science that produces knowledge-in-implementation” and “design practice as inquiry” [Carroll and Rosson 92]. In this spirit, this research was integrated with real design work that was itself intrinsically motivated. It is science because it documents and analyzes the process and product of this work, producing knowledge to guide future design. This kind of research is different from other forms of empirical study in that the researcher takes a proactive role. Rather than a detached observer, in the case studies of this research, I was a participant-observer (meaning I observed and participated) with a stake in the intrinsic goals of the design work. In each of the case studies of this project, I was both a researcher and a software-engineer, collaboratively analyzing, designing, and implementing software artifacts with the educators who would use them. So positioned, I was intimately and subjectively engaged with factors that affected the development process and the use of these applications—factors that would not have been accessible to an (supposedly) objective observer.

The generality of this project’s conclusions are not based on statistical principals. This is partly due to the long duration of real-world design, which limited this research to a small number of case studies. Likewise, the premise that these cases are naturally motivated means that subjects could not be randomly selected or assigned discrete, pre-defined tasks. Instead, future, similar design situations will use the results of this research in a heuristic fashion. The rich ethnographic presentation of what did and did not work, to what degree, and why will allow other designers to determine how and if they can use these results in their own situations. This implies that the results will be useful even where things did not go as
I had planned: the vacuous result of “failure to reject the null hypothesis” is impossible. This type of research trades statistical generality for increased ecological validity. Because the object of study is a naturally occurring phenomena, rather than an experimental construction, the research is guaranteed to pertain to real-world events. The danger here is that the results may pertain to only one or a few idiosyncratic situations; in the laboratory. on the other hand, the danger exists that the results will apply to no situation in the real-world.

1.3.1.2 Ethnographic Interpretation and Coding

I did not define a set of discrete a priori measurements for this research. Rather, I collected extensive qualitative data throughout the case studies, which I hoped would capture their essential features. This data included several traditional ethnographic sources such as field notes, transcripts of audio recordings (both of design sessions and of interviews with educators and students), and open-ended written surveys (for student response). Artifacts also provided data, including those used in the design process (e.g., e-mail correspondence, sketches, and mock-ups) and traces of use in the applications themselves (e.g., log files and the persistent record of structured discourse). Analyzing the data from these case studies involved my subjective interpretation of the categories that gave meaning to all the participants in these design and use experiences (the educators, the students and myself). While my aim, in many cases, is to identify the categories of others, the educators and students, ultimately this analysis is a product of my interpretation. For this reason, I will self-consciously use the verb interpret throughout my analysis in this text to emphasize the subjectivity of the analysis.

Figure 1-2: Ethnography in Design and Research
I adapted the method of ethnographic coding [Downey 94][Seidel 88] to this present research. In this method, as the researcher interprets categories in the data, he or she assigns codes to them and tags relevant sections of the data with these codes. In this way, the researcher lays his or her interpretation of the domain over the data as a template or schema. This technique is flexible: the researcher can code regions of data with multiple categories, and categories can have arbitrary relationships to one another. In the present research, I first coded the data through paper and pencil notations and I found this to be the most important part of the process—the formulation of the categories in my mind. In some cases, however, I used a software text management product (Folio Views [Folio Corp. 94]) to electronically assign these codes to data segments in order to support easy retrieval. (Appendix 1-1, page 32, shows two example excerpts of ethnographically coded data.)

Figure 1-2 illustrates my use of ethnographic methods at two levels within this research: 1) as a technique within the collaborative design process of each case study and, 2) as a research method, to study both collaborative design and application use. As this figure indicates, the technique of ethnographic coding is central at both levels and categories from each contribute to the written ethnography that is the end product of this research. (I also refer to this figure throughout the following two sections.)

1.3.2 Studying Application Design

One objective of this research was to learn about collaboration between design professionals and educators. In the following case studies I analyze design in several ways. First, I examine the interactions between technological possibilities, pedagogical goals, and other contextual factors (e.g., the educators' technological viewpoint or the organizational constraints of public schools) as design ideas emerge and are implemented in applications. Second, I focus on communication within design, particularly, the use of various design representations (e.g., mock-ups, drawings and scenarios) as props to support design conversational. Transcripts from audio recorded design sessions provided the data for this analysis which describes the relationship of design discourse to variables such as representation type, stage of the development process, and different educators. Studying design collaboration in this domain is significant because teaching is a complex and diverse practice, which makes design a daunting task for a person from outside this "culture" (e.g., the typical software engineer). Ethnographic study of the domain is one approach to solving this problem; collaborating directly with the educator in design is a complementary approach. In addition, I expect that the following case studies, in which educators design learning activities based on existing network technology, will inform the design of better tools to support them in this task—i.e., that will further empower them to design and implement network applications themselves.
Finally, I hope that my conclusions about collaboration in design will apply to other domains of design for complex work.

A process of collaborative design emerged in the case studies of this work, particularly those where I collaborated with K-12 public school teachers (see the inner, dashed box of Figure 1-2). This process began with unstructured conversation in which we (the educators and I) discussed their pedagogical goals and techniques as well as possibilities for using the network technologies in their practice. These early design sessions also included demonstrations, field trips to each other's work sites (e.g., the public schools or my computer lab), and "brainstorming" early design ideas. I recorded these conversations in field notes and audio recordings (which I later transcribed), and collected various artifacts. I then analyzed and coded this data, interpreting the major categories that structured our conversations (including motivational, social, technological, and pedagogical categories). I then developed scenarios and mock-ups to reflect my understanding of the shared vision (for the application) that we were developing in our meetings. I used the categories to guide this effort by attempting to incorporate them (particularly resolving conflicts and illustrating support for goals) in these early design representations. I would then, in turn, use these representations to mediate further, more focused design discussion. Again the notes and transcripts from these conversations would feed forward into continued ethnographic analysis and coding, and further development of representations. The product of this process was an application design: a design for both a pedagogical activity and the Internet-based system used within it. Likewise, implementation of this design produced both the system and the various materials used within the activity—instructions sheets, etc.

The use of representations in design, particularly scenarios, was a primary interest in these case studies of collaborative design. Scenarios, as I define and used them, provide an informal, narrative, textual representation of design. They describe applications by describing the concrete activity (or a selected portion of the activity) that encompasses interaction with the computer system. In other words, scenarios are an activity-oriented representation, whereas, mock-ups are system-oriented. It is important to note that I used scenarios as a representation of envisioned (hypothesized) activity design not a specification of completed design or analysis. The purpose of these artifacts was to provoke conversation, to induce new design ideas and reveal contradictions and, to confirm a shared vision by making it explicit. They served as conversational props\(^6\) for a communicative process of mutual learning, in which technology experts

\(^6\) I use this term throughout this text to signify the general class of physical objects (e.g., paper scenarios and drawings, computer mock-ups, etc.) that can support face-to-face design conversation.
(myself) and domain experts (the educators), came to know each others’ worlds and the new one that they were designing.

1.3.3 Studying Application Use

Another objective of this research was to learn about the targeted class of application: asynchronous structured discourse in education. In addition, creating real applications of this class (applications designed with practicing educators and used within their “live” curriculum) was itself an important objective in this project. Besides the intrinsic value of creating real tools for real work, this objective supports the ecological validity of the results of this research. In my study of these applications, I focus on their social and communicative aspects—i.e., my interest is computer-mediated human-human interaction, rather than direct human-computer interaction. In the following case studies, I will analyze how these aspects of the applications relate to (both support and defeat) the pedagogical goals of the educators as well as how they are perceived by the students.

I employed several data sources in my analyses of these applications in use (again, see Figure 1-2). First, these applications both recorded and structured the computer-mediated discourse within their respective activities. This discourse record provided data for analysis. In this analysis I considered how specific pedagogical goals led to discourse structure design and, how well that structure served these goals. Also, I looked at how the actual use of the system matched or deviated from this normative structure (i.e., what discourse acts actually emerged vs. what were prescribed). Second, log files generated by the HTTP server on which the applications were implemented provided quantitative description of use. These tracked usage not recorded directly in the discourse record—i.e., reading vs. posting. Finally, I used post-hoc interviews and open-ended questionnaires (with both the educators and students) to interpret their conceptualizations of the implemented applications.

1.4 Related Work

Both my research approach (qualitative and ethnographic vs. experimental) and orientation (collaborative design, computer-mediated communication, and education) were shaped by a wide array of prior research. I present that body of work here, organizing it into two sub-sections: work related to the process of design and work related to the targeted class of networked applications.

1.4.1 Design Process
1.4.1.1 Participatory Design and Hermeneutics

Participatory design (PD) covers a wide range of theories and practices [Muller and Kuhn 93] that attempt to empower all stakeholders in the design process. PD has its roots in Scandinavia [Bjerknes, Ehn, Kyng 87] but has become popular in North America and Britain as well [Muller 91]. The rationale for PD is three-fold: it promotes democracy in the workplace [Ehn 88]; it increases stakeholder commitment to the product [Bjerknes 93]; and, participation of domain experts is an epistemological necessity for product quality because they hold the relevant domain knowledge [Bodker 91; Ehn 88].

All these claims for PD are relevant to the design of educational networks. First, this research presumes that good teachers know best how to teach within their own specific context, and that this knowledge is critical to the design of tools for them. Second, educators have traditionally had the power to decide what specific activities and materials they use in their classrooms (even if a general curriculum is mandated for them). Third, empowering educators to design their own network applications will increase their “buy-in” to this new technology.

Several researchers (e.g., [Ehn 88]) use hermeneutic philosophy as a theoretical basis for PD.\(^8\) This philosophy states that objective reality does not determine a person’s understanding of the world; rather, understanding emerges through interpretation within each individual’s prior background of understanding. This lack of objectivity in the world applies to human practice as well: it is impossible to represent what a person does objectively through detached reflection and formal description (this includes people reflecting on their own work). Instead, the hermeneutic viewpoint emphasizes practical understanding—understanding the world in the act of doing. This implies that an effective designer must learn about work in the context of the everyday activities of expert practitioners and, that the practitioners can only relate their work to new tools through hands-on use (of mock-ups or prototypes) within this context.

Following the hermeneutic point of view, this research conducted and studied design within the everyday setting of practicing educators. According to this theory, educators (like any other skilled practitioner) cannot fully objectify what they do, and furthermore, without a shared background, a software designer will not form a compatible interpretation of the educator's practice. Likewise, computer experts cannot objectify network technology and educators will interpret this within a different background. Therefore,

\(^{1}\) The term stakeholder refers to everyone affected by the product of design, e.g., end-users, trainers, managers, marketers, designers, programmers, etc.

\(^{8}\) Bodker [Bodker 91] advances similar arguments based on Leontiev’s theories of human activity [Leontiev 72]. See also [Winograd and Flores 87] for a thorough discussion of hermeneutics, which leads them to a new approach to design based on the recurring structure of everyday language for action.
design will proceed best as a process of mutual learning in which designers and educators come to share a background of understanding by working together directly in the real worlds of design and education.

1.4.1.2 End-user Application Tool-kits

Hermeneutic arguments suggest that the best situation for design would cast the same person as both designer and the domain expert. This would eliminate the need to represent practice objectively for the sake of communication. Rather, practitioners could experiment with their own designs, first hand, and modify them until they met their needs. This ideal motivates research in end-user programming and application tool-kits.

Nardi [Nardi 93] examined two popular genres of end-user programming systems: spreadsheets and CAD systems. Her ethnographic study produced several conclusions. First, Nardi cites evidence that people (other than computer programmers) can and do successfully employ formal languages in their activities. She explains peoples' general reluctance to learn formal programming languages in motivational terms:

... it is only when people have a particular interest in something ... that they readily learn the formal languages and notations that describe the elements and relations of the system of interest.

Second, Nardi argues that neither natural language nor visual programming is an optimal model for end-user application development. Rather she concludes that hybrid systems combining visual frameworks with textual languages are best. The electronic spreadsheet, which combines a graphical table with a textual formula language, is an example.

Finally, in a preceding report, [Nardi and Miller 91], the researchers conclude that although people usually think of spreadsheets as single user programs they also support collaboration. This is due first to the two programming layers within spreadsheets: the formula language and the macro language. The formula language allows end-users with little programming skill to accomplish basic tasks while a smaller cadre of more advanced users/programmers provide more general macros (which are still specific to the local work environment). Second, they claim that the structured presentation of data within a spreadsheet's visual framework supports knowledge sharing. Nardi and Miller claim that this general architecture, a multi-level textual programming language coupled with a visual framework, should generalize to other task domains.

The case studies presented in this document can inform the requirements for an end-user tool-kit allowing educators to develop Internet applications. Nardi's work both inspired and complements this work by providing an "existence proof" that non-programmers can develop their own applications and by illuminating desirable architectural features of tool-kits in general. The present research differs from
Nardi’s in that it investigated how and if the target class of applications can be useful in education; in Nardi’s work, the usefulness of spreadsheets and CAD systems was taken as a given. Like Nardi, however, the methods of this research were primarily ethnographic.

1.4.1.3 Ethnography

Fetterman gives a classical definition of the term ethnography [Fetterman 89]:

Ethnography is the art and science of describing a group or culture. The description may be of a small tribal group in some exotic land or a classroom in middle-class suburbia.

The hallmark of ethnography as a method of social science is the immersion of the scientist within the studied social setting. Further, the goal in ethnography is to obtain a qualitative understanding of this setting in contrast to more quantitative methods of social science [Shapiro 94]. Within the field of anthropology itself (the “home” of ethnography) there is controversy over this method. Some anthropologists [Rosaldo 93][Traweek 88] have argued against any claim of objectivity in ethnographic study. Rather, these authors argue that researchers must factor themselves into their ethnographic accounts, describing the situations under which they form their interpretations.

Several researchers have recently applied ethnographic methods to research and design of interactive computer systems. The primary benefit of ethnography within this arena is its increased sensitivity to social and organizational context [Hughes, et al., 95], particularly in comparison with analytic methods (e.g., task analysis [Diaper 90]) and laboratory-based empirical methods (e.g., usability engineering [Good, et al. 86][Whiteside, et al. 88]). In an engineering context, the downside is that ethnography requires long term study, which can be a scheduling problem. Further, ethnography produces qualitative, discursive, and lengthy results, which are difficult to transform directly into design [Hughes, et al., 95].

By attending to social context, ethnography can reveal aspects of a target activity that are significant to design but missed by traditional requirements analysis. An ethnographic study of air traffic controllers provides an example of this [Hughes, et al.. 92]. There, a system design, proposed before the study, would have eliminated physical manipulation of paper flight strips that carry data about air traffic positions. The ethnographic study revealed that the planned automation would have removed a vital double check of this data’s validity from the collaborative work flow of the control room.

Specific ethnographic techniques vary. Goguen and Linde evaluate a host of techniques, borrowed from the social sciences, for systems requirements engineering [Goguen and Linde 93]. These include

9 See [Monk, et. al., 1993] for a debate between ethnographers and experimental psychologists over these issues.

10 See [Anderson 1994] for an alternative appraisal of the appropriateness of ethnography in systems design.
questionnaire and open-ended interviews, focus groups, protocol analysis, and discourse analysis. They argue the importance of "natural setting" and "member's categories" in analysis. They point out that some of these techniques are problematic because they are based on categories that belong to the observer but have little or different meaning to the group under study—forced choice questionnaires are the extreme example. For this reason, they prefer the interaction approach of ethnomethodology.

Ethnomethodology is a sub-discipline of sociology concerned with the way people collaboratively construct meaning in the world through interaction (particularly, oral verbal interaction). In her seminal work applying ethnomethodology to systems design, Suchman used the naturally occurring discourse between collaborating users of a copying machine to critique its "intelligent" help system [Suchman 87]. The strength of this method is that its data occurs naturally (although, the conclusions still come from the observer's interpretation). What is more important from a practical standpoint, as pointed out in [Goguen and Linde 93], is "this method is only applicable to situations where there is significant social interaction [to observe]."

Categorization is fundamental to ethnography: to understand a culture, one must first understand the perspective from which its members view it. Identifying the way members categorize their world is a crucial first step. As Goguen and Linde put it, "The idea is to find the categories that members themselves use to order their social world ..." In addition, however, the scientist always brings prior categories into the study, some of which originate in scientific theory. Fetterman, makes this distinction using the terms emic and etic: the emic perspective is that of the "natives"; the etic perspective is external and "scientific." This dichotomy oversimplifies things somewhat: both the member's categories and the scientific categories presented in an ethnographic account are the product of the scientist's interpretation of reality and theory.  

A method of ethnographic analysis based on identifying categories has been reified in a software product called *The Ethnographic* [Seidel, et al., 88, Chap. 7]. Here, the analyst assigns codes to sections of textual data (interview transcripts, etc.) that identify patterns and concepts. The authors suggest that the analyst start with codes that are "more concrete than abstract": i.e., begin with emic categories and later integrate them into a etic, theoretical framework. They also emphasize, however, that subjective interpretation is unavoidable at all levels. This method directly inspired the "ethnographic coding" component of the collaborative design process I used in the case studies of this work (as described above).

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11 Nonetheless, the distinction seems useful in the context of design, particularly for design rational: it should be possible to trace synthesized design decisions (etic categories) back to the existing emic categories that produced them.
1.4.1.4 Analysis and Modelling

The intent of the ethnographic case studies of this research is to produce insight into both a specific class of application and the collaborative design process. Both of these goals, and my approach to them, are related to prior work in the analysis and modelling of application domains. On the one hand, the case studies themselves constitute an application domain representation (albeit of a more discursive nature than traditional analysis models), which can inform future design of both applications and new tools and procedures to develop them. On the other hand, I employed representations and analysis methods (particularly scenarios) within the design processes of the case studies themselves, which are also related to prior research.

Holtzblatt and Beyer propose apprenticeship as a model for requirements analysis [Beyer and Holtzblatt 95]. Arguments for this method are similar to those for PD: practitioners hold the domain knowledge and they can only reveal fully this in the act of doing their work. This model (like the earlier work in contextual inquiry [Whiteside, et al. 88]) shares with ethnography the immersion of the designer within the practitioner’s work environment. It is more specific than ethnography, however, in prescribing a master/apprentice relationship between the designer and practitioner.

Education (at least as this research approaches it) is a qualitatively different work domain than that usually studied in requirements engineering research: it is less structured and proceduralized. For example, in their apprenticeship research, Beyer and Holtzblatt emphasize that the designer must “see the work structure.” Further, they describe a requirements gathering process where the “apprentice” looks on as the “master” performs the task, occasionally “interrupt[ing] the flow of work” with an observation or question. The ethnographic study of air traffic control rooms, described in [Bentley, et al. 92], likewise deals with more discrete, normalized tasks. As pointed out in [Hughes, et al 95]:

[Ethnography’s] main use has been in research, and in field sites which are small scale, involving highly focused interactions.

In contrast, the domain analysis presented in the following case studies is at a higher level, attending to pedagogical goals, social consequence of Internet features, etc., rather than proceduralized work sequences.

Ethnography, applied to systems design, is in some ways similar to object-oriented analysis (OOA). First, Coad and Yourdon tout OOA (as I and others do ethnography) as a method for understanding an application domain before specifying functional system requirements [Coad and Yourdon 93]. Besides sharing this common purpose, the technique of identifying member’s categories in ethnography is similar to the task of abstracting domain objects and classes in OOA. This similarity is clear in Booch’s
description of OOA: "we seek to model the world by identifying the classes and objects that form the vocabulary the problem domain" (emphasis added) [Booch 91 p.141].

Ethnography and OOA also differ in significant ways. An ethnographer tries to understand and represent (in the text of the ethnography) the world from the perspective of the human members of a group. In contrast, the object-oriented analyst typically models the world from the computer system's perspective. This is apparent in Coad and Yourdon's emphasis on "system's responsibilities" (original emphasis):

    With OOA, an analyst studies the overall problem domain, filters that problem domain understanding to just those aspects which are within the system’s responsibilities, and models it accordingly. [Coad and Yourdon 93, p. 53]

Another difference is that OOA models emphasize static structure more than dynamic behavior. The primary components of OOA are classes, objects and their interrelationships, particularly, taxonomic and part-whole relationships—these represent domain structure. For the most part, modeling behavior consists of specifying the discrete sets of "services" that individual classes provide. Coad and Yourdon do suggest a richer representation of behavior that includes interaction [p. 151]: "threads of execution may be named, defined and presented using different line patterns [connecting the classes that call and provide services]." Likewise, Booch uses the term "mechanism" for the global behavior of the system. In both cases, however, the modeled behavior is restricted to the "system's responsibilities." (Hoydalsvik and Sindre make similar observations about OOA in their argument that OOA is more target-system than problem-domain oriented [Hoydalsvik and Sindre 93].)

1.4.1.5 Scenario Representations

In contrast to the structural and system orientation of OOA models, scenario paradigms emphasize the activities (actual or envisioned) in which people use a system. Scenarios have recently become a popular representation in design research and practice [Carroll 95], however, their defining criteria vary across those who use them. Most advocates agree that scenarios provide an "outside" [Kuutti 95] (or "work driven" [Carroll 94]) point of view, in contrast to the "internal" (or "technology driven") view point of more traditional representations, such as object models. In addition, in most methods, scenarios are narrative in form. a scenario "describes a process or sequence of acts, not individual acts" [Kuutti 95]. (Although see the "microscenarios" of [Neilsen 95] for a counter example: Neilsen calls simple phrases, e.g., "[to] make friends," microscenarios.)

Scenario-based design methods also vary in both scope and formality. For example, Carroll implements scenarios as informal textual descriptions of concrete use instances, which he considered to be "open-ended" and "fragmentary" representations [Carroll 95]. On the other hand, Jacobson's use-cases are represented in formal languages (he suggests directed graphs and state machines) and form a complete
system specification: “taken together, a system’s use-cases represent everything users can do with [the system]” [Jacobson 95]. Despite their formality, use-cases still resemble scenarios more than object models (which Jacobson develops in conjunction with use-cases) in that “[use-cases] describe the system from the outside ... [and] capture task domain knowledge.” Use-cases do not attempt to represent social interaction or other context independent of the system; instead, these sequential descriptions are specifically limited to direct user-system “transactions.” Kuutti makes the distinction between “rich” and “narrow” scenarios [Kuutti 95]. Use-cases are an example of the latter; rich scenarios, on the other hand, describe the “work processes” in which an application will be embedded. This capacity to include aspects of context (social, psychological, organizational, etc.) is commonly claimed to be an advantage of scenario representations (or even a defining characteristic; e.g., see [Nardi 95]).

Researchers have also emphasized the utility of scenarios for participatory, or cooperative design. Muller et al. describe a design method (called CARD) in which “users” (and other “stake-holders”) participate directly to create scenarios in the form of graphical story boards [Muller et al. 95]. This method employs “playing cards,” which represent “screen images or task components,” as “low-tech” materials for design. These researchers emphasize the value of low-tech materials for equalizing ownership in design; because these materials depart from the normal work artifacts of both designers and practitioners, they form “a shared language space that is owned by no one (or everyone).” Likewise, Kyng advocates the use of scenarios as means of communication between practitioners and designers [Kyng 95]. Kyng views scenarios as design “hypotheses” versus “fixed requirements” and (invoking a hermeneutic argument) emphasizes that these descriptions alone can never be complete and rich enough to evoke an adequate understanding of the situations they describe, particularly technological possibilities. Instead, he emphasizes the need to complement scenarios with hands-on use of mock-ups in realistic work situations.

A particular concern in scenario-based representation is where the scenarios come from. The very capacity of scenarios to express the practitioner’s view point and to include the social and organizational context of use moves them away from most designers’ sphere of expertise—the system. In Kyng’s cooperative design approach [Kyng 95], scenarios are not introduced until the middle stages of the design process. In the earlier phases, designers learn about the target work context through extensive observation, interviews, and participation in “future workshops” (where designers and practitioners envision technological possibilities). Scenarios and mock-ups are created after this learning period in which a shared background of understanding is established. Carroll and Rosson take a less empirical

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12 They use a different set of low-tech materials for participatory design of user interface components; i.e., the structure and presentation of the system.
approach to generating scenarios [Carroll and Rosson 92]. Instead, they use a typology of "six generic usage situations" to guide the generation of a "comprehensive and coherent" set of scenarios. These researchers derived this "task-analytic" framework from their own experiences with scenarios in various design projects. Reflecting their particular research orientation, however, this particular framework is biased towards learning-about-the-system situations (e.g., "Searching for information [about the system]") and might not be suitable for other domains, e.g., expert use.

The scenarios that I used in the design projects (the case studies) of this research were, like all scenarios, written from an external vs. systems point of view. In addition, they were rich in scope, including organizational and social context, and written as informal, textual narratives. Like Kyng and Muller, I was especially interested in using scenarios as a communication medium for collaborative design; unlike these researchers, however, I was the sole author of all the scenarios I used. As described above, I derived scenarios from ethnographic coding and used them to reflect my understanding back to my collaborators.

Ethnography, scenarios, and OOA differ along two dimensions: first, from greater to lesser emphasis on social and other contextual factors; second, from lesser to greater formality in representation language. All three techniques work to inform the designer about the target domain. They differ, however, in their facility as communication vehicles. On the one hand, natural language narratives facilitate communication between designers and practitioners; on the other, formal representations ease the transition from domain analysis to software construction.

1.4.2 Computer-mediated Communication Applications

It is now common for computers in all contexts, home, work, academics, etc., to be connected to some kind of network. From a systems perspective, this presents new technological possibilities like data sharing and client-server program models. From a social perspective, however, designers must now think of computers in an additional and fundamentally different way—as a medium for human-human communication.

1.4.2.1 A Two-level Perspective

Sproull and Keisler propose a two-level framework for describing the effect of any kind of change and apply it to the study of computer-mediated communication (CMC) [Sproull and Keisler 91]. For example, in the case of e-mail there are first-level effects such as shortened delivery time for text messages (compared to surface mail) and the convenience of asynchronous communication (compared to "telephone-tag"). There are also less obvious (and often unanticipated) second-level effects of e-mail that enable organizations to work in completely new ways. For example, Sproull and Keisler describe a
situation where individuals use e-mail to broadcast requests for help on specific problems to their entire international organization. For the first time, the collective knowledge of this organization is an accessible resource.

From an anthropological viewpoint, Perin describes a second-level effect of computer-mediated communication that she claims has caused some managers to reject groupware systems [Perin 91]. Perin reports that groupware systems, including e-mail, facilitate the formation of electronic social fields, "semiautonomous and self-regulating human associations," within bureaucracies. Because these associations are less visible than those supported through more traditional channels of communication, however, managers may "associate escape, subterfuge, and subversion with them." and hence, they may reject the technology that sustains them. Communications theory also offers insight into the second-level effects of CMC. Chesebro and Bonsall describe CMC as a "highly selective communication medium ... [in which] all nonverbal cues are eliminated" [Chesebro and Bonsall 89]. Besides removing face-to-face channels like gesture and voice tone, CMC removes epistolary "clues" like handwriting and choice of stationary. Chesebro and Bonsall also describe "communicative gains" from CMC: it focuses more attention on the meaning of the written words, both by the author and the reader.

Sproull and Keisler report several empirically derived social-psychological (second-level) effects of CMC in "electronic groups" [Sproull and Keisler 91, chapter 4]. First, they report that participation is more equally distributed (particularly across status levels) in both real-time conferencing and e-mail compared to face-to-face meetings. They attribute this finding to the lack of status cues in electronic messages. Second, they found that e-mail allowed more participants to "talk first" (because there was no need for turn-taking) and that this "diminished the credibility and impact of high status members." They conclude from this and empirical measures of quality that, "when groups should favor expertise over [status] position, then electronic discussion can lead to better-quality decisions." Finally, they found that the time to reach a consensus was longer in computer-mediated discussions—a disadvantage of CMC.

Sproull and Keisler also report several surprising effects of CMC regarding self-disclosure and emotion in communication. They cite a study of alcohol consumption where the consumption amounts reported through a computer based interview correlated better with actual alcohol sales than did the amounts reported to human interviewers (the later were low). Similarly, they found that university students were more likely to report that they had used illegal drugs in an e-mail survey than in a pencil and paper survey. They attribute this increased "honest" in "self-disclosure" to two features of electronic communication. First, because the medium is "plain text," communication lacks "personal information" and, therefore, people are "less influenced by social conventions" and "how they compare with others." Second, they claim that people perceive electronic communication as more ephemeral and hence more
private than face-to-face speech (even though the opposite is likely the case). Sproull and Keisler also attribute the phenomenon of "flaming" in electronic discussion to perceived ephemerality and "lack of tangible reminders of [the] audience." In addition, they suggest that CMC's impoverished channel of communication promotes flaming because people feel they must use stronger language to convey their message.

1.4.2.2 *Educational CMC: Social Knowledge Construction—Learning in World 3*

Many researchers have applied CMC mechanisms in education. I describe two such mechanisms, CSILE and CLAIRE, which fit the asynchronous structured discourse model, here. I will describe Daedalus [Daedalus Group Inc. 96] (a synchronous, unstructured mechanism), which is an instance of the more general ENFI model [Bruce, et al. 93], in the context of case study 1. As I will argue throughout, perhaps the most important second-level effect of the ASD applications I studied, as well as the CSILE and CLAIRE systems, is that, by recording discourse as a persistent, structured and public artifact, they all facilitate the social construction of knowledge.

The CSILE system [Scardamalia, Bereiter and Lamon 94] [Scardamalia and Bereiter 93] allows students to record arbitrary information as text and graphic "notes" in a communal data base. This information is by default accessible to other students who can inspect and attach comments to it. The CSILE system does not prescribe specific learning activities, but its designers believe that it foster a new kind of discourse in learning: "the kind of discourse that advances knowledge in science and disciplines," rather than "discourse in which students display or reproduce what they have learned" [Scardamalia and Bereiter 93]. The CSILE advocates believe that the computer, by "objectifying knowledge and bringing it to the forefront of the classroom activity," changes the students' goal from "improving their own minds" to "improving the knowledge itself."

Scardamalia, et al., compare this re-situating of knowledge and learning (from the individual to the social sphere) to Karl Popper's three world theory [Popper 72]. As quoted in [Wertsch 91], Popper's philosophy of science defines three worlds of existence: *World 1*, "the world of physical objects or physical states"; *World 2*, "the world of mental states"; and *World 3*, "the world of objective contents of thought, especially of scientific and poetic thoughts and of works of art." The CSILE researchers hope to emulate in educational activities what Popper saw as the business of science: improving and advancing knowledge as an external abstraction—*World 3*. They wish to replace the "information transmission" model of education with the "scientific model of knowledge building." They further emphasize that this does not simply mean teaching individuals the scientific skills of observation, experimentation and measurement; rather, it means changing the classroom dynamic from one of individual pursuit of internal knowledge to
one of social construction of knowledge as an external, public object. These researchers offer a range of empirical results that support the claim that the CSILE system accomplishes this and, further, that social construction leads to better individual apprehension.

Scardamalia, Bereiter and Lamon also describe a recent addition to CSILE that allows students to work together through a more structured dialog. A "group note" is a linear dialog in which each "addition" is tagged with an explicit type, such as My theory, I need to understand, New information, or Comment (the set of types is extendible). In addition, the CSILE researchers have experimented with a "summary note," which augments the group note. Group members were supposed to periodically update the summary note to reflect the emerging consensus of the group. They have found in practice, however, that students use the summary notes to store factual statements (usually from outside sources) rather than to represent group synthesis.

Like CSILE, CLAIRE [Wan and Johnson 94] is a CMC system that facilitates collaborative construction of knowledge; unlike CSILE, however, the CLAIRE application includes a specific learning activity. In the first phase of this activity, CLAIRE learners summarize and evaluate a scientific text (e.g., a research paper in software engineering). They do this by constructing models of the text's structure and by attaching evaluative comments to these models. Learners use pre-defined sets of node and link types to construct their models as directed graphs. In the first phase, students work privately: the individual learners cannot see what each other is doing. In the second phase, the learners collaborate by comparing, arguing, and integrating their models. The results reported in the work on CLAIRE are more qualitative than those reported for CSILE. The researchers found that most students believed that the learning activity was valuable. They also report, however, that the learners spent most of their time and effort (including collaborative effort) constructing the individual summative models rather than integrating them (the opposite of what they expected). They attribute this to the students not understanding the node and link primitives as well as they had anticipated.

The CLAIRE and CSILE projects promote learning as collaborative, social construction of knowledge. Both systems support this by objectifying knowledge, making it available for shared access and supporting asynchronous structured discourse about it. They differ in the amount and type of structure they support, however. In particular, the CLAIRE system prescribes a structure (node and link primitives) that learners use to model objects that are external to the dialog. CSILE, in contrast, only prescribes structure for the discourse itself (such as "note" types and the types attached to group note "additions").
1.4.2.3 Speech Acts and Structured Language Systems

In their seminal work *Understanding Computers and Cognition* [Winograd and Flores 86], introduce a new class of computer systems based on the structure of human conversation. They do not propose computer systems that understand or engage in conversation (in fact they call upon hermeneutic philosophy to dispute this possibility), but rather systems that objectify and track the progress of human conversation. This model is relevant to my research in that it both objectifies and explicitly structures discourse.

Winograd and Flores employ Searle’s universal taxonomy of speech acts [Searle 79] to describe the structure of conversation. Searle defines five categories of what people do with language acts:

We tell people how things are (Assertives), we try to get them to do things (Directives), we commit ourselves to doing things (Commissives), we express our feelings and attitudes (Expressives), and we bring about changes in the world through our utterances (Declarations). [p. viii]

Searle distinguishes the propositional content of an utterance from its illocutionary force. His five categories form a taxonomy of illocutionary force based on twelve dimensions along which utterances vary, besides content. Of these twelve dimensions, illocutionary point, the purpose of a speech act, is fundamental. Other dimensions include the strength with which a point is presented and the relationship of an utterance to the rest of the discourse.

Winograd and Flores base their “workgroup system” *The Coordinator* on recurrent patterns of “conversations for action,” particularly, patterns of directives and commissives. For example, a manager might request that an employee produce a report by a specified time (a directive); the employee might then agree to produce the report (a commissive). To begin this conversation within The Coordinator the manager would select the explicit illocutionary force request from a set of alternatives, enter the propositional content (that the report should be written) as free text, and specify explicit temporal relationships between this request and other actions in the system. Likewise, the employee would explicitly commit to or negotiate the request. Winograd and Flores claim that objectifying conversation within The Coordinator avoids misunderstandings of what commitments people have made and helps people monitor the state of their work, reified as a set of ongoing conversations. Later work used this approach in a new model for workflow in organizations [Median-Mora, et al. 92], a model based on coordination structure (conversation) rather than individual task structure and information flow.

The Coordinator system and the theory behind it have been the focus of debate within the computer supported cooperative work community (see [Winograd 94], [Suchman 94], and [Bannon, et al. 95], for a recent episode). A summary of the earlier debate in [Michelis and Grasso 94] presents the following
criticisms (among others) that various researchers have directed at the language/action perspective: 1) Searle's taxonomy of speech acts oversimplifies real conversation; 2) forcing explicit declaration of illocutionary force is really a means of control over those using the system; 3) the system does not support negotiation of meaning within conversation; and, 4) the system proposes a fixed set of models, excluding the situated design of new ones by local groups. Reder and Schwab also fault the explicitness of The Coordinator saying there are often individual and organization benefits to masking one's communicative intent [Reder and Schwab 88]. Michelis and Grasso attempt to reconcile several of these criticisms with the language/action perspective in their Milan Conversation Model. This model distinguishes free conversation from structured negotiation for commitments; the later is embedded in and given meaning by the former. Thus, the system allows conversation for purposes other than making commitments (e.g., negotiating meaning), but still supports making commitments explicit.

Because the ASD applications I studied structure and objectify conversation, in a manner similar to The Coordinator, they are vulnerable to the same criticisms. An interesting question for my research is how these criticisms pertain in the domain of education. In other words, is there pedagogical value to normalizing discourse in some situations? I will discuss the particular WWW-based mechanism that these applications were based on (World-Wide Web Interactive Talk [WIT 96]) as well as the argumentative planning model of discourse that inspired it (IBIS [Kunz and Rittel 70] and APIS [Rittel 80]) in the context of case study 1 (chapter 2, Networks for Asynchronous Structured Discourse).

1.5 Four Case Studies of Design and Use

The data for this research came from four "real-world" case studies of application design and use. All of these were long-term projects that developed customized Internet-mediated communication applications. In three cases, I worked closely with one or more practicing educators to develop these applications; in the last, I was the educator. I present the data from each case study as a narrative ethnographic account in a separate chapter. These ethnographies are, for the most part, self-contained and can be read in sequence or independently. The final chapter integrates the findings and results from these four cases within the framework of the arguments laid out at the beginning of this introductory chapter (pages 3-2).

1.5.1 Overview of the Case Study Chapters

I present the following four case in chapters 2 through 5:

1. (Chapter 2) On-line Debates: An ASD application supporting on-line debate of ethical issues in computing. This case study includes a short design history and three semesters of use in a college Computer Science course.
2. (Chapter 3) Issues On-line: An ASD application that allowed students to present (on the WWW) written positions on issues in science and society. Subsequently, the students’ peers reviewed their positions through on-line, structured discussion. This case study includes a long design history and a relatively brief period of use in three sections of a high school Physics course.

3. (Chapter 4) Multimedia Magazine: A non-ASD application that supported the creation of an on-line multimedia magazine about a county in Virginia. This application used the Internet both as a discourse and publishing (broadcast) medium. This case study includes a long design history; however, because few students used the system directly, it says little about use. This project involved two middle school teachers (one General Science, one Language-Arts) and their five combined class periods over one full school year.

4. (Chapter 5) On-line Discussions: An ASD application (embedded within a larger application of the Internet) that supported on-line teacher-student and student-student discussion of computer programming assignments and exams. The larger application included the use of WWW pages to deliver course materials on-line (broadcast) and the use of e-mail for one-to-one (teacher-student) discourse. This case study includes a detailed analysis of the application’s rationale and use, because I was the educator, however, it does not include a collaborative design history. This project spanned two semesters of an undergraduate college Computer Science programming course.

The case study chapters share a common structure. Each begins with an overview of the context of the project, the circumstances that initiated it, its major themes, and its relationship to the preceding cases. In the first three cases, a detailed history of the collaborative design process follows this overview. In these histories, I show how the ethnographic and collaborative design methods revealed the work practice (pedagogical goals, organizational context, etc.) of each educator and how the final application design emerged. Since I was both the educator and designer in case study 4, an extended description of my own goals, teaching context, and the application replaces the design history. In all but case study 3, a detailed analysis of the students’ (and, to a lesser extent, the educators’) experience using the applications follows the design history. I base these analyses mainly on open-ended (written) student-response questionnaires. Finally, each chapter concludes with a summary and discussion of its major findings regarding either the collaborative design process, the ASD applications in use, or both.

1.5.2 The Space of Case Studies

Table 1-3 illustrates the “space” defined by the major similarities and differences among the four case studies. The first row of the table indicates which of the three research foci (ethnography, design, and use) each case supported. The last row indicates the relevance of each case’s data to the themes from my arguments about design and use (see pages 2 and 3).

These case studies were similar in several ways. First, all the applications were based on the WWW Internet technology. Furthermore, three of these applications fit the ASD model and shared a common underlying system implementation (case study 3 only fit this model under a loose interpretation and it did not share this core system). Also, in all of these cases the applications originated in the pedagogy of the
educators, rather than a researcher's theory or experiment. Finally, the design work in each case, occurred within the educators' work environment, again, as opposed to a controlled laboratory environment.

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<td>Network access quality</td>
<td>good</td>
<td>poor (SLIP)</td>
<td>poor (SLIP)</td>
<td>good</td>
</tr>
</tbody>
</table>

There were also significant differences among these case studies. For example, a major difference between the college level cases and those at the K-12 level was the quality of computer and network access. At the college level, network connections were through fast and reliable Ethernet, whereas in the public schools, network access ranged from none to at best SLIP connections.\textsuperscript{13} Also, in the college cases, many students had their own network enabled computers and there were ample public access facilities. In contrast, the number of networked computers available in the public schools was quite limited. There were also pedagogical differences. Besides different educational levels and subjects, the educators'

\textsuperscript{13} SLIP stands for Serial Line Internet Protocol. This software allows Internet connection through an ordinary telephone line, using a modem.
computer and network experience varied. For example, in the middle school case, the educators were very experienced using computers in their teaching but had little "technical" computer knowledge. In the high school case, in contrast, the educator was quite technically adept with personal computers but had less experience using them in the classroom.
Appendix 1-1 Examples of Ethnographic Coding

(Top: excerpt from a design session transcript; Bottom: excerpt from a questionnaire)

Then they'll work on their I Search paper, that other period. Does that make sense to you?
L: Um hum.
M: It a while to figure out.
S: It took us hours to figure this out. Or to come to this.
M: See second period let's say I have a group of kids - we have the same schedule. All the periods. I teach she teaches, but second period a certain group of students are scheduled to take science and a certain group are scheduled to take English. OK, now if we want to combine those to classes and have those groups of kids working, the problem is if we have everybody in second period science and everybody in second period English working at the same time, then its like, OK they're working on this project, but then what do we do with them like, ahh they have me for second period science then when they go to later in the day they've already been working on this language arts kind of thing already. What the heck is she going to do with them?
S: And mingled with different kids.
M: Right.
S: I mean we could work two different periods in the day and get it done better, but what we thought we would do is then have it so, if they came second period an then they came back sixth period, then sixth period they'd work on their I Search paper which is an individual project. Um ... and we thought we'd, if they were working in a magazine group, that they would be in this room [Room's room - the room we were in] and if they were working on and--of course I have tables too now so it doesn't matter too much--this room is bigger--if they're working on their individual I Search project then they'll work over in my room. One period they'll be in here working on the magazine and the one period that day they'll work on their I Search paper.

Student 85
- Didn't see any problems.

Student 86
- No. You were careful to project our privacy. There could be problems with the honor code, but his problem already exists in any programming class.

Student 87
- I thought it made the class more like a team. I am glad though that the grades are password protected. I think that is a good idea.

Student 88
- No.

Student 89
- Not noticed.

Student 89
- No problems. As fair a class as ever.
2. CASE STUDY 1: ON-LINE DEBATES (COLLEGE ETHICS)

2.1 Networks for Educational Infrastructure

During the Fall semester of 1994, a group of faculty in the Computer Science department at Virginia Tech began a research project with the following goal:

... to enhance the computer science undergraduate learning experience by integrating courses with usable and useful computerized materials comprising a comprehensive Digital Library.¹

This effort was organized under an NSF funded research program titled Educational Infrastructure (EI). As this quote indicates, the focus of the EI project was network-based digital libraries and information retrieval. Nonetheless, this project also provided a context for my own study of a different kind of network-based educational application, which I call asynchronous structured discourse (ASD).

2.1.1 Networks for Delivering Educational Material

The most visible result of the EI project was that several Computer Science faculty members adopted the World-Wide Web (WWW) for the “on-line delivery of academic material”² in their courses. This material included syllabi, course notes, assignments, etc., as well as published supporting texts. This use of the WWW transcended research—it became part of teaching practice. As a principal in the EI project asserted (in a message sent to the project’s electronic mailing list; original emphasis):

... this department is rapidly moving towards on-line delivery of critical academic material ... [this] is now a critical part of both our department’s research program AND educational program ...

The EI project emphasized a new medium for delivery, more so than new patterns of communication. In fact, the faculty and students often referred to the EI courses as “paper-less classes.” The participating EI faculty primarily used the network as a means to transmit information from themselves (the instructors) to the students and, to a lesser degree, for the students to send information back to them as “on-line submission” of homework and exams. Hence, this project transposed the traditional classroom social structure onto a new medium (the network), largely intact.

2.1.2 Networks for Discourse and Constructing Material

The effect of the EI project on our department’s “educational program”—the adoption of the WWW to transmit materials—provided a context for my own research. I studied a fundamentally different kind of

¹ From the EI Project Proposal Abstract.

² The categories on-line delivery, on-line submission and paper-less classes appeared on the EI project’s electronic mailing list.
educational application that utilized the network as a medium for discourse rather than delivery or submission. Perhaps more importantly, these applications prescribed activities in which students communicated with each other (vs. student-teacher interaction). Furthermore, because these applications recorded the students’ discourse as a persistent artifact in the network medium, they changed the students’ role within the social structure of the “classroom” (now extended into network space): the students became authors of material delivered through the net, in addition to being its audience.

I implemented two applications of asynchronous structured discourse within the EI project context. I will describe and analyze the first of these, the On-line Debates (OLD), in this chapter; I address the other in chapter 5. I initially developed the On-line Debates in collaboration with one of the EI principal investigators, Professor John A. N. Lee (JAN). JAN adapted the undergraduate Computer Science course Professionalism in Computing for partial delivery through the World-Wide Web in the Fall semester 1994; he taught this class in the Fall semesters of 1994 and 1995. The design process within this project was succinct and is the secondary focus of this chapter’s analysis. The primary focus is the educational application itself: the network-based educational activity and the software system that supported it, as well as the results of the activity—particularly, the students’ conceptualizations of their experience.

2.2 Designing the On-line Debates

The design process in this project was short and straightforward. It was largely a matter of adapting two existing network applications to the goals and technological substrate of the Professionalism in Computing course, in its new EI format. One of these existing applications, the Daedalus Integrated Writing Environment (Daedalus) [Daedalus Group Inc. 96a][Kemp 93], supplied the original motivation and the pedagogical theory for the On-line Debates. The other, the World-Wide Web Interactive Talk (WIT) [Luotonen 94], supplied a specific, highly structured, software mechanism. Most of the new design work that JAN and I completed involved transposing an educational activity, which was already a part of this course, across media: from face-to-face (FTF) to computer-mediated communication (CMC). Thus, the design effort in this project focused on activity design; it borrowed the software system design almost verbatim, from WIT.

2.2.1 Networks for Writing Communities

One of the objectives of the Professionalism course, as stated in its on-line syllabus, was: “... to provide computer science students with a writing intensive experience ...” (emphasis added). I had served as a

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3 This contrasts sharply with the high school Physics project I will describe in Chapter 2, which was influenced by the On-line Debates and produced a similar application.
graduate assistant (the "grader") for this course in a previous semester and was indeed surprised at the amount of writing it required (and that I had to evaluate)—after all, it was a computer science class! Subsequently, in an early part of my dissertation research, I had the opportunity to observe an English composition class that utilized the Daedalus system. At that time it occurred to me that the Daedalus philosophy might work well for this writing intensive computer science class as well.

Actually, what I had observed was a single component of the Daedalus environment called Interchange. Daedalus Interchange (henceforth, I refer to it simply as Daedalus) is an instance of a general class of educational network applications known as ENFI (Electronic Networks For Interaction) [Bruce, et al. 93]. Most ENFI applications are same-time/same-place, synchronous CMC mechanisms used to teach writing. In a typical ENFI activity, students are seated at computers within the same room. Using specialized software, such as Daedalus, the students engage in on-line "discussion," usually about some topic specified by the teacher.

![Diagram of a Computer Integrated Classroom](image)

*Figure 2-2: Computer Integrated Classroom* (from [Bruce, et al. 93])

Figure 2-2 shows the configuration of the Computer Integrated Classroom (CIC) used for Daedalus writing activities in the English Department at Virginia Tech; Figure 2-1 shows a schematic representation of a typical ENFI screen as seen on a single student's computer. In an ENFI "discussion," students (and the teacher) type comments into their private Compose window, which they then send to the rest of the class. The comments of all participants, with their names (or pseudonyms) attached, scroll in real-time through the Dialog Window.

When I first heard of this idea, I thought it was rather strange: if the students are in the same room, why not just turn around and talk to each other? Why isolate them at computers with their backs to each other? Part of the answer, of course, is simply that the goal is for the students to write not talk, and engaging the
students in a computer mediated "discussion" simultaneously engages them in writing (because ENFI systems are text-based, rather than audio/video, for example). But this was not writing in its traditional, solitary form. In ENFI, the students write collaboratively, immersed in a writing community, and for a real audience—their peers—rather than for a "grader." The ENFI philosophy argues that in this atmosphere, students are writing for an authentic purpose—they are genuinely trying to communicate with and persuade their colleagues [Bruce, et al. 93, Introduction].

I interviewed an English instructor at Virginia Tech who used Daedalus in the CIC. Although this educator described herself as a computer novice and even though she had experienced some awkward technical problems in the CIC (which she feared made her look "out of control" in the classroom) she was excited about the "changed dynamics" when students "wrote" in this environment:

They get very focused and the 25 students are writing for an hour and 15 minutes. ... sometimes they get into flippancy's, but most of the time they stay fairly insightful and in tune to the text that they are trying to discuss. It's really neat.

ENFI systems change the social structure of the classroom. Proponents point out that, in the ENFI environment educators directly model the target skill—they "work in the medium [text] they are teaching." Also, the teacher's role shifts from "evaluator to coach/participant." [Bruce, et al. 93]. Likewise, the Virginia Tech English instructor I interviewed emphasized that Daedalus and the CIC had changed her role with respect to the students:

It's very much that we try to re-conceive the teacher as a facilitator, rather than as a lecturer. ... That's one thing that I like about computers, anyway, they really help do that; [take the focus] off the teacher as the bearer of knowledge. That's the best thing about the computers.

She further described changes in social relations among the students, saying that the on-line medium both increased and leveled the amount of class participation:

And its nice that they don't see each other, they can only see the text of each other. You know they can't see the faces, they can't make jokes... they can't see the body jokes, or the, the rolling the eyes... And the people who are usually quiet in the large, in the open discussions, talking discussions, who are good typists, become the dominate people in the class. And then in the regular classroom, you get the opposite... then the people who are the jokesters can dominate... back and forth like that.

If you've ever sat in on a freshman comp class, we have about three people or four people who get very talkative and the others are very quiet... this one in particular [referring to a transcript of a Daedalus session] is very quiet, in regular class, and so is he, and look what they do when they come here, they say all sorts of really neat, nice things... You get more [and] you get almost an even amount of participation from everyone.

Finally, an important feature of the ENFI mechanism is that the on-line discussions can be recorded. ENFI discussions are often used as pre-writing exercises and ENFI proponents attest to their effectiveness for stimulating thought. But ENFI's contribution to the writing process can be more concrete—because
the ENFI records are in a digital text format, students and teachers can use them as a starting point for formal writing.

2.2.2 Networks for Asynchronous Structured Discourse

While Daedalus provided the pedagogical rationale for using network-based discourse in the Professionalism class, WIT supplied an appropriate network mechanism. When I initially approached JAN about using Daedalus, he replied that he could not use it because it didn’t work through the Internet (less yet the WWW).⁴ (At that time, the Summer before the Fall 1994 semester, he was creating the first WWW pages for the EI version of the Professionalism class.) About a month later I discovered WIT, a WWW-based mechanism for structured asynchronous discourse. It appeared that this mechanism could support pedagogical objectives like those of Daedalus and integrate well with the EI technological substrate.

![Figure 2-3: WIT Discourse Structure](image)

WIT is an on-line conferencing system that was created after the 1994 World Wide Web conference to discuss technical issues about the WWW itself [Luotonen 94]. The WIT mechanism was implemented using the Common Gateway Interface (CGI) and Hypertext Markup Language (HTML) forms, which allow a very basic style of interaction within the WWW medium.⁵ WIT was designed to be a formal and persistent conferencing forum. In the words of its creators (emphasis added):

A WIT discussion has a certain structure to allow people (or programs) to see what the state of play is. It is an attempt to improve on the mayhem of newsgroups and mailing lists, where you can't see whether a point has been settled, and it is very easy

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⁴ The Daedalus Integrated Writing System was originally implemented on local area networks only. The Internet-based DaedalusMOO system was later introduced [Daedalus Group Inc. 1996b].

⁵ CGI and HTML are components of the WWW technology.
to bring up the same point again and again. If you contribute to a WIT area, your message will not evaporate after a few days, but will be part of the knowledge structure of the database. [Luotonen 94]

Figure 2-3 illustrates the structure of discourse in WIT. A WIT area consists of multiple top-level topics, for example, “How should tables be implemented in HTML?” A WIT participant can create proposals that respond to (answer) a topic and arguments, which agree or disagree with proposals and previous arguments (i.e., arguments can be nested, forming an argument tree below a proposal).

<table>
<thead>
<tr>
<th>Topics</th>
<th>Proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td>From: John Doe</td>
<td></td>
</tr>
<tr>
<td>Date: 13 Feb. 1995</td>
<td></td>
</tr>
<tr>
<td>Topic: How to do HTML tables?</td>
<td></td>
</tr>
<tr>
<td>Let's do them like LaTeX</td>
<td></td>
</tr>
<tr>
<td>Why don't we use the same tags and features used for tables in the LaTeX markup Language.</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>Disagree</td>
</tr>
<tr>
<td>✓ Good idea; LaTeX provides X</td>
<td></td>
</tr>
<tr>
<td>✗ X is not possible on the net</td>
<td></td>
</tr>
<tr>
<td>✗ LaTeX lacks Y</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2-4: A WIT Proposal**

Each component of a WIT discussion (topic, proposal or argument) is implemented as a separate WWW page with hyper-links to the other components that are attached to it. Figure 2-4 schematically depicts the layout of a hypothetical WIT proposal page. The Topics and Proposals buttons at the top are hyper-links back to the list of all topics and the list of proposals (for the current topic), respectively. The argument tree for this proposal appears at the bottom of the page. The arguments attached to a proposal are listed as single line synopses at the bottom of the page. The indentation of these lines indicates the structure of the argument tree; a graphic check-mark or cross indicates the type of each argument, agreement or disagreement, respectively. Participants add new arguments by pressing the Agree or Disagree buttons, which produce an CGI/HTML form, like that illustrated in Figure 2-5. Here, the participant enters the one line synopsis and the multi-line full text of a new argument, then “presses” the Post button. This creates a new argument page and a new synopsis line in the proposal’s argument tree. The argument synopsis lines are hyper-links that lead to the respective argument pages. These have the same structure as proposal pages, including their own Agree/Disagree buttons, which allow posting arguments against arguments.

**Figure 2-5: Form to Enter a New WIT Argument**

![Figure 2-5: Form to Enter a New WIT Argument](image)
The discourse structure in WIT was inspired by the concept of Issue-Based Information Systems (IBIS) [Kunz and Rittel 70]. Kunz and Rittel introduced IBIS as a conceptual model “to support coordination and planning of political decision processes.” They initially implemented IBIS as a manual, paper-based procedure, but noted its potential for automation and integration with computerized information systems. (Other researchers have implemented computerized versions of IBIS-like systems to support the software design process [Conklin and Begeman 83] [Rein and Ellis 91].) Issues (which correspond to topics in WIT) are central to the IBIS model. Kunz and Rittel distinguish four issue types, each of which corresponded to a type of question:  

- **factual issues**: “Is X the case?”
- **deontic issues**: “Should X become the case?”
- **explanatory issues**: “Is X the reason for Y?”
- **instrumental issues**: “Is X the appropriate means to accomplish Y in this situation?”

In the IBIS process, after an issue has been formulated, a set of different positions (analogous to WIT proposals) is attached to it. Next, an argument sheet is attached to each position, which contains both arguments supporting and opposing it (these are gleaned from face-to-face deliberations).

Both IBIS and its descendent APIS (Argumentative Planning information System, described in [Rittel 80]) emphasize the need for open and controversial discourse in order to solve planning problems. Rittel described planning problems as “wicked problems”: problems that cannot be completely formulated before attempting their solution. Therefore, he argued, a planning system must start out essentially empty and then draw out and record issues and evidence as solutions are explored—they dynamically construct a “problem-scape.” Rittel also claimed that the “deliberate search for controversy” built into IBIS and APIS-like systems minimizes the risk of overlooking important factors or viewpoints in this process.

WIT is certainly an argumentative system in this sense. By polarizing the discourse—forcing interlocutors to explicitly tag each “utterance” as an agreement or disagreement—it indeed begs for controversy. The IDIS/APIS model describes a richer discourse structure than WIT, however. First, IBIS/APIS allows various types of relationships between issues; WIT does not represent relationships between topics. Second, IBIS includes the utterance type question of fact to represent requests for “non-controversial information” that are “directed to experts” (if the answer to such a question is in doubt, a

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*In [Rittel 1980] these questions were stated in a form that afforded answers other than yes and no, e.g., “What is was will be the case with X?” and “What is was will be the case with Y?”*
new issue is created). Also, in addition to tagging arguments as supporting or opposing an issue, in APIS, an argument may simply "refer to" a position.

2.2.3 Networks for Debating Ethical Issues

When I first suggested to JAN that we try WIT in the *Professionalism* course, I was thinking of using network-based discussion as a pre-writing exercise in which students would explore issues prior to writing their formal, individual papers (like the Daedalus Interchange I had observed). I suggested this in the e-mail message that initiated this collaborative design project:

> My thought was that we could set up our own WIT home page for the course ... and create topics for the various issues that will be considered. Under these issues, students could make and argue over relevant proposals.

I had also noticed the description of a face-to-face debating activity in the course's Web pages, however. In this same e-mail message, I suggested that we might "move some of this on-line":

> I looked at [the Web pages] and it is very exciting. I see that debates are a part of the course grade. Perhaps the WIT paradigm can be used to move some of this on-line?

JAN had already designed the debates as a structured discourse activity. In fact, the Debates discourse structure was nearly isomorphic to WIT's. Instead of topics, each debate was rooted in a scenario (a brief story) which described an ethical dilemma involving computing professionals. The students assigned to each scenario would formulate pro and con positions (corresponding to WIT proposals) with regard to the actions of the people in the scenarios and then debate the opposing sides in front of the rest of the class. This oral debate, like the written discourse in WIT, consisted of posing arguments for and against the positions.

The pedagogical goals for the debates and the *Professionalism* course in general, as stated in the course's WWW pages, also aligned well with the IBIS/APIS rationale (emphasis added):

> [to teach students] to make rational decisions regarding their responsibilities to the community;

> to develop in students an ability to analyze ethical problems;

> [to make students] capable of looking at both sides of an argument and ... able to weigh those positions in deciding what position they choose to take for themselves.

This emphasis on rational, analytical, and dialectical argument matched the IBIS inspired structure of WIT perfectly.

In our first design meeting, JAN and I established that the debate activity would be the only target of our work. We also defined the basic phase and role structure that this activity would add to WIT's discourse structure:
Each debate would last for one week.

In the initial period of each debate, the system would only grant "write access" to a small group of students (those assigned to that debate) for asserting positions.

After that, the entire class would have write access for posting arguments (the debate period).

Finally, the assigned group would use the discourse record of the debate to prepare an in-class presentations of its results.

At this point, after a single face-to-face design meeting, the basic application design was established—it was a straightforward transposition of an existing face-to-face assignment onto an exiting network mechanism. The case with which this happened contrasts sharply with the High School case described in the next chapter; there, finding an assignment to match the technology was the hardest part of design. Figure 2-6 visualizes the On-line Debates application as a system (adapted from WIT) and its encompassing pedagogical activity. (This figure first appeared as Figure 1-1 (chapter 1) as the paradigm for ASD applications; it is described in detail there.)

Figure 2-6: Visualization of the On-line Debates Application

### 2.2.4 Design through Mock-ups, Demo's, and Scenarios

The remainder of the On-line Debates development process consisted of just four design meetings. In each of these, a design artifact mediated the design conversation—i.e., served as a conversational prop. In three cases, the artifact was a mock-up or early running version of the system; in one case, it was a textual scenario—a story that envisioned the activity under design. In the case study of the following chapter, I found that these two types of design-mediating artifacts—system representations vs. activity representation—had a strong effect on the subject of design conversation: system models produced conversation about system structure and presentation or about the general technological substrate; activity
models kept the focus on pedagogical goals and activities. Although the present case study was consistent with this finding, the effect was less pronounced. In this case, pedagogical goals and the design of the On-line Debates activity dominated the design conversation even in those meetings mediated by system models. I believe that this difference had two causes: first, WIT provided an appropriate system design almost without change; second, JAN was already quite familiar with the WWW technology and computers in general (after all, he is a professor of Computer Science). Hence, the design process involved less learning, in regard to these areas.

**Preparation**
1. JAN organizes the students into debate groups. He assigns an Ethical Scenario to each group.
2. JAN gives Stuart a list of the groups including the following for each:
   a) The Scenario text (in HTML format?)
   b) A list of the group members with the following information for each:
      i) user name
      ii) password
      iii) full name
      iv) e-mail address
3. Stuart creates group and password files for the students. He also enters himself and JAN as class members, but not as members of any debate group.

**The Debate Process**
The following steps are repeated for each debate, only one debate is active at a time.
1. JAN gives the class paper copies of the scenario and instructs the class on the debate procedure.
2. Stuart authorizes the members of the debate group for posting Positions.
3. Each group member, at their convenience outside class, independently formulates one Position and posts it. The group members post their positions either from their own personal computer (assuming they have Mosaic 2.0) or from a publicly available computer (e.g., in the undergraduate lab or in the library).
4. During this period, other class members read the Scenario and any posted Positions; only the group members post new Positions, however. (Also, anyone can browse future debate Scenarios or past debates—including their Scenarios, Positions, and Arguments.)
5. At the end of the Position posting period, Stuart de-authorizes the debate group for posting Positions. He also authorizes all the class members for posting Arguments.
6. Class members (including the group members), at their convenience outside class, independently formulate Arguments that Agree or Disagree with posted Positions and other Arguments. They may formulate and post several of these throughout the remaining period of the on-line debate.
7. At the end of the debate period, Stuart de-authorizes everyone from posting Arguments. He then generates hard copy of the debate content and gives this to the group leader.
8. The group works together to digest the debate content using the hard copy or the debate’s Mosaic pages, which remain online. They formulate conclusions and a summary of the argument structure.
9. Finally, the debate group presents their summary and conclusions in class.

**Figure 2-7: On-line Debates Activity Scenarios**
The first system model was a mock-up that I constructed by simply changing the vocabulary (e.g., "topic" to "scenario") in a set of HTML files taken directly from the WIT system. We centered two other meetings around incomplete but running versions of the system. In the first two meetings based on these system models, we quickly accepted the structure and presentation of the mock-up or demo and moved on
to activity design. For example, the most significant result of the second of these (which presented the first running version of the system) was the addition of a "pilot debate" to the activity schedule. One goal of this pilot was "to get the kids some experience with the system," but we were also concerned about the students' motivation to participate. Here, our approach was to pick a "hot topic" for the pilot, namely, censorship of the alternative USENET newsgroups on the department's undergraduate computer system. Also in the hope of motivating a lively debate, we decided to invite the faculty to participate in the pilot as well.

We centered one of these four mediated design meetings around two textual scenarios, see Figure 2-7. This design representation provided a concrete, temporally ordered description of my own conceptualization of the activity that we were designing. My goal was to identify any differences between my conceptualization and JAN’s. In writing the scenario, I found that I was forced to fill in details that we had not discussed in prior meetings. This was due to the concreteness and sequential organization inherent in narrative—it made gaps visible. Further, by walking through the steps of the narrative together, discrepancies in our respective mental models of the activity became the focus of conversation and redesign. The scenario worked well for this communicative purpose; in addition it was effective at prompting new design ideas and illuminating JAN’s pedagogical goals. The following sections illustrate these.

2.2.4.1 Synthesis vs. Analysis in Debate

We first conceived the idea of new positions in the scenario-based design meeting. This critical design incident is the best example of the scenario prompting discussion that led to a new design idea. When JAN read step 5 of The Debate Process scenario (Figure 2-7) aloud, he questioned a design assumption that I was "forced" to make explicit in the act of writing this concrete narrative:

J: All right, [he is reading from the scenario] "End of the posting period, Stuart de-authorizes the debate group from posting positions [he reads "positions" with a questioning tone] he also authorizes all class members for posting arguments." Now, what's the difference between a position and an argument in terms of the way it appears on the system?

L: ... I laid this out as having an initial period in which just the group members stated their positions and then that period ends and then all the class members can then agree or disagree with those positions, those are arguments, in this lingo.

J: Sure

L: So two different phases there.

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* This had been proposed by some Computer Science faculty. The alternative newsgroups include some controversial material, including "pornographic" images.
J: OK, but, my question was, I guess it's a matter of terminology then, if anybody else in the class now, including of course the people [group members], says, "I have a 5th position, a 6th position I want to state," how do they do that?

L: So, OK, the way I had laid it out here was that positions would be posted only at the beginning of the debate and then that was cut off and then only arguments. So you're saying you'd also like them to be able to add positions, throughout?

J: I guess I'm saying that, but let's talk about it ... Because there ought to be, somehow as you go through this process, ... new insights ... that are different than the four [initial] positions.

Although JAN describes it as "a matter of terminology," it was actually a matter of temporal structure. We had used the terms "position" and "argument" frequently in previous design conversations, however, we did not realize that there were actually two types of positions (initial positions, posted by the group, and, new positions, posted by all class members throughout the debate) until the scenario clearly delineated the temporal boundaries (phases) of the activity and the actions allowed within each of them. Three conversation segments followed in which our focus switched between the educational activity and the system structure and presentation. We discussed specific system changes, such as special buttons and colors for new positions, but we did not pin these down and they were not implemented. On the other hand, the activity design was changed and the pedagogical purpose for this change was made explicit (emphasis added):

J: I don't want to say, "This group came up with four positions and those are the only four things you can discuss."

L: Right. Because really the whole sake of argument is to resolve positions or come up with new, and yet different, positions.

J: Yeah, synthesize arguments, [as well as] analyze arguments.

2.2.4.2 Restricting the Forum of Debate

We had originally envisioned the On-line Debates as a component of a larger debating activity—a warm-up for subsequent oral debates in class. Early in the design process, however, JAN changed the scope of the on-line component—it became the only forum for debate, followed by an in-class summary of the results. When we reviewed the activity scenario, he elaborated his goal of restricting the debate to the on-line forum. For example, when I mentioned student e-mail addresses in the Preparation scenario (Figure 2-7), JAN replied:

J: We want to keep the debates as much as possible in the domain, as opposed to people doing things on the side.

For this reason, we did not include e-mail addresses in the implemented system. Similarly, after reading the last step (step 9) in The Debate Process scenario, which read, "Finally, the debate group presents their summary and conclusions in class," he added:

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8 Similar changes were implemented the following semester.
J: Ah, let’s, on that number 9, just there’s a caveat that says, “without further discussion.”

2.2.4.3 Designing System Structure for a Paper-less Library

Another design goal, which emerged in the scenario-based meeting, reflected the distinction between the delivery and communication that I made at the outset of this chapter. In this case, JAN emphasized that the ethical scenarios, used within the On-line Debates activity, should be both continually available (to students within a semester) and reusable (by professors across semesters). In other words, the ethical scenarios, which were the referent of the students’ discourse in the debate activity, would also be maintained as part of the “paper-less” library of “material” that would be delivered to them through the net.

The concreteness of the activity scenario, my articulation of previously unspoken details, effectively brought this design requirement out in the open. In reaction to step 1 of The Debate Process scenario, which proposed handing out paper copies of the ethical scenarios to students before the debate period, JAN replied:

J: OK, item 1, uh, no. We, we’re trying not to give out paper in class, at that point. But what we will do is post in on the Web.

L: Right.

Next JAN suggested a structural design idea to support this goal:

J: That’s why, in some respects, we need to have two versions of this, not versions, two postings of it, one is freely available so that they can look through them anytime they want, and the other is a copy that goes at the head of the debate.

The conversation that followed, in which we negotiated the meaning of this utterance, was awkward. We were sitting across a desk from each other trying to communicate structural issues in words:

L: OK. But you see those as two different things?

J: Not necessarily. But from the, uh, let’s call it the debate page, you may have to create a link into it.

L: Right. But on that first page that I had in my stuff, it was a list of kind of the titles of each scenario, and I had envisioned that from there you’d link to the scenario page... So [the full text] can be on the Scenario page.

J: Yea, ... on the page itself.

L: And below that would be the positions as they are posted.

J: As they’re posted.

L: That’s exactly what I had in the stuff so far.

J: Yeah. The only thing I’m saying is, uh, we’d like to have a way to get to the scenarios without having to log on to the debate page.
L: All right. That’s an interesting point because I had envisioned that anyone, at all times, could get to the debate page and get to the scenarios, could actually read everything. The only thing that would be limited to certain periods would be the ability to post Positions or Arguments.

J: Yeah, but I’d like to make sure is that we maintain the Scenarios as part of the additional library, of the overall course, rather than merely being embedded in a single page, do you see?

L: I see.

L: So having the scenarios separate from the rest of the debate structure.

J: Yeah, at least as a storage item, when you get to each debate, we’d like to be able to pull in that scenario.

L: Right, I got you.

J: All right, keep going [he continues reading from the scenario] ...

While the narrative scenario effectively brought the basic structural requirement to the fore in our conversation, it was awkward designing its implementation in language, without the aid of other representations—we simply skipped the details in this meeting. We fully redesigned the page structure to separate the static and dynamic parts of the debates in the final meeting, where we used the running system and structural diagrams to mediate conversation. During the entire scenario-based design meeting, communication was difficult whenever conversation turned to issues of structure and presentation. In retrospect, it seems clear that effective design conversation requires complementary props to model the activity and the system—scenarios (and speech) work well for the former, the latter requires other instruments.

2.3 The On-line Debates Experience

From a first-level technological perspective, the On-line Debates (OLD) were similar to the other on-line components of the Professionalism in Computing class—they all utilized the WWW. In fact, when I asked the students how the OLD “supported” or “fit in” with the rest of the class, most replied simply that it fit in “pretty well”—to my surprise, few mentioned the delivery vs. discourse distinction that was prominent in my own mind. For example, one student described the OLD activity as “just another assignment that needed to be done.” Despite this common (perhaps justified) tendency for students to group all school work within a single category—“school work” vs. “the real world”—a second-level, social analysis reveals that the OLD differed significantly from the other network usage in this class. Closer inspection of the students’ experience with the OLD will reveal this. The following analysis is

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9 See the Related Work section of Chapter 1 for an overview of the two-level perspective for CMC [Sproull and Kiesler 91].

10 Even when I explicitly asked the students to compare the OLD to other uses of the network in this class (in the Fall 95 questionnaire only) few drew this distinction.
primarily based on the students' responses in open-ended questionnaires and focus group interviews. (Appendix 2.1, page 71 presents the questionnaire from Fall 95: these items were a superset of the other two semesters.) In this analysis, I have tried to separate first-level usability concerns from the students' deeper, social conceptualizations of their experience—the later is the interest of this research. I concentrate on the students' conception of both CMC in general and the specific features of the WIT paradigm, i.e., structure and asynchrony.

2.3.1 Motivation and Participation

Table 2-1 summarizes the volume of participation for all three semesters of the On-line Debates: participation is measured here as the average number of postings per debate. The amounts are broken down by posting type (speech act); for example, in Fall 94, an average of 17.4 arguments were posted to each debate, where 8.8 of these were agreements and 8.6 were disagreements. The number of students in the class and the number of debates running concurrently varied across semesters. This makes comparison difficult, but it does appear that the first semester, Fall 94, had slightly greater participation than the last, Fall 95: JAN taught the class in both of these Fall semesters (another professor taught in Spring 95) and told me that he had couched participation as more of a voluntary act in the latter than in the former. The graphs in Figure 2-8 and Figure 2-9 illustrate the temporal pattern of participation, both posting and reading, for the first four debates of the Spring 95 semester. In this semester, four debates ran concurrently over an eleven day period with a total of twelve debates run over three such intervals. (The other semesters ran two debates concurrently over four intervals for a total of eight.) The sub-period from

<table>
<thead>
<tr>
<th>Semester</th>
<th>Positions all (I/n)</th>
<th>Arguments all (a/d)</th>
<th>All Postings</th>
<th>Required Positions</th>
<th># of Students</th>
<th>Concurrent Debates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 94</td>
<td>5.1 (4.3/9)</td>
<td>17.4 (8.8/8.6)</td>
<td>22.5</td>
<td>2 Pro, 2 Con</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>Spring 95</td>
<td>3.0 (2.0/1.0)</td>
<td>14.7 (7.4/7.2)</td>
<td>17.7</td>
<td>1 Pro, 1 Con</td>
<td>46</td>
<td>4</td>
</tr>
<tr>
<td>Fall 95</td>
<td>5.4 (4.5/9)</td>
<td>10.0 (4.1/5.9)</td>
<td>15.4</td>
<td>2 Pro, 2 Con</td>
<td>38</td>
<td>2</td>
</tr>
</tbody>
</table>

The connection between students' participation in the debates and their course grade was weak in all semesters, counting only as general "class participation." Postings to the debates were never explicitly assigned grades.
Friday through midday Tuesday was reserved for the students assigned to each of the four ethical scenarios (about four students were assigned to each) to post their pro and con positions. From Tuesday afternoon through the following Monday the debates were open for all class members to post arguments and new positions.

The bimodal pattern exhibited in these figures, both for all accesses (posting or reading) and for posting alone, was typical of all the debates in all three semesters. Students tended to participate the most, just after the debates were open for argument and just before they were closed. The spurt of accesses on the Sunday and Monday following the debates (9 and 10 April in Figure 2-8) reflects the group members reading (and probably down loading) the debates in preparation for their oral presentation of the results—this pattern also appeared in all the debates.

![Figure 2-8: Spring 95 Debates 1-4 — All Accesses (reads and posts) by Date](image)

![Figure 2-9: Spring 95 Debates 1-4 — Posts (positions and arguments) by Date](image)
The distribution of participation across students, measured in posted arguments, was skewed. Figure 2-9 shows that a relatively small percentage of students were responsible for half of the postings in all three semesters; conversely, a significant percentage of students in each class did not post at all. Figure 2-10 illustrates the full distribution for the Fall 94 semester (the other semesters were similar).

### Table 2-2: Summary of Student Participation
(participation defined as posting arguments)

<table>
<thead>
<tr>
<th>Semester</th>
<th>% making no postings</th>
<th>% making half of all postings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 94</td>
<td>28 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Spring 95</td>
<td>22 %</td>
<td>26 %</td>
</tr>
<tr>
<td>Fall 95</td>
<td>19 %</td>
<td>19 %</td>
</tr>
</tbody>
</table>

Figure 2-10: Fall 94 — Number of Posted Arguments by Student

#### 2.3.1.1 Requirement and Engagement

Why did students participate in the On-line Debates? The most obvious motivation was to meet the requirements of “another assignment that needed to be done.” Even though the link between a student’s participation (both volume and quality) and course grade was somewhat indirect in all three semesters, students frequently cited “grades” or “requirements” as their primary motivation when I asked why they participated (item 1 of the questionnaire):

\[94-11: I made at least 2 positions, and maybe 4 posts. Read mostly. I participated what I thought was needed for a grade.\]

About the same number of students, however, reported personal motivation for posting (or not posting) to the debates. These students (several of whom cited the “grade” motivation as well) apparently saw the debates as something more than an assignment—it was meaningful discourse, sometimes engaging, sometimes not:
s95-1: [I participated] Quite a bit, but only on topics I felt had any merit. There were topics which I felt were pretty rotten.

s95-19: I wrote one of our groups initial positions and responded to 6 other debates. I participated because it was required, but also interesting.

2.3.1.2 Quotas and Construction

How did the students participate in the debates? I found two distinct categories—two kinds of obligation—that seemed to guide the students’ pattern of participation. First, many students described their posting strategy in terms of rates or quotas:

f94-5: I tried to post at least once to every debate.

f94-6: At least I post per debate. I felt obliged, and my duty. Class participation, ya know.

f95-14: I tried to participate at least once in each group’s debate. I participated to remain active in what was going on.

In some cases, the students’ perceived the quota in utilitarian terms: an exchange of postings for course credit—“class participation, ya know.” In others, as reported by a student in the Fall 94 focus group, the perceived quota derived from a sense of moral obligation—an attempt to aid classmates:

The expectations were a little vague. I posted to each one ... I guess it’s good in a way, that there weren’t specific assignments that said you must post once to each debate, but somehow, there ought to be a medium in there somewhere ... I felt sorry for [groups with low participation] ... [I] tried to feed people.

In contrast to motivation based on quantity, other students decided when and where to post based on the content of the discourse:

s95-37: I read the arguments and their successors and when I strongly agreed or disagreed with a position I posted a response.

f94-14: I posted about 4 times and read most of the other debates that were going on. I only posted when I felt it was appropriate and the subject sufficiently interesting.

s95-11: I just read through and posted where I felt it was necessary.

s95-24: I posted about 5 messages. They were very good points that nobody had said. I didn’t post more because everything was said by the other people.

These students expressed a responsibility to contribute constructively to the discourse: their postings should be “appropriate” and “necessary,” “good points” but not redundant, and reflect their “strong,” sincere feelings. These responses begin to indicate that some students viewed the product of the debate (the discourse record) as a “public good” [Kollock and Smith 94] (a collaboratively constructed resource for the benefit of all, rather than the fulfillment of individual assignments) or, as “objectified knowledge” [Scardamalia, et al. 94] (see Related Work in Chapter 1). The purpose of their own postings was to contribute to this collaborative effort rather than fulfill their individual quota, or help classmates fulfill theirs. For example, several students (like s95-24 above) emphasized originality as a feature of a good
post (indeed several students were frustrated that others had beat them to the punch in making specific points). The fact that discourse in the OLD was recorded in a persistent, structured and publicly visible artifact is likely to have heightened this conviction.

2.3.1.3 Class Time and Personal Time

![Figure 2-11: Spring 95 Accesses and Posts by Hour](image)

![Figure 2-12: Fall 95 Accesses and Posts by Hour](image)

The OLD, like WIT and unlike Daedalus, was a different-time/different-place communicative activity. For many students, this was a "convenience." Their responses reflected a sense that the OLD offered freedom from the narrow time constraints of in-class activities. The following responses were typical of this sentiment:

f94-5: This form [the OLD] allows me ample time to participate whenever I want.

s95-3: Whenever time allows me to do (usually late at night)

s95-32: Just whenever I felt compelled to

Figure 2-11 and Figure 2-12 illustrate the pattern of participation in the debates by time of day for the Spring 95 and Fall 95 semesters (this data was not available for Fall 94). These confirm that the students did indeed take advantage of the temporal freedom offered by the OLD.

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Likewise, several responses reflected the geographical convenience of the OLD. These named many different sites from which the students had accessed the debates, including, various campus labs, the library, and home. The following succinct response illustrates particularly well how the OLD mechanism allowed students to work on this social, interactive assignment in the time and place typically reserved for personal, individual work:

s95-16: I used my computer in my room. I posted on the weekend.

On the other hand, some students viewed these same features of the OLD as more constraining than traditional in-class activities. For example, one student (f94-6) complained that the on-line forum, in contrast to face-to-face, took his "personal time as opposed to class time." Of course other assignments in this course (e.g., writing papers) required students to work outside of class hours. On their "personal time." The OLD was different because it required students to interact outside of class hours. The following exchange in the Fall 94 discussion group illustrates the students’ mixed opinions regarding the class time/personal time dichotomy:

3: Actually I could almost agree with the argument that all of the trappings could actually get in the way of the debates themselves—getting connected to Mosaic—and you’ve only got that set time to do it so if your busy that week, you don’t have a chance to get to the lab, or whatever.

1: Yea, but ... let’s say you do it the last hour of class; now instead of having 4 or 5 days you have one hour to speak your peace.

2: It’s an hour that you’ve already dedicated to being in class anyway. And in reality, if I’m going to give up 25 minutes for a debate, I’d rather debate it in person here ...

For some students, the fact that this forum required a networked computer with a forms-capable WWW browser actually made the OLD less convenient and affected their pattern of participation:

s95-14: As a [specific brand of computer] owner (hope the bitterness is conveyed), I posted when I could get on a lab computer (usually between 12 am and 7 am in the 24 hr Hillcrest lab).12

f94-3: Lack of time and inability to get my SLIP up during the day on VTTELNET have hindered further participation,

s95-41: Since I don’t have my own computer, I have to go to the lab. Whenever I’m there for other classes, I will take a few minutes out for the debate.

While the last of these responses describes the OLD forum as constraining, "I have to go to the lab," it also demonstrates the freedom this forum offered over same-time/same-place interaction: the students could participate in their spare minutes when other course work bought them into the lab.

12 This kind of computer had been the official departmental machine for a year or so before prior to the semesters in which the OLD was conducted. Several of the juniors and seniors involved still had these machines, which did not run a HTML/CGI forms-capable WWW browser.
2.3.1.4 Duration and Passivity

Many students wished they and others had participated more and they frequently cited lack of time as a reason for under-participation:

s95-41: I participated in the On-line debates somewhat. It was fun. I wish I had more time for it though.

f94-7: I posted as frequently/as much as I could. Time restricted me because I felt it was necessary to read them and ponder them post.

f95-16: Somewhat—it was hard to find time to read the lengthy descriptions.

The last two responses emphasize that the textual, asynchronous debate format slowed down the interaction, in the sense that one was obliged to put more time and thought into utterances: one must "read and ponder" rather than just speak. Another student (f95-6) compared the OLD to other uses of the network in the class saying, "[It] took the majority of the time that we spent on the net." (Some comments blamed purely first-level effects of the technology; e.g., connecting a SLIP consumed a lot of time.) Many students were more specific, stating that the reason for under-participation (as they perceived it) was that the argument phase (the week each debate was open to the entire class for posting) was not long enough. This is typified and reiterated in the following compendium of one student's responses to several questionnaire items:

s95-6: [I participated] very little, because they were not long enough ... [the on-line format (vs. face-to-face)] was nice but more time would be better ... they were tough to get going ... make the time longer.

Several students in the Fall 95 semester described the OLD (and the WWW in general) as a "passive" medium, meaning that they had to periodically check for new postings—there was no automatic notification when changes occurred. Likewise, several students in all semesters indicated that they, and others, would have participated more but they simply forgot the debates were there (emphasis added):

s95-39: I participated mediumly. Read somewhat frequently but did not participate in the last week because I forgot it was still running.

f95-13: One position posted for my group's scenario. Three posts in response to other groups' scenarios. Wanted to participate more, but kept forgetting.

f95-9: Two postings, I didn't participate more due to lack of reminder that the system even existed.

f95-10: [I participated a] fair amount, Web is passive.

Two features of the OLD (and the asynchronous structured discourse model in general), in combination, created this passivity: asynchrony plus the shared discourse record. Again, while many students perceived asynchrony as a convenience (see the previous sub-section) it also meant that the students were responsible to define additional "class time," outside the regularly scheduled class hours. Furthermore,
“utterances” within this discourse mechanism were posted to a single, shared object (in contrast to e-mail mailing lists, where they are copied and delivered to the interlocutors’ personal mail-boxes). This external object creates a new “place” (see [Curtis 94]) in addition to the familiar places of a class, and the students must now remember to go there.

2.3.2 On-line vs. Face-to-Face

At the end of each semester, I specifically asked the students whether they preferred the on-line format of the OLD or live, face-to-face debates. A plurality of students preferred the on-line version of debating. This was reflected both in my own open-ended questionnaire and in one item of a forced-choice questionnaire administered within the E1 project in the Fall 94 and 95 semesters. The results from both questionnaires are presented in Table 2-3 and Table 2-4.

<table>
<thead>
<tr>
<th>Table 2-3: On-line vs. Face-to-Face (open-ended questionnaire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you prefer this form of debate or would you prefer traditional face-to-face debates?</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>OLD</td>
</tr>
<tr>
<td>F-to-F</td>
</tr>
<tr>
<td>Equivocal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2-4: On-line vs. Face-to-Face (forced-choice questionnaire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The idea of doing collaborative work, such as the debates, using WWW (or an equivalent system) is attractive to me:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>true</td>
</tr>
<tr>
<td>somewhat true</td>
</tr>
<tr>
<td>somewhat false</td>
</tr>
<tr>
<td>false</td>
</tr>
</tbody>
</table>

One advantage of open-ended questionnaires is that they allow respondents to articulate the categories they used to make sense of an issue, rather than simply reporting the “bottom line.” In this case, although several students did cite categories reflecting first-level effects (i.e., convenience and efficiency) in their responses, many of them also called upon second-level categories (social systems effects) when comparing the two media.

2.3.2.1 Opinions or Real Interaction

The concern most frequently expressed in response to this question was that the OLD lacked real interaction:

194-3: This form of debate is good, yet more interaction would be better.

13 In order to glean quantitative results from the open-ended questionnaire, I coded each response as either, favoring the OLD, favoring face-to-face, or being equivocal (no opinion, or a preference for combining the two forums).
f94-7: It is easier to rebut and counter arguments when you are immediately able to reply. The dispersed method of debating allows things to go at different rates, and people don't interact.

f94-16: I think the on-line debates are weaker [than f-to-f] because people tend just to post and not respond to their posts, thus making it an "opinion" forum rather than a debate.

Many students, as reported above, wanted more participation. These responses were more specific, however: they called for a "real debate," not just more postings but postings that responded directly to others ("rebuttals"), rather than just expressing one individual's opinion. A participant in the Fall 94 focus group described this sentiment well (emphasis added):

3: I tried to go out of my way to set up the trees so that I'd be disagreeing with somebody's agreement, or something like that, and try and get sort of a nested discussion because I felt that that wasn't used enough... you could really get a debate, a real debate, going in the discussion, rather than every body just posting an opinion.

![Figure 2-13: Argument Nesting for all three Semesters](image)

Several responses that called for greater interaction also suggested changes in the activity that might produce it. As reported above, these suggestions included, longer duration debates, and a less "passive" (e.g., sending an e-mail notice when another student posts an argument against a posting of your own). In addition, a few students suggested that their were too many initial positions in each debate. Figure 2-13 illustrates the amount of "nesting" in the debates for all three semesters. Clearly the Spring 95 semester produced the greatest amount of interaction, in this sense.\textsuperscript{14} There were also fewer initial positions for each debate in this class: each group posted one pro and one con position compared to two of each type in the Fall 94 and 95 semesters.

\textsuperscript{14} This class had more students but also ran more debates, yielding about the same number of students per debate.

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2.3.2.2 Equality and Time to Think

The most frequently cited benefit of the on-line forum was that it gave students more time to think about and polish their utterances before injecting them into the discourse (some students saw this as a trade-off with real interaction, however):

f94-3: I like both, but I prefer on-line debates because one has more time to respond with a full coherent argument.
s95-19: I prefer this form of debate because it allows you to think about your responses and make sure you say exactly what you mean to say.
s95-24: I prefer this kind. You can go home, take time to think and if you decide you can answer later. It's not interactive, but gives time.

Many students also lauded the OLD forum for promoting more equal participation across students, especially for those who were "shy":

f94-8: This on-line format gives everyone an equal opportunity to post ideas. Not as much interaction between debaters, though.
f95-15: This is good. People who are usually quiet and will not speak up in class now can easily express their opinions.
s95-15: Face-to-face debates might not get shy people involved.
f94-6: ... Some people are quiet & shy (not myself). This form allows them to voice as well.

Some credited the OLD for exerting more control over the discourse, preventing "shouting matches," and thus equalizing the participation:

s95-43: Face-to-face debates often deteriorate into shouting matches. Whereas the on-line debates give everyone a chance to be heard.
s95-23: I preferred this debate. Face-to-face debates often turn into arguments. This gives everybody a chance to say his or her say.

A few others cited the anonymity of the on-line forum. This is somewhat ironic because, as a deliberate part of the design, the students' real names were attached to all postings:

s95-11: ... [the OLD] gives more anonymity and might then encourage more response to the debates.

The participants in the Fall 94 focus group provided an example of a student who seemed to only find her or his "voice" on-line. Referring to this presumably "shy" student, one interviewee said, "[that person] said nothing in 14 weeks of class but did contribute to the debates." In fact, when I tallied the contributions by student, I found that this student (a non-native English speaker) was indeed the number one contributor. The self-selected participants in these focus groups tended to also be very active in the debates; the fact that the most active of them all did not to volunteer for the focus group might also reflect this student's shyness in face-to-face (English speaking) settings.
2.3.2.3 Impact and Realism

While many students credited the control, anonymity, and slower pace of the on-line forum for more thoughtful and egalitarian debates, others missed the "impact," "realism" and "excitement" of live debates (emphasis added):

s95-36: [I prefer] the traditional form. Electronic debate is weak because arguments do not have their full impact.

s95-7: [Face-to-face] is not necessarily organized or under control, but it's easier to stay on topic and get your point across.

f94-20: [On-line] is easier to get everyone together, but face-to-face debates allow you to really see, feel the progression of the debate and voice your opinions.

These students believed that face-to-face was a more effective forum; others simply said face-to-face was more exciting (emphasis added):

f94-18: It is handy, convenient, but face-to-face type would be more exciting.

f95-4: Traditional face-to-face. On-line lacks the emotional interest of a face-to-face debate. When we prepared for the debate, and it was much more interesting.

f95-10: It was good but still does not have the passion of face-to-face debating.

Finally, others, even if they preferred the on-line forum, regarded face-to-face as more realistic, more challenging—a "good experience" (emphasis added):

s95-30: Both are OK—face-to-face is a little more realistic but off-line allows for more planned thought-out concepts.

s95-20: Face-to-face would be a good experience. I think both are good.

s95-26: I'd prefer face-to-face because it requires you to have a very good understanding of the topic.

f95-5: Face-to-face requires faster thinking and is more challenging. I preferred on-line debates because it is not as confrontational.

One student in the Fall 95 focus group typified this attitude:

It could be said that putting the debate on the Web takes all the personal interaction out of the debate, it's not really a debate anymore ... We talked about this in class (here he refers to flaming people becoming more extroverted in CMC) so maybe its a good thing because it brings that out in them, but still it is allowing them to hide behind the computer and not interact with other human beings.

While this student alludes to the equalization effect, "it brings that out in them," he or she still considers CMC a crutch, something to "hide behind."

2.3.3 Structure

The OLD, like its ancestor WIT, differs from most CMC mechanisms in the large amount of structure it imposes on discourse. In the questionnaires for all three semesters, I asked the students what they thought
about this structure. As Table 2-5 indicates, most of the students responded positively. Most of these positive responses were terse, however, simply affirming that the categories did “make sense,” “seemed natural,” or “worked well.” On the other hand, the negative responses often cited specific problems. The responses I coded as equivocal were either vacuous or ambivalent—several of the later group cited interesting particulars, both positive and negative, which I discuss below.

Table 2-5: Student Reaction to the OLD Discourse Structure.

Did the categories Scenario, Position, New Position, and Argument (Agree/Disagree) make sense/seem natural/work well for the debates?15

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Equivocal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 94</td>
<td>14</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Spring 95</td>
<td>23</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Fall 95</td>
<td>21</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>13</td>
<td>15</td>
</tr>
</tbody>
</table>

2.3.3.1 Logical Organization and Clear Intentions

Among the majority of students who perceived the discourse structure positively, several added that it made the debates more organized, logical, or understandable:

f94-5: Yes, the categories made sense. The debate format was logical and straightforward. It was easy to follow.

f94-15: Yes—the format was good and easily understandable.

f95-11: I thought the organization was clear with this format.

One student even called for more explicitness in the types of utterances (more structure) in order to make the debaters’ “intentions clearer”:

f94-7: The Division was very good (Scenario/Position). Maybe when doing New Position, have Pro-Con similar to Agree/Disagree. We'd started the “CON: <Title>” and “PRO: <title>” design, which I think helped make intentions clearer.

While the OLD activity design prescribed two types of position, pro and con, these were not reified as separate speech acts in the system design; rather there was a single speech act (a single button in the user interface) that students used to assert a position—its polarity was implied in its content. Figure 2-14

15 These three phrases were substituted into the question in respective semesters. I tried different wordings after I received many terse responses on the first questionnaire, such as “Yes, they made sense.” The different phrases did not seem to affect the pattern of responses across semesters, however.
illustrates a case where some students made the polarity of their positions more explicit in the position's synopsis (as student f94-7 suggested).

2.3.3.2 Complex Scenarios

A primary goal in the design of IBIS, WIT, and the OLD, was to make the logic of the argument and the intentions of the interlocutors more explicit (even polarized). Many students reported, however, that the structure of the OLD system and activity made discourse more difficult. First, several students complained that the complexity of the scenarios made it difficult to identify what the pro and con positions were:

f94-10: [The categories] made sense but I would like to see another category that clearly specifies what the issue is—it sometimes seems rather vague.

s95-42: In most cases, the categories were appropriate; perhaps some scenarios could have been reworded to better fit the categories.

f95-17: Yes [the categories worked well, but] some scenarios did not work well with PRO and CON positions.

As described above, IBIS issues (which correspond to OLD scenarios) were supposed to be questions that were amenable to yes/no answers (or, at least, to discrete alternative proposals). On the contrary, most of the scenarios in the OLD were not of this clear-cut form and the students assigned to a scenario usually had to derive such a question from it in order to pose positions with pro and con polarity. Unfortunately, this question, "what the issue is," was only represented implicitly in students' posted positions. The OLD scenario (and its posted positions) presented in Figure 2-14 (from the third week of the Fall 94 debates) illustrates this problem.

This scenario, like many of them, does not explicitly specify which point of view (here, the bank's or the hacker's) to consider in formulating pro and con positions. In this case, the group members apparently resolved that pro would be in support of the bank's charges of wrongdoing (probably because the bank is the subject of the last sentence). They might just as well have decided that pro would support the action of the hacker, however. Also, most of the scenarios, like this one, were complex, raising several smaller issues, each of which could be the focus of pro and con positions. For example one thread of argument that developed for this scenario focused on the issue of the system giving a "welcome" message (hence validating the hacker's entry); another focused on the hacker using someone else's name. As one student in the Spring 95 focus group (who lamented the lack of philosophical rigor in the debate activity) put it:

4: One of the problems was that the questions [the scenarios] were way too broad ... or there were four or five issues in the question that were separate from each other so there wasn't really a pro or a con position, it was a different issue ... there should be one question ... one distinct question.
While such complexity and vagueness might foster richer discussion in an open forum, an issue represented as a single, succinct and well defined question would be more congruous with the highly structured, dialectical nature of the OLD system. Another approach to repairing this problem would be to add another level of structure in which students would extract and explicitly state the multiple issues (questions) within each scenario. Each of these would then be open to positions (and these to argumentation).  

![From: Eric Wiess — Communications of the ACM, 33(11), pp. 111-132](image)

**COMPUTER HACKER ("BREAKER"): ACCESSING COMMERCIAL COMPUTER SERVICES**

Without malicious intent, a computer hacker was scanning telephone numbers with his microcomputer and identifying those numbers that respond with a computer tone. He accessed one of these computers, using a telephone number he had acquired. Without entering any identification, he received a response welcoming him to an expensive and exclusive financial advisory service offered by a large bank. He was offered free of charge a sample use of some of the services if he would give his name and address. He provided someone else's name and address and used the free promotional services. This stimulated his interest in the services that bank charged for and gave him sufficient knowledge of access protocol to attempt to use the services without authorization. He gained access to and examined the menus of services offered and instructions for use. However, he did not use the services. By examining the logging audit file and checking with the impersonated customer, bank officials identified the computer hacker and claimed that he had used the services without authorization.

**Positions**

**CON**: The Bank Should Have Had Stronger Security

It's unethical to snoop around on someone else's computer systems

**PRO**: The hacker knowingly provided false information.

**CON**: No harm was done to the bank or its computer system.

**Figure 2-14: A Complex OLD Scenario**

**2.3.3.3 Logical Ambiguity in Arguments**

Among those responses suggesting that the OLD should impose less structure, the most common was to eliminate the explicit agree/disagree distinction for posted arguments. There were two types of problems cited. First, the symmetry of arguing pro and con positions simultaneously made the proper location for an argument ambiguous or redundant:

---

16 This re-design resembles the “claims analysis” structure of [Carroll and Rosson 92] in which the first step of analyzing a design scenario is to extract its distinct “features,” each of which will have both “up-sides” and “down-sides” (like pro and con positions).
s95-23: Disagreeing with a PRO argument was sometimes too much like agreeing with the CON argument.

s95-2: [The structure] seemed pretty natural, but often I saw [postings] that should have been in the “Pro” section, rather than the “Con” or vice versa.

Second, the reversal of logic when arguments were nested (posted to previous arguments rather than top-level positions) disoriented some students:

s94-4: Yes [the categories made sense, but] one suggestion: have some statement saying that this supports or opposes the overall act. I disagree with a disagree with a Con point of view—do I support or oppose the overall argument or action?

s95-22: ... it was hard to tell sometimes if an Agree was agreeing with the position stated or with the Disagreement directly before.

Nonetheless, my inspection of the debate records revealed few instances of structure problems—e.g., students classifying an argument as an agreement when its content actually disagreed with the position or argument to which it was attached. Even if some students were critical of the explicitness and complexity of the discourse structure, they did understand it. Furthermore, these responses indicate that the students considered the logic of utterances quite carefully—probably more so than in an non-mediated, face-to-face discussion.

2.3.3.4 Structure and Restriction: The OLD vs. USENET newsgroups

A few students responded to the question about structure by saying they would have preferred a less “restrictive” format:

s95-5: ... An open discussion would have been better.

s95-7: ... The agree/disagree was restrictive and didn’t allow for “remarks” or “comments” if someone just wanted to bring up a point.

In particular, several found the OLD’s two explicit speech acts to be constraining. Some (like s95-7) may have been satisfied with the addition of a third explicit act—a neutral “comment.” Others, like the following participant in the Spring 95 focus group who was frustrated by the polarized argument types, definitely called for less, not more, structure:

4: I thought the Agree/Disagree was more of a hindrance really.

L: How’s that?

4: Because when you read a Position and you think that they were wrong in one point and right in another do you agree or disagree?

---

17 Recall that such an argument type was described by Rittel for the APIS model: neutral comments were also allowed in the two other WIT-like applications I will describe in chapters 3 and 5.
If a student has posted a previous Position that is vague or ambiguous, this situation is similar to the Complex Scenarios described in the preceding section. Often, however, a Position (or previous argument) makes a single assertion as a chain of logic, or marshals multiple points of evidence. In this case a respondent may wish to agree with some points and disagree with others. In this case, the WIT/IBIS model encourages the respondent to factor his or her response into separate arguments. i.e., to post both agreements and disagreements to the same position. The student quoted above disliked the fact that this formal, dialectical model was “built-in to” the system. Instead, he preferred the less structured (less constrained) USENET newsgroup mechanism—“a wonderful format for the debates”—adding, “[the skill of making sound rational arguments] does not have to be built-in to the interface, [it] has to be built-in to the people.”

In response to another questionaire item, many students agreed that the OLD was more restrictive than other CMC mechanisms, both for better and worse. This item specifically asked students to compare the OLD to mechanisms like newsgroups (emphasis added):

s95-25: These debates have a specific topic that wasn’t deviated. On newsgroups they go off on tangents.

s95-42: The debates have a more rigorous and formal structure. Seem to stifle the interaction to some degree.

s95-30: Newsgroups are a bit less formal than this, and they often draw attention to thousands as opposed to a class of 40.

s95-20: [Newsgroups] get more heated.

The last three statements above echoed the desire for more participation and interaction that many students had expressed in response to other items. In this case, the students proposed newsgroups, a less constrained CMC mechanism, as the solution—a way to promote more lively debate. In the Spring 95 focus group, this association of newsgroups with more “heat” was a major topic:

3: [In newsgroups] you have more of a sense of point-counter-point kind of argument that you can get into.

L: Why do you think that the newsgroup structure has more of a point-counter-point?

1: Well flame-wars are very popular on the newsgroups and this is a perfect example of how it works.

*: [laughter]

3: You see these things [flames] everywhere, people love to argue on newsgroups.

... L: [10 minutes later] Was there a lot of flaming going on ... a lot of inappropriate comments?

*: “some”

0: It wasn’t getting heated, though.

*: [agreement]
It would have been much more fun if it'd been like a newsgroup, where it would get heated.

This language reflects the students' freer, more playful conception of discourse within the newsgroup forum: newsgroups are "much more fun," "people love to argue on them." On the other hand, the OLD was more formal and controlled, less like open discussion.

A total of 9 students (1 in Fall 94, 8 in Spring 95), in response to one or more questionnaire items, explicitly stated that they preferred USENET newsgroups to the On-line Debates. These students often explained their preference by citing first-level usability problems with the OLD—problems which could be remedied without changing the system's discourse structure. (For example, newsgroup software often includes a facility to automatically "quote" a previous posting when you reply to it.) I also found, however, that a preference for newsgroups corresponded to feelings about deeper, second-level characteristics of discourse. For example, in 7/9 cases these students indicated that they preferred less structured media.\(^{18}\) Also, only 1 of these students preferred CMC (in general) over face-to-face, while, 4/9 explicitly preferred face-to-face. Furthermore, none of these 9 students were among the 22 who cited "time to think" as a benefit of CMC. Students who prefer newsgroups tend to prefer fast-paced, high impact discourse forums over those that are disciplined, rational, and detached, like WIT and the OLD.

### 2.3.4 Publicity

#### Table 2-6: Student Reaction to the OLD

<table>
<thead>
<tr>
<th>Public Visibility</th>
<th>Like</th>
<th>Dislike</th>
<th>Indifferent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you like or dislike the fact that your postings to the debates are visible to the entire Internet community?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall 94</td>
<td>2</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Spring 95</td>
<td>9</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>Fall 95</td>
<td>9</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>9</td>
<td>57</td>
</tr>
</tbody>
</table>

Although only class members could post to the debates,\(^{19}\) the entire Internet community was able to read them. This public nature of the debates, coupled with the fact that the students' real names appeared on their postings, caused some concern in the Fall 94 semester. In that semester's focus group interview, one

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\(^{18}\) Here, I counted cases where a student simply expressed a preference for newsgroups in response to the question about structure in the OLD, in addition to, more explicit statements like, "open discussion would have been better" or "get rid of Agree/Disagree."

\(^{19}\) The OLD (and the other two WIT-like systems I implemented) enforced this through HTTP userid/password authorization protocol.
student said that he disliked having his name on the position he posted because, since the pro or con stance was assigned, it might not reflect his true feelings. Furthermore, even if the position did align with his true feelings, this student was concerned about making them part of the public record. As he put it, “sometimes, although my belief on something is strong, it is not necessarily going to keep me employed.”

Motivated by this comment, I decided to explore the students’ conception of the public nature of the OLD application. This feature distinguishes the OLD from many other educational applications of CMC. For example, ENFI applications are typically implemented on local-area networks; likewise, dedicated mailing list servers, which are not open to the public, are frequently used in college classes. On all three semesters’ questionnaires I asked the students if they liked or disliked the fact that their postings were visible to the Internet community. The derived quantitative results for this item appear in Table 2-6. Overall, and in each of the three semesters, the majority of students lacked strong feeling one way or the other. Several of these (7/57) elaborated, saying that it was a moot point because no one on the net would be interested, anyway. For example:

f94-7: It is fine for it to be visible—I doubt very seriously that people would be interested would be able to find it.

f95-26: Doesn’t bother me either way—there is nothing personal or confidential being posted.

f95-28: It’s irrelevant—how much does the Internet community care?

The most concern about publicity came from the Fall 94 students (they were the only ones to offer any details in their responses):

f94-5: I don’t mind too much. Unfortunately, anybody in the world, including potential future employers can view what I write.

f94-5: I dislike the fact that everyone could read the postings and knew who wrote the post. I think, we should use random aliases instead of names.

f94-18: I don’t like it. If posted, I like to be anonymous.

In the later two quotes, the students objected to the lack of anonymity, rather than the public scope of visibility, per se.

On the other hand, several students perceived this feature as beneficial. These responses expressed two directions of benefit: public to students and students to public. First, 5 students indicated that the public audience positively affected the quality of the students’ postings. For example:

s94-14: [It’s] good, people tend to craft responses better when viewed by many.

f95-8: I like it because it makes you consider things more before you post.

f95-18: [I] like it—people should learn that what they say can have an impact if stated correctly and published properly.
This belief supports the ENFI proponents' claim that "a real audience" better motivates students to write [Bruce, et al. 93]. It also aligns with the experimental results of [Cohen and Reil 89], which demonstrated measurable improvements in the writing of seventh graders when they addressed distant peers via a computer network vs. their classroom teacher. Second, as the last of the quotes above also suggests, some students believed that their postings in the debates could contribute to ("impact") the Internet community. There were 5 other responses that expressed, more or less explicitly, this idea that the Internet community could benefit from the students. For example:

f94-3: I have no problem with it at all. In fact, I wouldn't mind seeing the debates publicized on larger USENET groups.

s95-9: [I] like [it]. I think if people are interested in the discussions they should be able to read them.

s95-20: I like it. This gives people outside Va. Tech. the chance to benefit from our activities.

2.3.5 The On-line Debates and the Rest of the Class

Table 2-7: Integration of the OLD and the Class in General

<table>
<thead>
<tr>
<th></th>
<th>Fit Well</th>
<th>Not Well</th>
<th>Equivocal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 95</td>
<td>23</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Fall 95</td>
<td>9</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>14</td>
<td>21</td>
</tr>
</tbody>
</table>

As described above, the On-line Debates essentially transposed an activity that was already part of the Professionism class onto a new medium. It seemed that this new activity would fit well with the rest of the class, after all, the content (ethical issues in computing) was unchanged and the new medium's technology (the WWW) had become part of the class anyway—used to deliver other course materials. Nonetheless, in the Spring 95 focus group, I was surprised that several students were dissatisfied with the integration of the OLD into the rest of the course. In response, I added items 5 and 6 (see Appendix 2.1, page 71) to the Spring and Fall 95 questionnaires in order to explore the students perception of this issue. Table 2-7 presents a quantitative summary of the students' responses to item 5.21

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20 This question was worded slightly differently in the two semesters. In Spring 95 I asked how the OLD "fit (or did not fit)" within the class; in Fall 95 I asked how well the OLD supported the course "objectives and assignments."

21 I coded responses that clearly expressed an opinion as "Fit Well" or "Not well". I coded ambivalent and vacuous responses as "Equivocal".
2.3.5.1 Off-line Instruction for On-line Debates

Some students in the Spring 95 focus group were unhappy with the quality of discourse in the OLD. They felt that their fellow students needed more instruction on the technique of "logical argumentation," and that this instruction should be part of the live classroom not part of the on-line system:

4: ... [requiring people to argue in a logical manner] wasn't anywhere in the assignment ... for people who haven't done this type of argumentation saying, "You attack a premise, you attack an inference, you don't attack a person ... you don't just state the negative of the position you're arguing against."

L: Was that the kind of thing you were taught in this class?

*: Not at all ... It wasn't even covered, mentioned.

L: So the only thing you had to go on ... were the buttons ... the Agree and Disagree?

*: [agreement]

1: The things we had learned in the past.

L: [talking to 4] Do you think the kind of thing you've been talking about can be built into the system [using more structure]? 4: I don't think it's structure, it's an intro to logical argumentation ... in the assignment ... in the intro. say, "Here's the appropriate comments to make." ...

*: It should be part of the class.

1: Go over it in class, have it in the assignment ...

Several of the students in this focus groups did not like the explicit dialectical structure that was built-in to the OLD system. (The focus group participants in both semesters tended to be newsgroups enthusiasts.) Nonetheless, they seemed to feel that too little structure had been built-in to the students through classroom instruction. As student 4 suggested, "[good debating technique] does not have to be built into the interface, [it] has to be built into the people."

The following four questionnaire responses echoed this call for more classroom instruction:

s94-12: I liked this form ... [but] a demonstration of the procedure for performing the debates should be done in class. 22
s95-33: [We] never really discussed debating or anything similar in class.

s95-7: It would have been nice to overview the progress of the debates in class, but that is hard to do with a one class a week class.

s95-10: They sort of fit in, but not enough emphasis was placed on justification with ethical theory.

22 This was a response to the item comparing on-line to face-to-face. The Fall 94 questionnaire did not ask about integration with the class specifically.
2.3.5.2 Ethics and Writing

Among those students who indicated that the OLD did fit well with the objectives of the class, the most frequently cited particular (13 responses) was *discussion of ethical issues*. For example:

s95-4: I liked the debates. Fit well with the ethical questions of the class.

f95-17: Had to think about ethics.

s95-39: It fit well with the discussion of the ethics and elocution. Tied nicely together.

s95-3: 1) writing 2) express my opinion 3) chance to analyze other’s opinion 4) ethical topics. Fit well.

This is not surprising, the on-line statement of the course objectives mentioned ethics several times: e.g., “to provide the computer science graduate with a foundation on which to base future ethical and professional behavior,” and “to develop in students an ability to analyze ethical problems.”

On the other hand, few students associated the course goal of providing “a writing intensive experience” (also published in the on-line syllabus) with the OLD. While several students did mention the “papers” they had to write (usually disparagingly), they did not seem to conceptualize the writing they did for the OLD in the same way. Surprisingly, the response from student s95-3 (quoted above) was the only one to equate posting to the debates with writing. On the contrary, student s95-39 (also quoted above) associated the OLD with “elocution” not writing and another (s95-21) placed the debates and writing in direct opposition: “They [the debates] fit much better than the stupid 10 pg. papers.” The most extreme response of this type came at the beginning of the Fall 94 focus group interview. When I asked (at the beginning, for the sake of warm-up) how the students liked the class in general, one replied, “If I ever have to write this much again I think I’ll kill myself.... I did not like the writing at all.” Ironically, this student was one of the most active participants in the debates and one who had wished that others had participated more. While the new medium that the OLD brought to the debates—i.e., text—was an important pedagogical aspect of this application (recall the writing intensive component of this class), writing per se was transparent to the students themselves.

2.3.5.3 Technology

For several students, the connection between the OLD and the rest of the class was technological—both were based in the WWW. The following responses to the “fit-in” question (item 5) were typical:

s95-13: Yes [it fit]; it added to our use of the Internet.

s95-40: It fit with the style.

f95-11: It kept in context with the concept of the “paper-less course.”
In the Fall 95 semester questionnaire only, I specifically asked the students to compare the OLD with the rest of the course technologically: "How did On-line Debates compare to the other uses of the network in this class?" (item 6). To my surprise, only 3/23 students responded that the OLD allowed them to construct on-line materials or interact with each other:

f95-3: The other uses didn’t require me to post anything.

f95-13: The debates were obviously more interactive than the other Web portions of the class.

f95-21: It was better because it was interactive.

In contrast, 4 students explicitly reported that there was no difference, for example:

f95-11: I do not feel that there is any difference.

f95-12: About the same, not more difficult, not more efficient.

Apparently, most students did not consciously share (or at least did not articulate) my discourse vs. delivery categorization of the OLD versus other network usage within the EI project. Nonetheless, many of the interview and questionnaire responses described earlier did reveal the students’ awareness of their agency within the OLD—their responsibility for its content, as opposed to simply receiving information.

2.4 Summary and Discussion

2.4.1 Collaborative Design

Although the process of design was a secondary focus in this case study, some interesting results did emerge. This design process was succinct because the system was largely given to us by WIT. Hence our design conversations remained focused primarily on aspects of the activity, which we transposed from the face-to-face to the CMC medium. I found scenarios useful as a representation of activity design, in several ways: to make my understanding of the activity more concrete and to reflect this understanding back to my collaborator (revealing discrepancies in our respective envisionments); to stimulate new design ideas (sometimes in response to discrepancies); and, to elicit the educator’s tacit pedagogical goals. There were occasions where the design conversation turned to system aspects (e.g., structure or presentation), however, and I found narrative scenarios inadequate, here. In these cases, mock-ups and abstract structural diagrams provided more effective conversational props.

2.4.2 Asynchronous Structured Discourse in Education

Perhaps the most interesting result of this case study is that the two of the features of the On-line Debates application that were the most salient to me during design were largely transparent to the students in use. First, the OLD did indeed result in students constructing course material rather than just receiving it
through the network. Very few students articulated this categorical distinction, however. In fact, when asked directly, many of the students said that there was little difference between the OLD and the other WWW pages used for delivery in this course. On the other hand, while some students considered the OLD just another artificial assignment, many others were truly engaged by it as discourse, and expressed a sense of responsibility to post constructively to it. Second, while the OLD undeniably contributed to the “writing intensive” experience for these students, they did not perceive it that way—almost none of them described what they did as writing. In fact, some students who were most engaged in the debates as discourse complained about the other, writing component of this course. Many students were engaged by the OLD discourse and, they were writing. But, as in the ENFL model, they were writing within a community (not individually) and for a real audience.

Participation and motivation were salient category for both the students and the designers. The actual participation was skewed across the class population with 20% of the students authoring more than 50% of the postings and more than 20% not participating at all beyond posting their assigned positions. Many students wished that there had been more participation, in general, and more interaction (as opposed simply posting opinions), in particular. Many students said that the debate period did not last long enough or that they simply forgot to participate because the mechanism was “passive.” Others suggested fewer top level positions would foster more interaction (I found evidence to support this in the Spring 95 debates). Again, this common concern to increase the volume of discourse (even to “heat” it up) indicates that many students were engaged in this writing activity, even if they didn’t view it as such.

The students’ reactions to the asynchronous property of the OLD were mixed. Many saw this as a convenience; others saw it as an encroachment of “class time” into their “personal time.” Furthermore, some described the technology itself as a burden—an additional overhead in the learning activity. Nonetheless, a plurality of the students preferred the OLD over face-to-face debating. The most commonly cited advantages were that the OLD helped level the participation (i.e., encourage shy people who would not speak up in class to participate) and that it allowed students more time to formulate quality utterances. On the other hand, some said that CMC created an artificially controlled environment that lacked the rapid interaction (the “challenge”) of face-to-face debate. Some simply said the OLD was therefore less exciting, others implied that it was a less realistic learning experience.

A large majority of the students in all three semesters liked the WIT/IBIS-like structure of the OLD. A few elaborated, saying that the explicit structure made the overall discourse more organized and intentions clearer. On the other hand, some complained that the scenarios (the referent of debate) were too vague or complex, making it difficult to formulate explicit PRO and CON positions. as the activity prescribed. Others said that the logic in a chain of polarized arguments was difficult to relate back to the original
issue (the scenario). Nonetheless, my inspection of the discourse record itself showed that the students were able to categorize their postings (tag them as Agree or Disagree) accurately. A small group of students were quite vocal in their preference for the less structured USENET newsgroup mechanism for debate. These students viewed the OLD’s structure as a restriction, an impediment to the kind of fast paced, “heated” discussion that they enjoyed in USENET. This group of students was disjoint from those who cited “time to think” as a virtue of CMC; they also preferred the impact of face-to-face communication.

Finally, most of the students were not concerned about the public visibility of the OLD activity; several expressed doubt that anyone outside the class would care. On the other hand, a few students viewed the publicity as beneficial, saying it encouraged the participants to produce higher quality postings.
Appendix 2-1: On-line Debates—Student Response Form (F95)

Please describe your experience with the On-line Debating system. Say anything you want in addition to these questions (write on the back, if needed). Your response is anonymous.

1. How much did you participate in the On-line Debates? Please say why you did or did not participate.

2. Did the categories Scenario, Position, New Position, and Argument (Agree/Disagree) work well for the debates? Can you suggest changes or additions to the debate format?

3. Do you prefer this form of debate or would you prefer traditional face-to-face debates? Do you see strengths or weaknesses of either form? Did you ever discuss the debates in a face-to-face setting?

4. Do you like or dislike the fact that your postings are visible to the entire Internet community?

5. How well did the On-line Debates system support the objectives and the other assignments in this class?

6. How did the On-line Debates compare to the other uses of the network in this class?

7. Have you participated in other network discussion formats (e.g., news groups, Daedalus, e-mail lists, etc.)?
3. CASE STUDY 2: ISSUES ON-LINE (HIGH SCHOOL PHYSICS)

3.1 Introduction

This chapter describes a second case study of the application of Internet-based structured asynchronous discourse in education. In contrast to the On-line Debates, the collaborative development process in this case study was long and complex. This process involved a substantial amount of design conversation in which the educator and I explored general technological possibilities and pedagogical goals, as well as, negotiating specific application design and the division of labor within the development process. Although this project began prior to the On-line Debates development effort, the actual implementation and use of this network application occurred well after the first round of On-line Debates had been completed. In fact, as I will describe in some detail, the On-line Debates application would play a large role in the ultimate product of the current design process.

![Diagram of Design History Time-line]

Figure 3-1: Issues On-line Design History Time-line

(Tick marks on the upper horizontal indicate meetings; those that produced critical design incidents are labeled. The lower horizontal indicates the major phases of the design process; these correspond to the section headings of this chapter.)

Another significant difference between this and the case study of chapter 1 is the level of education. In this project I worked with a High School teacher, Allan Browne, to apply the network in three of his 12th grade Physics classes. The difference in educational level was significant not only in the intellectual and emotional maturity of the students (although the later, in particular, was significant) but also in the institutional context of design and use. Educators in the K-12 public school system have much stricter constraints on their work schedules and academic freedom than do University professors. In addition, the
public schools in which I worked (both in this case and in that of the following chapter) had only minimal access both to the network and to computers in general as compared to Virginia Tech.

Because the design process in this case was long and complex, the first and longer part of this study presents a design history of the Issues On-line application. This history describes a series of critical design incidents embedded in the series of meetings (design conversations) that produced them (see Figure 3-1). The second part of the chapter describes the outcome of using this application.

3.1.1 A Solution Reconstructs the Problem

A major problem in this project was finding a Physics "assignment" that would make use of the network. This appears backwards: one might expect any engineering effort to proceed with the technology (the network, in this case) responding to a prior problem (pedagogy, in this case). This project, however, like many applications of technology (especially computer technology), to some extent resembled "a solution in search of a problem." This cliché understates the case, but at times finding a use for the network did become the focus of our effort. Furthermore, network technology, both in general and in the specific features offered by asynchronous structured discourse would largely construct the pedagogical problems we would try to solve.

3.1.1.1 From Peer-Review to Debate

The search for a network-based Physics assignment began with the educator's, Mark's, idea of using the network for peer-review. Mark's original "grand vision" was to construct a system that would allow students to publish anything they wanted on the network and receive feedback from the entire Internet community. This system, as we initially conceived of it, included automated mechanisms for students to submit their work for publication, to track and retrieve comments, and to reply to those comments, including the ability to change their original work in response. As we designed this system, played with the available technology, and thought about exactly how the mechanism would be used as a class activity this "grand vision" changed. In the end, the assignment and activity we implemented was more prescribed and narrow than our initial vision. In fact, the fundamental mode of discourse changed from peer-review to discussion—even debate.

3.1.1.2 Time, Space and Audience

Technology (and it's specific context) simultaneously frees us from prior constraints and imposes new constraints upon us. An obvious freedom offered by computer networks is to enable communication partners to be distributed in both time and space. In fact, the goal of allowing people (e.g., parents) outside the traditional space and time of high school activities to directly participate in the students' work
was one of the early motivations for using the net in this case—for finding an assignment that used it. Ironically, constraints of the technology, at least our limited access to it, caused the ultimate activity to occur in a largely same-time, same-place context with only the students themselves directly involved. A significant result of this experience, however, was that even though the time and space distribution of the network activity was less than the potential, the network medium still had a large effect.

### 3.1.2 The Educator's View of Computer Technology

Allen Browne, the educator I collaborated with in this project, liked computers. On many occasions he referred to activities involving computers as “play,” as having “fun.” He had considerable experience with computers before our collaboration. He had done a Computer Science minor along with his Physics bachelors degree and had worked as an operator in a VAX computer installation at his university. Allen and one other teacher at the school were thought of as computer experts by many of the other faculty. On several occasions, this fellow teacher (who was not involved in our project) appeared after our meetings to engage in friendly debate with Allen and myself over the relative merit of Macintosh vs. IBM PC-type computers. These two teachers had installed the school’s local area Ethernet—pulling the cables, installing the face plates, etc. Allen also served as a personal consultant for other faculty at the school. On one occasion I witnessed him leading a fellow teacher though the school’s computerized grade submission process. In another incident, a fellow teacher, after losing a considerable amount of work due to a faulty word processing program, appealed to Allen for help recovering it.

Allen's affinity towards computers affected the way we interacted throughout the collaborative development project. On the one hand, compared to the middle school teachers whom I collaborated with in a concurrent project (see chapter 3), it was much easier for me to talk to Allen about technical matters. Also, mundane tasks such as delivering computer equipment were much simpler with Allen: I could just drop off the boxes; he was able and willing to set up the equipment himself. A example of this contrast appeared in my field notes from a day that I divided between the middle school (with many SLIP problems and much frustration) and installing a modem at the high school with Allen. Modems, and especially SLIP connections, are frequently problematic, but for Allen, in contrast to the middle school educators I was working with on another project, this was OK—a source of amusement:

> This experience was an extreme contrast to that at the middle school this same day. [Allen and I] experienced many problems (we did not have a DNS server in the SLIP so we had to find some IP numbers in order to get anywhere), but [we] approached each of them as a puzzle to be solved.

On the other hand, Allen's familiarity and interest in computers was at times a source of frustration for me. He was eager to dive into the internal implementation details of the system features we proposed and
to discuss the World-Wide Web (which we planned to build upon) at a general technical level. Indeed, on many occasions he showed considerable insight in these areas. Several entries in my field notes describe my frustrated efforts to stay on my predetermined agenda: concentrating on his pedagogical goals and the computer functions as they would appear to the end-users—the students.

3.2 Designing Issues On-line

As I described in chapter 1, there are both practical (practitioners know about their own work) and political (practitioners have a right to a say in their own work-life) reasons to collaborate directly with practitioners in the design of computer applications. I invoke both of these for the purpose of my work. Being a practicing educator myself I strongly believe that individual educators should develop their own pedagogical philosophy and practice. But this is not just a moral conviction; I also believe this results in a better product. So, my concern with collaborative design is more focused on the practical rationale and I will have little to say here and elsewhere about the political issues. (See [Bjørkness and Bratteteig 94] for a recent discussion of this distinction and a call for greater emphasis on the political rationale.)

Under either rationale, a central assumption of collaborative (or "participatory") design has been an egalitarian relationship among the collaborating designers. As pointed out in [Markussen 94], researchers in this area often use terms like "mutual learning" or "experts working with experts," which imply symmetry where it certainly does not exist. After all, some of us design computers for a living while others teach high school. While I may use such expressions myself, I will also try, for the sake of collaborative design, to point out the asymmetries in the design process that I describe here (as well as in the next chapter). Likewise, in a formal linguistic analysis [Timpka and Sjoberg 94] identified three different "voices"¹ in participatory design: the voice of participatory design (refers to the process itself, particularly resolving conflicts); the voice of practice (refers to work practices and the product in context); and the voice of engineering (refers to technical problems and constraints). Much of the "data" I report below is based on transcripts of collaborative design conversations and I found all these voices present there as well.

3.2.1 Initiating Collaboration: Early Conversations

¹ They use Bakhtin's notion of "voice": the "perspective" and "frame of social reference" of an utterance, as opposed to the physical voice of an individual.
3.2.1.1 The Idea of Networked Peer-Review

The collaboration began when I approached Allen during a summer workshop sponsored by the Virtual Schools planning project. Allen was one of six K-12 public school teachers who had been selected to participate in this one year project. At this three day seminar, held at Virginia Tech, researchers from various disciplines, and representatives of a corporate partner, met with the educators. The purpose was to get to know each other, to talk about the goals of the project, and to get hands on experience with the network technology that would soon be available to them. (The project would supply the 6 schools with high speed T1 Internet connections, local area Ethernet networks, and a handful of Macintosh computers.) Allen mentioned the concept of peer-review during brief introductions in which each of the six teachers said a little about what they would like to do with the network. This appealed to me because of my predominate interest in the network as a communication medium (as opposed to an information source or medium for delivery materials). When I suggested a collaboration Allen seemed quite interested; in fact, (as I describe it in my notes) he seemed almost to sigh in relief at the prospect of help. I followed up on this conversation with an e-mail message proposing that we meet to talk about "potential collaboration on [his] use of the Internet (Mosaic, etc.) in his teaching." He accepted, proposing that we meet at a local restaurant.

3.2.1.2 Roles and Referents in Design Conversation

Our first two meetings were in restaurants. This frustrated me. I was anxious to start "the design process" and I did not think we could do real design in such a setting. My frustration is revealing: although I wanted to do "collaborative design"—I wanted the product of design to originate in Allen's pedagogy—I still considered the process of design my jurisdiction. In my previous work experience as a software engineer I would begin new design projects by envisioning the user interface of the system through drawings (as opposed to written specifications) and I wanted to test this in a collaborative process as well. I also thought Allen's classroom, with its chalk board, would be an ideal setting for collaborative drawing. When I suggested that we meet there so we could "sit down and draw pictures of what we wanted to do," he surprised me by responding, "you mean write specifications?"

In the first restaurant meeting, we negotiated both the purpose of our collaboration and a common technical level for conversation. At the start Allen asked me, "So, what do you want to do with my kids?"

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2 Some of my tasks at the high school and middle school (e.g., delivering and setting up computer equipment) constituted my informal role in this NSF funded project, which was intended as a precursor to a larger network infrastructure project. Other graduate students, performed this function at four other public schools in our county.

3 I also wanted to move to an environment where I could "get quality data," i.e., tape record our sessions.
I explained that he was my primary interest—how we designed together. I explained my philosophy of participatory design and described some of my work experiences that had formed it: we then traded computer stories for a while. He told me about a software system, sort of an electronic grade book, that he had once thought through in great detail (but had not implemented). He also sketched his ideas for a system that became the starting point and continual bench-mark for our subsequent conversations—the "grand vision." This vision was for a general on-line repository where students could place their work for perusal by parents and others.

This first discussion was ambitious and I was both excited and challenged by the complexity of the grand vision. I suggested that we could write new network software clients perhaps like Mosaic but customized for his pedagogy. He expressed caution saying, "Do we really want to do that? Won't there be problems?" My response, "Yes. That will be the fun part" revealed my own conception of computers as play—a conception that we shared. He then suggested that we work on delivering Physics simulations (programs written in an educational course-ware authoring language) over the network. Here, perhaps as the first concrete instance, he demonstrated his ability and eagerness to dive into implementation details.

He asked me if Mosaic was capable of starting programs. This insight impressed me. I knew Mosaic could start user defined viewer programs for specific types of files and this might work for retrieving and running these simulations, but this was a still a gray area in my own knowledge of the technology. I was challenged by his technical insight; in my prior conception of participatory design, I was supposed to supply the technical knowledge and he, as the collaborating domain expert, was supposed to supply the pedagogical expertise. In my field notes I worried, "Am I needed?"

In our second conversation, again across a restaurant table, the mismatch between my preconceived division of labor in participatory design and our emerging relationship became more acute. My field notes state that in this discussion I tried to keep Allen on "the application level of design: i.e., get him to think about Physics education," whereas, he tended toward the "computer technology" level. Several statements revealed his penchant for technology. When I referred back to the idea of sending physics simulations over the net he countered doubtfully that these files averaged "5 meg" in size; when I prompted him to elaborate his grand vision, he did so in technical terms, describing "a file [containing] hidden codes": he also proudly described a "dispatcher" program he had written for the PC—"it thrashed ... [but] it did multi-tasking": and, at one point, he expressed disdain for his alma mater's CS department saying, "[they train] application writers."

I was much more technically conservative in this second meeting. This was partly an effort to reassert my technical leadership—it was also prudent. I pushed for using off-the-shelf software: Mosaic and the World Wide Web, in particular. Allen replied that his vision did not look like Mosaic—it had more than
one window. (The multiple vs. single-window distinction would continue to be important in our design conversations, as would the choice between buttons and text for hyper-text links. Allen readily conceptualized the computer in terms of user interface building blocks.) This was the first indication of how the technology would constrain as well as extend Allen’s pedagogy. This was also a clear case where I injected “the voice of design.”

At the end of the second restaurant meeting, I again told Allen I’d like to meet in a place where we could draw. This time he replied, “Oh so you want me to make my ideas specific!” We ended up, however, with Allen coming to the computer lab at Virginia Tech about a week later to look at some existing applications of HTML forms. I had described forms as a possibility for implementing his vision with Mosaic. Allen seemed much more excited about coming to the lab than meeting in his classroom. This time I was explicitly prepared to “talk technology” with him and as I showed him applications on the Internet that used forms, we also looked at their source HTML, noting how the buttons and fields were “coded.”

Of the three example applications that we looked at, one of them was WIT (see chapter 2), which would prove to be particularly important in our design. I selected it as a demonstration because it showed how forms could create a communication forum on the Web, as opposed to an information retrieval mechanism. After the demos, I asked Allen if it looked like this mechanism would be adequate for his vision. He quickly answered no. I then suggested that it might be enough to get us started. We scheduled our next meeting for about a month later (a month into the school year) in his classroom. At last we would meet where we could “design”: I was anxious to find out how much substance the grand vision actually contained.

3.2.1.3 The “Grand Vision”: Pedagogy Revealed through Design

In my notes I label this as the “First Design Session.” Finally, I had the design context I wanted: we met in Allen’s classroom; we were able to draw our “design ideas” on the blackboard; and I tape recorded our interaction. During this conversation Allen drew concrete pictures of his envisioned system. As it turned out, the system we ultimately implemented did not look like these drawings. Nevertheless, this session was critical to the final design. Many new questions and concepts were brought to the forefront in the act of making the vision concrete and we negotiated their answers and meaning as we went along. The drawings turned out to be less a “specification” than a catalyst for conversation and mutual understanding.

This design session proceeded primarily with Allen drawing, while I interjected questions. My motivation for having Allen take the lead was philosophical: I believed, and wanted to demonstrate, that teachers were capable of doing design. Through this conversation, however, I began to learn about Allen’s
pedagogical goals even though they were usually not stated as such and I did not ask about them directly. The questions I asked were primarily technical, about mechanism, but his replies typically included, at least implicitly, his pedagogical rationale. For example, when I asked how reviewers would post their comments, he replied: "I think that the people who review them should be able to read ... other people's reviews, so we can't do e-mail." I believe that having Allen do design, explicitly in terms of user interface components, was an effective technique for eliciting these goals.

3.2.1.3.1 Peer-Review vs. Parental Monitoring

The session began with negotiation about which of two ideas to start with: I asked, "... peer review ... or parents monitoring what is going on." We had discussed these as semi-independent ideas in our previous conversations. At this point, it was not clear whether they were indeed different things, but we decided to begin with peer review. In the remainder of the project, we never mentioned the other as an independent idea again.

3.2.1.3.2 Structure, Freedom, and Diversity

Early in this meeting, the following statement revealed that Allen had definite ideas about what made a system "sophisticated," in particular, more sophisticated than Mosaic, with its single viewing window:

I'd like to get more sophisticated than just, view ... Instead of just putting the picture in there [in response to a view request] it pulls up a window, and there's a graph, or something like that.

As he continued to describe the more sophisticated system several related categories, both pedagogical and technological emerged:

In the grand scheme ... a way that the students themselves could define their structure ... [write] a paper and break it into pieces that they want ... Instead of forcing students, to say, "I want you to make 'Procedures,' 'Discussions,'" blah, blah, they can make what they want and tack it all together ... custom ...

They define Intro and Graphs ... when it [the system] pulls it up it says, 'OK these are the places in the document you are defining,' and it creates a row of buttons over here ... Just based on the document. You want to see the graphs, boom, hit the button and it takes care of it. And another student's paper might work differently and they define their own things, and it's all inside the document that gets sent and read by this program that we have created ...

Which I think is definitely getting more sophisticated than just [Mosaic] forms.

From these statements (made while drawing a component of the user interface on the blackboard) part of his philosophy began to emerge. First, structure was important; the students should break their papers into defined pieces. It was also important, however, not to "force" the students to use a pre-defined, ("blah") structure, rather, they should be free to "define their structure ... break it into pieces that they want ..." Finally, he encouraged diversity: "... another student's paper might work differently." This pedagogy both induced and became clear in the technical features he proposed: separate windows for
"pieces," "buttons" to move between them, and a program (a pre-processor "that we have created") to generate the on-line representation based on the student's "own things ... [defined] inside the document."

3.2.1.3.3 Writing Code
Allen distinguished "writing code" as a special category of computer work and his assessment of the students' ability to write code both influenced and was revealed by his design. For example, he rationalized the pre-processing program (proposed in the quotation above) as. "an organizing program ... [which] merges [the pieces] together ... otherwise, [the students] have to be able to write HTML." When I asked if that was a problem, he replied, "yeah, they can't write code." A few minutes later, however, I proposed that using HTML forms and Mosaic (rather than writing custom software) "would get us started sooner"; he replied, "Yeah, because we don't have to write any code." Apparently, whether writing HTML constituted "writing code" depended on the writer: for most high school students, HTML was code, and they could not write code.

This negotiation of meaning (when "HTML." equals "code") resulted in another instance where we compromised the grand vision. Allen proposed:

For the time being, the ones that I want to submit just to get us started, I can help the students write the code, write the HTML,
directly, rather than, 'til this other part [the organizing program] is working.

3.2.1.3.4 Students Submitters and Outsider Reviewers
The first third of this hour long conversation was almost exclusively about how a student would submit "a piece of work to the system" and this topic resurfaced throughout. This surprised me; coming in to this meeting, I had only thought about the mechanism that "outsiders" would use to post reviews. Allen was more student centered than I; his first concern was how the system would support them. This difference in perspective became apparent early on. I was confused about a button labeled "Submit" that Allen had drawn and I asked, "I thought it was the outside reviewer who would be pushing the buttons ... to be able to select what they wanted to see." Allen, answered, "The student has to create the document" and he gave a scenario where a student used the organizing program and the Submit button to put a piece of work on-line.

Later in the conversation, Allen refined his vision for supporting the student author by articulating two system functions: the organizing program and a remote submission "protocol." Both his technical knowledge and enthusiasm are evident in this exchange, but I, worried about the implementation effort, inject "the voice of design" to draw the design back again:

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4 He further qualifies this program as "this program on the side, which is not part of BEV." meaning that it runs on the client side.
L: You’re talking about them being able to do the submit from long distance?

B: Yeah … and it being able to view the files that they have on their disk, which means that we have to have another program … suspend the Mosaic program … and write its own communications on the Internet. Is that possible?”

L: Yeah Mosaic does all kinds of different protocols … but for starters

B: Oh sorry, yeah …

Allen rationalized his remote submission idea saying it would allow him to “activate” other classrooms for submission. Including outsiders in the peer-review activity was a goal from the beginning, although, we usually talked about outsiders as reviewers. Ultimately, no outsiders participated as reviewers or authors; nonetheless, their effect in the role of anonymous spectators (lurkers) was extremely significant to the outcome of this project.

3.2.1.3.5 Research or Anything: The Referent of Peer-review

Another foreshadowing of the evolution of the project came when I asked what the proper term for a “posted piece of work” should be. Allen replied that he had originally thought the students would post “research” but now was thinking they would post anything they wanted to get feedback on. He cited a project that the students had just completed as an example. In this project the students drew a floor plan of their home and computed its most space efficient room. (We later agreed that this project would be useful for constructing a mock-up of the peer review system in HTML.) Here Allen’s pedagogy emphasized freedom: “anything they want.” At this point we envisioned the technology, the network and the software, we would develop (e.g., organizing and submitting programs), as a means for enhancing the students’ freedom. Later this same technology, and constraints of time and development effort, would eliminate much of this.

3.2.1.3.6 Two Levels of Peer-review

We next discussed how reviewers would submit their comments about students’ work. I proposed a scenario based on the “posting” mechanism I had implemented for another Web-based system used for online debates. This prompted a new design idea from Allen. He asked, “Can I complicate this a bit,” and proceeded to draw a new window on the board. This window contained the abstract and a set of buttons leading to the other sections of a student’s report. He then proposed:

I picture sort of two levels of reviewer comments … it’d be nice if the user [reviewer] had a way to … instead of leaving some big comment, they could tag a note to the data [one section of the whole work] and say, ‘I think one of your numbers is wrong.’

Again, the act of designing this mechanism (which we began to call “post-it notes”) prompted Allen to reveal this pedagogical motive. Immediately after describing how it might be implemented, including drawings, he offered this analogy:
Sort of, instead of like the teacher taking a student's paper and writing a big letter [grade], explaining it and throwing it on there, it's like taking a post-it note and putting it next to something.

The rationale for this feature was that it would allow more specific, thoughtful feedback. "[put] next to" its referent "instead of ... thrown on there."

The specific user interface and activity that Allen designed for post-it notes in this session changed substantially in our ultimate implementation. Like several other general system features that emerged that day, however. "two levels of reviewer comments" did persist as an important technical and pedagogical concept.

3.2.1.3.7 Responding to Responses: Peer-Review or Discussion?
Allen next envisioned how students might respond to reviewers comments:

It would be great if in addition the student could, not necessarily respond to a response, but ... [after seeing a comment] expand on that ... it'll add a field that just the student can add ... and that's the end of the comment [it doesn't go on for ever] ... if the reviewer has a question, the student could, that could become part of the document.

In retrospect, this was clearly a critical incident in our early design. It was the first sign that we would ultimately design a discussion activity rather than one based simply on publication followed by review. It's hard to tell if my mention, earlier in the conversation, of the On-line Debates application had prompted Allen to suggest this (I suspect that it did in part). There is no doubt, however, that this prior application would significantly shape our later design.

3.2.1.3.8 Getting away from Linear
For Allen, an important measure of educational software quality was how "linear" it was. He first indicated this by saying that the post-it note reviews would make the system "less linear."

Later as we were wrapping up the conversation he adds: "From a design perspective, I am trying to get away from linear types of things" and he continued by describing the evolution of educational software:

... interactive flash cards ... [to] games ... [to] interactive physics ... Finally you can use a computer in an educational setting.

When I then compared Mosaic to linear flash cards (viewing one page at a time in sequence) he replied, "The hypertext ability I think is a step up"; I add, "And of course the network part."

Although the system that we would finally implement did not resemble "interactive physics," which Allen held in highest esteem, it did have non-linear qualities. In this system, the on-line pieces of work were structured in non-linear hypertext. Of greater consequence, however, the activity of review was non-linear (in some cases perhaps more so than Allen might have wanted). By this I mean it did not proceed as a prescribed sequence of human-computer interaction, like the drill-and-practice of "interactive flash
cards.” Even though the application was highly structured (both the system and the activity) the dynamics of human-human interaction (mediated through a computer) would produce unanticipated results.

3.2.2 Getting Something Tangible: Props for Design Conversation

**Submitting a Project**

1) A student in the physics class wants to submit his latest physics project for peer review. He begins by conceptually organizing this project into a set of discrete components; e.g., Abstract, Data, Graphs, Tables, Methods, Conclusion, etc.

2) After deciding what the components are, he begins to format the contents of each of them in a prescribed way. This is all done mostly with plain text files using blank lines to separate paragraphs, etc. Two graphs stored in GIF files (they were scanned in at the high school) also are included.

3) The student is working on his home PC. When all the components have been defined and formatted, he opens a SLIP connection (using his BEV account) and e-mails the component files to the mail address of the BHS Physics Peer Review Server.

4) When this mail is received, the server places it into the Peer Review Data Base. This makes the project available for review on the World-Wide Web.

**Reviewing a Project**

1) A physics professor at Va. Tech has heard of the Peer-Review system at BHS that it is linked into the BEV Mosaic pages. He follows his HotList link to the BEV Home Page and from there follows a link to the BHS Physics Home page.

2) From the physics class home page, he browses the students’ projects; he moves between the project pages, reading their abstracts. He finds one that is related to his research and begins to explore its components.

3) He notices that a calculation is incorrect in one part of the project and attaches a post-it comment with a correction. He also attaches a post-it to a graph suggesting a better use of color.

4) Finally, he moves back to the project page and enters a comment praising the project overall.

**Reviewing Comments on a Project**

1) A student wants to check if anyone has posted any comments about his project that recently went online. He connects a SLIP from his PC at home, opens Mosaic, and goes to his project’s home page (its URL is in his HotList).

2) He checks the list at the bottom of the project’s page and sees one new comment has appeared. He clicks on this and the text of the comment comes up.

3) After reading the comment, he decides to follow its advice and correct one of his calculations. He enters an annotation to the comment stating this intention.

**Figure 3-2: Peer-Review Scenarios**

At the end of the Grand Vision session, Allen and I negotiated about how to proceed:

B: Let’s see if we can get something tangible here, cause I’m willing to put together a sample one that I can give to you that you can play with.

L: OK... actually, another way to go about might be for me to mock up something like this [referring to the drawings] and give the HTML files to you ...

We both saw the need, at this point, for what I, as a software designer, call a prototype or mock-up. I was surprised, however, that he not only suggested this first but, in fact, he proposed to “put it together” himself! Even though this exchange provided evidence for one of the theses I wished to demonstrate, that teachers can design, I again felt my technical role in our collaboration challenged; hence my counter offer. After some discussion about writing HTML we agree that I would take the first stab at mocking up his
drawings and then give them to him to refine. He replies: "Yep. I'm pretty good at following code that's already written."

I constructed a mock-up of the "screens" Allen had drawn in our meeting. I had to transpose these in the HTML pages; HTML 2.0 did not support horizontal layout. Also, they were not completely functional because I did not write the "code" that HTML forms require (here I mean what I thought of as "real code": programs written in the C programming language). The mock-up was essentially Allen’s design, however. In addition, I wrote a set of three scenarios to illustrate my conception of the peer-review activity. These scenarios (presented in Figure 3-2) formed a concrete, narrative description of the sequence of events in one complete hypothetical instance of peer-review. I hoped this would illustrate by example my interpretation of the design issues and ideas we had discussed. For instance, we had decided that students could not "code" HTML so in the scenario the student formats his project in "plain text files using blank lines to separate paragraphs"; this is later processed into the "Peer Review Data Base."

My original intention in creating the scenarios (as well as the mock-up) was to, as Allen had put it, "make things tangible." In particular, I thought that these concrete representations would serve as communication aids (props) for further conversations in which we would generate and refine design ideas. Likewise, I intended them as a check of my mental model against Allen's. They did serve these purposes but, as I was surprised to discover, the act of writing the scenario was itself a catalyst for design—this time design as a solitary activity. Because of the temporal sequence inherent in the narrative, because it was detailed and concrete, and because it was written, I was forced to think through the process more completely than in conversation about design, particularly the connections between phases and events.

3.2.2.1 Scenarios, Mock-ups and the Referent of Conversation

Our next meeting, about two weeks after the Grand Vision session, consisted of two phases: discussion of the mock-up I had built and discussion of the scenario I had written. These two conversations were markedly different.

In discussing the mock-up, the topic frequently turned to the technology of implementation. This was not my intention: I had hoped that we would use the mock-up to refine our initial application design. In analyzing the transcript of this first phase of the meeting, I was able to identify a sequence of conversation segments that were distinguished by transitions between three referents: the application we were designing (particularly the activity and its pedagogical purpose), the details of the system's implementation in HTML, and aspects of the mock-up itself (its completeness, my effort in make it, etc.). Simply counting these segments by referent shows the emphasis on technology in this conversation: 4 segments referred to the application; 8 to the implementation; and 3 to the mock-up.
Analyzing the nature of these segments shows that the bias towards implementation was even stronger than these simple frequencies suggest. The four segments that did concentrate on the application were relatively short and simple, for example:

L: I don’t know if you wanted to do a [separate] home page for [each] student or not...
B: I might actually like to

Although simple, this example was at least *formative* in nature; i.e., it was about a design possibility. I hoped that the mock-up would provoke a lot of formative discussion. Two of the four application oriented segments were primarily *summative*, however, assessing the design already reified in the mock-up, rather than producing new ideas. For example, in the last of the four segments Allen simply declared, “This looks good.”

On the other hand, the segments that focused on the implementation technology were more complex:

L: [Referring to the labeled buttons that lead to sections: Introduction, Conclusions, e.g.] These are actually names you had drawn on the board ...
B: How much work was it to make these GIF’s [the graphics format used to create the buttons]?
L: ... very little ...
B: How big are they?
L: Not big ... once they get cached ...
B: I didn’t know the viewer had a cache!

In another case, using the mock-up, I walked through an oral scenario to illustrate how a reviewer might post a comment. This did not produce the result I desired. It prompted neither summative evaluation of the existing mock-up design nor generation of new design ideas. Rather, Allen used a feature of Mosaic that allows you to inspect the HTML source code for the current display to figure out how the input forms (in particular, cosmetic horizontal lines) were implemented. The mock-up and oral scenario piqued his technical curiosity.

The discussion of the written scenario was quite different. There was no discussion of HTML and there were several complex exchanges about design ideas. I had made two paper copies of the scenario and we sat across a lab table, away from the computer. I began by saying, “So we talked, and I thought about it, and I kind of whittled it down to this ... Let’s see if we can converge on a mental model.” I read the first scenario, “Submitting a Project,” aloud: this resulted in the following exchange about how a student might publish a piece of work within our system:

B: Or even, they could “up-load” their text file to this program and say, “I want to create an area called Discussion.” And they select that area and they say, “put what I just created”
L: Yeah, in a real interactive mode.

B: ... select it and say, "here" ... that way they could just create an abstract or something and just go through and select, like a sentence here from the beginning paragraph and say, "add it," and select another paragraph, "add it," and it just kind of dumps it all in there. And then they could go up and edit it ... that would be adding something to it, where they actually are editing what they just inserted.

Allen proposed a significantly new and complex design idea here: adding a specialized editor to the system. Furthermore, the style of discourse had changed: he was now narrating his own scenarios that changed or embellished mine.

We did still talk about implementation, but the issues were more application specific—they were revealed by and directly determined the design described in the scenario. Compare the following exchange with the one about "GIF's," above (here, we are discussing the second scenario, "Reviewing a Project"): 

L: I included [in the scenario] the distinction between post-it notes and general comments, but I did not have that in the mock-up...

B: It's almost like, when you submit a comment, it alters the student's actual document, the HTML page or something. That's the only way you can do it, I think.

L: [I say that WIT and the On-line Debates do this] ... basically we will be maintaining some kind of a data base...student projects, comments that have been entered by people, and links between them, you know, this comment's attached to this project at this point, then when someone is browsing, our server's just reading this data base and generating HTML on the fly...

B: Can it do that? When I point to something can it point to... does it have to point to a document that already exists or can the other end just kind of feed?

in fact we would use this WIT-like implementation (database and generated HTML), for both general comments and an approximation of "post-it note."

I do not mean to imply in this analysis that the scenario was useful and the mock-up was not; in fact, I believe that they complemented each other. In the exchange presented above (and one other not presented here), while discussing the scenario, I referred back to the mockup to make points clear. The mock-up gave us a visual, structural reference that complemented the behavioral, temporal scenario. Also in this case, the mock-up revealed the bounds of the available technology: e.g., the horizontal layout and the exact post-it notes mechanism that Allen had envisioned could not be implemented in HTML 2.0.

3.2.2.2 Playing the Student's Role: Designing an On-line Project

At the end of the design session in which Allen articulated the Grand Vision, he had proposed putting an example student work in HTML. We discussed this again at the end of the mock-up/scenario session and decided that in our next meeting, about one week later (mid October), we would play the role of a student
and design how an example project would be “put together” on-line. At this point, Allen had made two desirable features of an on-line piece of work clear: it should be non-linear (assembled from smaller “sections”) and “the student would [decide how to] put it together.”

The design conversation in this meeting was like the mock-up/scenario session in that it used a prop: in this case a student’s project that Allen had recently graded. It differed from that session, however, and more resembled the Grand Vision session, in that the design activity was constructive: Allen transformed the linear piece of work into a non-linear presentation. He did this by marking up the project itself, identifying its sections, and by drawing an “outline” (a map) of how these sections would be linked together in hypertext (see Appendix 3.1, page 138). This conversation, except for its final segment, remained exclusively in the domain of our specific application vs. the domain of general technology. I further classified the conversation segments as concentrating on structure, presentation, or implementation with respect to putting the piece of work on-line, or concentrating on the application’s activity (what people would do with the on-line work).

I only coded the first segment as structural; i.e., concerned with how the project was divided into sections and how these were interconnected (with hyper-links). This frequency is deceiving because this was by far the longest segment of the session. Once Allen had established the structure, however, the design conversation turned to how the work would appear on the screen (presentation) and how we would implement the links—as buttons or textual hyper-links. The layout and the size of individual sections (keeping them small enough to avoid scrolling) was his major presentational concern.

The only point where the conversation turned to general technology (independent of the application) was at the end. Concern about the large figure in this project (a drawing of the floor plan which I had converted to a GIF image) lead to discussion of baud rates and alternative browsers for people with slow modems. It is interesting, however, that an activity oriented segment occurred in the midst of this transition from presentation to technology:

L: [I mention that the drawing will have to scroll, it is so large.]

B: Yeah, we’ll put a warning there, “Are you sure you want to scroll?” …

L: [I agree] … If we are going to cater to parents using modems, we will want to put warnings of links that will take a long time.

B: The parents won’t care, its the college person who is just fliting around … the parent I think would be willing to wait and see it.

...

* This project was a two page written report that analyzed the floor plan of a house finding the most space efficient room.
B: [He mentions people with 2400 baud modems and the conversation turns to technology.]

Here, the interaction between presentation and technology resulted in distinguishing two roles (categories of users) within the activity: "college people," outsiders who are just browsing, and "parents," outsiders with a more concerned interest. This is similar to the pattern in the Grand Vision session where, in proposing user interface mechanisms, Allen would articulate his pedagogical rational. In both cases, having Allen directly design (construct) the system, helped reveal his world-view regarding its use.

The title of this section (Playing the Students Role) reflects Allen’s interpretation of what we were doing. He wanted the students to have the freedom to design the structure of their own work; he reminded me of this on several occasions. For example, the following exchange occurred in the previous mock-up/scenario session, while we negotiated how to proceed with the design process:

L: I see a starting place on designing this ... [defining] what are the pieces that make up a piece of work.

B: Well, one of the ideas was to let the student decide for that particular one, then this other program would generate that part of the HTML code, that will allow you to call this particular section ... what ever you want.

L: [I go back to the mock-up on the screen and read the button labels] ... so those are pieces that the student has decided?

B: The student has decided to make those four things rather than some other four things or some other two things.

Unfortunately, constraints of time and technology would prevent us from “letting” the student decide” on this particular issue. (Note Allen’s mention of the “other program,” which was needed because students could not “write code”—this program was never implemented) The philosophy that students should be free of rigid, prescribed structure would be reified in the application in a different way, however; they would be free to express opinions in a public forum without direct teacher supervision. This freedom would have significant and largely unanticipated consequences.

3.2.2.3 From Mock-up to Reality—An Assignment for The World

Two weeks passed before our next design session. During that time I created another mock-up. I based this mock-up on the floor plan that Allen had “put together” (as a student might have chosen) in our previous meeting. I was excited about this mock-up because it was more specific, more real than the first. It was a complete student project, which had actually been handed in and graded. And, because this student had “done it on the computer,” I was able to use its contents directly in the mock-up.6

In the first half of this meeting we looked at the mock-up. Allen was “at the wheel,” clicking the mouse, but I made several suggestions about what to look at next. During this period, our conversation was

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6 The student had used a word processor for the textual part of the project and had drawn a figure, the floor plan of a house, by hand. Allen had scanned the figure into digital form for me.
similar to when we discussed the first mock-up: we talked more about the technology—how HTML, Mosaic and the network worked—than about the application. In this case, I classified 11 conversation segments as technology focused and only 5 as focused on the application. In contrast, in the periods of the conversation when we were not looking at the mock-up, I coded 7 technology and 10 application segments.

Clearly this new mock-up, as the referent of conversation, had a similar effect in this meeting as the first mock-up had in our previous meeting. This time, however, the part of the conversation that did not focus on the mock-up was different—things had become more real. Seeing a complete and concrete student project in the target medium (Mosaic) changed the target of our design process. This is revealed in the following summative exchange, which occurred immediately after viewing the mock-up:

L: I think it's going to be a really neat thing...

B: I just have to design some assignments for this now.

We were sold on the core technology and the general structure and presentation of the system, now we (actually Allen) needed to design the pedagogical activity that would use it—the “assignment.”

This was another critical incident in the design process because now something could actually be shown to the public, actually exposed to “the world.” and this reality made Allen more cautious. When I asked if the student who did the project (the one used in the mock-up) would like to have it put on-line, Allen replied (emphasis added):

I don’t know ... something more realistic that we developed for it ... I don’t think that this should be the first thing out there to the world ... it wasn’t really developed for that ...

I’ll start to come up with some kind of project ... with the eventual goal of, “we’re gonna put some of it out there” ... I’ll start trying to think of an assignment.

Although Allen was very sensitive to the privacy rights of his students, his rationale for not “[putting] it out there” was based on his own feeling that the assignment was not appropriate: “it wasn’t designed for that.”

Allen’s categorization of assignments as appropriate or inappropriate for peer review contrasted with his philosophy that students should use the system to publish “anything they want feedback on” (an idea that he expressed several times, both previously and even later in this same conversation). Again, I believe the reality of the mock-up caused this. Seeing a real piece of work, one he was already familiar with, in the network medium emphasized that the application we were designing would not only expose his students’ work to the entire world, but Allen’s as well—his assignments.
Allen's appreciation of the scope of the Internet audience was revealed several times in the post-demo portion of this meeting. For example, he suggested that we put this mock-up assignment on-line but "[where only] your CS major friends can access it ... a private address." Likewise, he later said: "We need a disclosure [a consent form for parents] saying, 'This is what it means when we put stuff out there on the net ... it's out there for 5.5 million people'."

The post-demo portion of this conversation focused more than ever before on schedule: both of the development process (our work) and of the assignment (the students' work). This was partly due to the simple passage of time—it was getting late. As Allen put it: "I really wanted to use it [the application] this grading period, but we are just moving too slowly." This was further evidence of the aforementioned transition in the design process: we now understood the basic technology and the structure of an on-line piece of work; designing the activity that would use these artifacts remained.

Two other phenomena emerged in this meeting, which foreshadowed events to come. First, Allen expressed frustration about his role in the collaboration:

B: I'm glad that you're feeling good about it [the project], because I feel like I've still not given you much information. I never know what you want.

L: What we really need is for you to have hands-on access to doing this stuff yourself.

B: As soon as I'm hooked in, I'd like to be putting this stuff to be working on it, myself.

We were both frustrated by Allen's lack of access to the network; the promised T1 line still had not been "hooked in" and this greatly limited his access to the materials of design. But I think the frustration was deeper—he did not know what I wanted from him.

Second, in the very last exchange of this conversation, as we talked about parental consent for putting students' work on the Internet, I said, "You're the one who'll catch the heat from the parents." He said he was not worried, and we both agree that parents would be happy about it. Allen had the last word saying, "These assignments are not personal ... like an English class." Perhaps the most significant result of this project was our failure to realize that a Physics assignment, within the liberals bounds of Allen's definition of such, and when set in a public electronic medium, can become very personal indeed.

3.2.3 Evolving the Assignment: Infusion of the On-line Debates
3.2.3.1 Research Review becomes Controlled Discussion

Our next meeting (about one week later, Nov. 7th), had two parts: we began with open conversation in Allen’s classroom (I had not prepared new design artifacts), then we went to my home to see the floor plan mock-up on the net, through a modem. I had put this on-line at a private address, as per Allen’s suggestion. We went to my home because Allen’s classroom still was not connected to the Internet—he didn’t even have a modem.

As Allen continued to search for an assignment, the envisioned learning activity continued to evolve from formal “peer-review of research” to a less formal “response environment.” This was a consequence, at least partially, of his liberal approach to science, as is evident in our early conversation about the assignment:

B: [an] assignment more on the creative side ... pick a concept in physics, a device, or sport ... illustrate it in any way except for a report ... the idea of acceleration ... a movie a poem ... anything they want.

... 

B: I know you call this a “Peer Review System,” in terms of “review my research, these are my conclusions, what do you think.”

Do you want to keep it limited that way, or can we incorporate other things, like if somebody made a poem? Not necessarily a peer review environment, but a response environment ... are we trying to limit the scope to science? I prefer to have it very open.

Later, when we envisioned how people would post comments to the students’ work, the language changed dramatically. Here, rather than “openness” and “creativity,” Allen spoke more about control and prevention. For example, he proposed a mechanism where a reviewer could send e-mail to the individual student rather than post a publicly visible comment:

B: ... that way ... some little thing not necessarily important for the public. It might reduce the number of comments. Like, when I see bulletin boards I see posts like, “I agree.” This might prevent people from putting tiny things like that ... If this becomes popular, with a thousand people reading it daily, it could get nasty.

His explicit rationale was to prevent “tiny things,” however, the phrase, “it could get nasty,” suggests he also envisioned “replies” with undesirable content.

The following exchange illustrates the tension that this project seemed to hold for Allen: although he was liberal in his pedagogy—students should publish “anything they want”—he knew that some people were “out of control”:

B: [some people] can’t control themselves ... reply, reply, reply ... totally out of control. I’m more of a restrained person.

* In the last meeting the demo (the files of the example student project) was physically located on the computer that we viewed it on, hence we didn’t get a feel for the speed a reviewer, working with a modem, would experience.

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L: [referring to the e-mail idea] To cut down on trivial postings?

B: No ... I wouldn’t call it censorship ... [but] a way people can make a better decision for themselves ... I’d never go out there and remove a posting, or something like that.

L: You wouldn’t?

B: No. Unless there is some extreme reason.

As it turned out, Allen did remove postings; in fact he removed the entire on-line discussion. I believe that the network technology was the key to this unanticipated action: It’s one thing to be pedagogically open (unorthodox) within the confines of a controlled classroom; it’s another thing when the classroom is the Internet and “the world” is watching.

In this meeting, the On-line Debates began to strongly influence the evolution of our design from peer-review to discussion. I had mentioned this project several times before as an example mechanism (and software implementation) for reviewers to attach comments to students’ works. This time I used the debates as an analogy of how the student authors might respond to reviewer’s postings. The On-line Debate mechanism supported a dialectical representation of argument, an arbitrarily deeply nested hierarchy of agreements and disagreements rooted at a debatable issue. In this analogy, I explicitly rejected the agreement and disagreement speech acts: I just suggested that we might use the same mechanism for posting responses to previous responses—for nesting. After seeing the debate system at my house he agreed, saying, “this could be useful in Physics.” Allen had proposed the idea of authors responding to comments from reviewers in the initial “Grand Vision” design session. At that time, he had implicitly distinguished this from discussion: “not necessarily respond to a response ... [but] add a field that just the student can add ... [and] that’s the end [it doesn’t go on forever] ...” On this day, however, in response to my asking if only the author (not other reviewers) should respond to comments, he replied, “As long as [reviewers] are making comments, [they] might as well have the option to put them wherever.”

It is significant to note that in this meeting, even the “hands-on” part at my home, there was very little focus on technology (only 3 out of 15 conversation segments). Our exploration of the technology was over; now we were searching for an activity. Focus on technology would return in the implementation phase of the project, but with a different mood, less exploratory, less playful. Finally, one of my prior intentions for the meeting, as stated in my field notes, was to talk about schedule. We didn’t do that explicitly, but we did simplify the project in two ways in order to reduce the implementation effort. First, we decided that “remote submission” and the “organizing program” were not required for now. Second, we agreed that “post-it notes” would be implemented simply as the ability to post comments on each page (each section) of a piece of work.
3.2.3.2 Authors and Reviewers become Debaters

Our next design meeting was two weeks later, in mid December. Since our last meeting (7 November) our encounters had been brief, just touching base or dropping things off (I had brought him a PowerMac. complements of the Virtual Schools project, and some network software, as well as a modem I obtained through the school district). We met in “the commons,” a large open space used as the schools lunch room and locker area, during dance team practice. Allen regularly volunteered to supervise these practice sessions. This was not his “duty” (all faculty had official duties such as bus duty or coaching); he did this on his own time—like the project we were working on.

In this discussion, for the first time, the activity we were designing took center stage. Although we did diverge into implementation and even pure technology a few times, for the most part we talked about what the students would be doing in the assignment. Two essential characteristics of the ultimate activity emerged in this meeting. First, Allen now envisioned the activity as debate rather than a three step publish-review-respond sequence. Second, the activity was becoming more circumscribed in three ways: when and where it occurred and who participated.

This meeting opened with the following exchange:

B: [groups of] 3 or 4 students which would make 15 or 20 assignments... related to Physics... research or opinion oriented...
   lend itself to debates.

L: Are you now talking about the discussion idea?

B: I’m thinking about them both [peer-review and discussion] together... I know I’m changing things on you constantly...

... 

L: Now you are using the word “debate”; that implies to me more than one level of comment.

B: I don’t know; maybe that’s what I mean.

L: We had talked before that a reviewer would post a comment and the author would reply.

B: In terms of this assignment, I think I’m really thinking debates.

L: [I ask if he’s seen the On-line Debates]

B: ... that’s exactly what I’m talking about.

The On-line Debates had influenced Allen’s vision of the assignment. This was the first time (at least as captured in my transcripts and field notes) that he had used the term “debate” in reference to our application. I had originally presented the On-line Debates as an demonstration of technology—how HTML forms could enable peer-review—but its influence had gone much further, affecting the activity. The activity was becoming a blend of the original peer-review and debate. In the first statement Allen distinguished research from opinion but said “I’m thinking about them both together.” Indeed, the
activity we ultimately implemented involved both research projects that students posted on the net and debate, wherein classmates expressed opinions about those projects.

As Allen envisioned the activity within the time structure imposed by the school system, it became more circumscribed. In the following statement, Allen, for the first time, envisions the "debate part" as a short, discrete period:

I'm thinking 4th grading period ... 25 of Jan ... Maybe if I hit them right after break ... they turn in 'scripts' or whatever by the third week ... the second half of grading period is the debate part, where I can evaluate them."

This language differs from earlier descriptions of a more open, long term activity, such as. "[they can] publish anything they want feedback on"—the activity had become more structured in time.

Limited access to the technology also increased the structure (decreased the freedom) of the activity:

L: [I ask how the students will get "access" to computers and the net]

B: ... including the library computers, maybe by that time there might be 6 or 7 computers ... and so until I get my T1 line ... I have 2 computers because there are two modems in the school ...

I want to be able to take the students, during class, to the library because that's where most of the computers are, and I can leave some in my room also ...

In this statement, and what follows, Allen describes the activity occurring as a group, within a specific location and time frame.

B: I should plan a day, once everything's posted, and take my students to a facility at Tech that's got access.

[We discuss a lab in the Computer Science Dept. as a possible place.]

B: If you can get it [the lab] for two hours that will give each student a chance to flick through, read some, respond to some.

That might actually serve the need that I have and then I could just give extra credit to those who take it further.

Here Allen described the activity as "two hours"; anything more would be extra credit. I had envisioned an activity that was more distributed (both in time and space) where students, parents and outsiders would access the system from their homes, libraries, universities, etc. Allen points out to me that we "can't assume" this; many students don't have access:

L: ... Hopefully the T1 will be here. If not, some of these students have BEV access at home right?

B: Yea, but we can't assume that they do.

The participants in the activity had also been narrowed. Allen is now described the activity as a class project. This change is clear in earlier exchange:

L: You could actually require the students in the class to debate each other.

B: Yes. And anyone else from outside is OK with me ... that will add color to it.
I had just realized that he was thinking of a class activity and he confirmed this by describing “outsiders” (the reviewers) as “added color.” As it turned out, there was no explicit outsider participation the activity—they did not contribute postings to the debate; however, the fact that the debates took place on the Internet, where outsiders could see it, was significant.

We talked about how outsiders would be admitted to the activity in this meeting. Allen was liberal about who we would admit, “anyone ... is OK with me,” but added that if they misbehaved, “I could turn off their account.” In retrospect, this statement emphasizes a feature of the particular communication mechanism that we were designing, namely that the discourse (debate) that occurred through it was persistent. Unlike the “live” classroom, stopping inappropriate behavior in this forum did not remove it from view.

3.2.3.3 Issues, Voice, and Requirements

Over the Christmas break, more than a month passed between meetings. During this period, Allen set up his new computer (the PowerMac from the Virtual Schools project) and the SLIP software to connect it to the Internet. He sent e-mail to me (which I read while I was back in Texas working for my old employer) expressing both pleasure and surprise that it all worked. I interpreted this as a very positive sign: Allen now had better access to the technology and was actively pursuing our goal.

This meeting had a different feel than the others—it seemed less like a design session. It began more like an interview focused on Allen’s pedagogical goals and, towards the end, it focused on the process of completing this project—who needed to do what. In particular, we distinguished the assignment. Allen’s curriculum—his responsibility—from the programming that I was doing.

I transcribed the tape from our preceding meeting, in December, in preparation for this one. While doing this, I became concerned that HTML forms and a WWW browser were the wrong technology for this activity. Allen’s description of the activity had changed substantially: he now spoke of “discussion” rather than “peer-review” and the activity occurring over a short time span with the participants co-located (“two-hours” at “Tech”). It sounded like he wanted a real-time discussion through the net and that would be better served through a mechanism like Internet Relay Chat (IRC). In IRC, textual contributions to the on-line discussion are simultaneously propagated to all its (temporally co-present) participants rather than being posted to a shared artifact that participants review at their leisure. I decided to ask Allen about this specifically and to ask him more generally about his pedagogical goals for the network.

I began the conversation by summarizing my interpretation of our meeting before Christmas. Then Allen corrected me:
L: ... this shift ... [from] the student puts his work on the net and then time passes, maybe days, and then outside people attack replies to it ... to this kind of on-line discussion ... a session where they debate in a condensed time frame ...

... [If you want] real-time discussion through the computer, then Mosaic may not support us well.

B: ... That's not what I was thinking ... That sort of sounds like the old “phone” utility from the VAX ... I meant put something out there and say, “Over the next week, I want you to read these and respond to them.”

The reference to the VAX phone utility indicates that Allen understood my distinction: VAX phone is basically a two participant version of IRC. In this instance, as throughout the project, Allen's technical experience greatly facilitated our mutual understanding.

Allen's proposed scenario “Over the next week ...” still indicated a significant change, which had emerged in the pre-Christmas meeting: the activity was becoming more “directed.” In contrast to freeing students, e.g., “to publish anything they want feedback on,” we now talked about requiring students. For example, late in the meeting he said:

... In fact it might even help me if I direct the students time a little more and say, “Your assignment is going to be ...” My requirement might be, “You have to post your position on 5 of them.” That might fine tune, help to give them some direction ...

(emphasis added)

The similar idea of “asking” students (in another class) to participate had come up in a November meeting while we were still thinking of peer-review. In that case the rationale was that authors might get no response otherwise; here the rationale was different—to direct the students' activity.

In this meeting for the first time Allen used the term “issue” to name the referent of the computer mediated communication activity we were designing. This occurred early in the interview portion of this meeting:

L: I had another question ... What are you after from the standpoint of a Physics teacher from this thing? How does this fit in with your curriculum? This debating thing.

B: Part of what I want from my students is, i want them to be forced to think about certain things. ... I mean ideas or issues ... what's wrong with this person's answer ... to be required to express themselves ...

It's rare in a Physics class to have a test where you have to explain yourself, and if it is done, it's commonly just to make your argument to the teacher and turn it in ... [I want to] sort of redirect it to bring the students into the discussion ... get them in to talk to their peers. The more people you have talking about something that's controversial or open to debate, the better it's going to be ... Expression is my main thing. Education people call it “voice” ...

Issues imply controversy—Allen used this term several times in this discussion. His envisionment of the activity had changed from a sober process of scientific “review” to an activity based on “controversy,” “expression,” and (as he said a little later in the conversation) “picking sides.”
This shift was probably influenced by the On-line Debates. It is clear, however, that the debate format also served his prior pedagogical goals: to extend beyond the paradigm of Physics education, “to get students to talk to their peers”; and to help student’s find their “voice.” He restates these goals later in reference to his past curriculum:

I need my topics . . . social issues . . . I’m not going to limit myself to Physics . . . I like to expand into other areas. I [once] had three students turn in Biology projects because I said they could. I just had to go get another teacher to help me with it. The whole plan is not just to do Physics it’s to do the debate thing.

Continuing the “interview,” I asked Allen (speaking as the devil’s advocate). “Why bother with this network stuff. what does it bring to the party?” His answer included the obvious first-level effects of network mediated communication—allowing distribution in time and space:

B: It’s going to let some of my students do this at home. And it’s going to provide, if I want to have an on-going discussion I either have to do it in my classroom or I have to get all the students together and do it. And if it’s out there somewhere available 24 hours a day, I think it makes it a little more convenient. But it also gives a sort of a log, a transcript, a record. for me to use, for them to use, something we can bring back and look at ...

L: [I say the log part is interesting.]

B. Sometime when students are forced to actually write it down they think more about what they are saying too, rather than just yelling things out.

This answer also articulated two important second-level effects. First, the discourse would be recorded in “a log,” which he and the students could “use” as a referent in further discussion; i.e., the conversation itself could be the object of study—an instrument of pedagogy. Second, writing, rather than “just yelling it out,” might result in more thoughtful, professional discourse. Both of these second-level effects were significant in the final activity that we implemented. As it turned out, the second of these had insufficient effect, in some instances, maybe even the opposite effect, and a lot of inappropriate discourse occurred. In fact, Allen would use the discourse log to respond to this—for post-hoc instruction in appropriate academic discourse.

Allen added one other reason for using the net, in this answer: “And, it gets them out there in the computer world, sort of a plaything.” Allen liked computers—they were fun, “playthings”—and he wanted the students to enjoy them also. This statement marked a transition in our talk of computer’s as playthings: previously we had referred to ourselves playing with the technology. HTML, etc.: from here on, we talk about the students playing with the product of our design.

This was an extremely fruitful meeting from a requirements gathering perspective: Allen readily expressed his pedagogical goals with respect to the technology. As I mentioned, the beginning of this meeting was interview-like; an interview would not have had such positive results earlier in the process.
however. This was enabled by our shared background of meaning (both technological and pedagogical) that came from four months of concerned and concerted work—designing together.

In this conversation, especially near the end, we talked more about the development process, particularly its division of labor, than about the design itself. We understood the essential features of the activity and technology; now we needed to define the details of each of these and bring them together in an application. Paradoxically, as we began to schedule this implementation process, we also began to separate the technology (the code) from the curriculum (the assignment):

L: So the first step for you is to decide what that top level assignment looks like.

B: Yeah that’s for me to work on... it’s actually going to part of my curriculum.

L: [I suggest working on it we regard to the technology.]

B: Yeah I can just think, “Your assignment will be to do this whether it depends on the computer or not ...”

L: That’s a good fallback for you: even if this doesn’t work out it’s still a good science assignment... It will work out!

For me, the theory of collaborative design motivated this separation: I believed that pedagogy (practice) should drive the design, not technology. Allen had also bought into this goal. When I told him, “I don’t want the computer to drive the curriculum,” he replied, “It’s not,” and at an earlier stage, when I emphasized that our design did not have to look like the On-line Debates, he said, “Yeah, I’m trying to come up with ideas myself.” It is clear to me, in retrospect however, that my original thesis was naive. The design could not proceed according to my ideal, which I described to Allen as “[first] looking at the assignment and [then] building the computer activity around it.” rather, the assignment had to grow out of our exploration and design of both the computer technology and the activity.

3.2.4 Design Convergence and Implementation

Our previous meeting had solidified a shared vision of the application as a discussion activity. It had also identified Allen’s next task: writing the official assignment. The final design of both the activity and the system structure and presentation converged quickly in the next two design meetings, in February. A third meeting, in which we divided that implementation labor, essentially marked the end of our formative collaboration.

Figure 3-3 visualizes the final Issues On-line application design as a transformation of the application model introduced in Figure 1-1 (chapter 1). In this case, the on-line referent of discourse is a set of issue/position statements written by the individual students (or small teams) in the first phase of the activity. Each statement includes four WWW pages: one to introduce the issue and state the author’s position; two containing supporting and opposing evidence for the position; and one that lists references.
In the second and third phase, the rest of the class reviews these on-line issue/position statements using the three speech acts Agree, Disagree, and Neutral. The first review phase was conducted in a same-time, same-place setting during three field trips. In the second review phase, students posted comments on their own time from home, school, the public libraries, etc. This phase was ultimately cut short, as I will discuss below.

![Diagram](image)

**Figure 3-3: Visualization of the Issues On-line Application**

### 3.2.4.1 The Activity: Textual Representations

The learning activity was the predominant referent of conversation in the first of these final design sessions. We used two conversational props in this meeting: Allen brought the assignment he had written, titled *Issues On-line*; I brought a revised scenario, titled *Peer-Discussion*.

#### 3.2.4.1.1 Allen’s Assignment Sheet: A fusion of ideas

In our previous meeting, Allen had said that “the debate thing” was most important (more so than Physics) and that “peer-review” was becoming less and less relevant. He also expressed some concern:

> I don’t want this to degrade down to a bulletin board. Then I’d feel like you hadn’t done anything new, because we had this grand vision from before. (emphasis added)

Aspects of the finished assignment (see Appendix 3.2, page 139), which was the focus of our next meeting, reflected this concern both for my research and for our “grand vision.” Nonetheless, the assignment prescribed an activity that was much different from the original vision: a controlled debate,
rather than open peer review, including many specific requirements. Still, the assignment distinguished itself as new and different from traditional pedagogy, even Allen’s. The opening, “Overview,” section of this one page assignment announced, “a number of different characteristics (compared to our recent projects),” and listed 5 particulars (I paraphrase these here):

1. You may work with one other person, or alone.
2. You’ll address scientific and social issues and, “take a stand.”
3. You will present your issue on the Internet.
4. Your presentation will be “reviewed and critiqued by your peers and anybody else in the entire world . . .” (original emphasis)
5. You will respond to “questions and comments” about your presentation.

The assignment specified (in the second section, titled Description…) that students should select an issue to research, “compile [their] information into four ‘pieces’,” and turn this in as files on a computer disk. Again, the instructions emphasize that this is not “like the traditional research paper.” The prescribed “four pieces” were:

1. Statement of the Issue (“explaining … which side you take”)
2. Supporting Evidence
3. Opposing Evidence
4. References

The assignment had two others sections. One, entitled “Evaluation,” stipulated that the grade would include “how active you were in reading and commenting on other projects,” but only if the schedule permitted “working on the Internet this grading period.” Otherwise, the grade would be based on the “content of the project” alone. The final section listed “Some Possible Issues,” including “Is nuclear power worth it?” and “Should we be doing cloning research?”.

The assignment finalized many of the design decisions that we had discussed. Many features did originate from Allen’s pedagogical philosophy as well as his original design—his “grand vision.” On the other hand, the assignment had been strongly affected by the available technology and the development context, including myself and, especially, the On-line Debates. This fusion of ideas is apparent in our conversation about the assignment sheet. When Allen first presented the assignment sheet to me, he described it as a return to our earlier design intentions:

B: ... This goes back in time a little bit, in breaking it into pieces ... My original plan was just a paper on-line, but I’ve decided I don’t want to go with that ...

L: [I ask what he meant by “going back in time.”]

B: The fact that it’s in pieces again; you push buttons to get from one to the other.

L: Back to the old peer-review [referring to the structure of the two early mock-ups] ...?
B: Exactly ... I like it better that way because it's easier for the students to do; they don't have to write transition sentences ... they can sort of set up these bullets of information ... people can then, under our vision, apply comments to those four section that each paper will have. (emphasis added)

Note that his first rationale for "going back to breaking it into pieces" is student oriented: "it's easier for the students." He adds, however, that this was part of "our vision," vestigial features of his preference for multiple windows and our desire to exploit the available hypertext technology.

3.2.4.1.2 My Scenario: Blindness and Vision

I had made a new scenario in preparation for this meeting based on the transcript from our previous interview-like conversation. This scenario reflected the new discussion vs. review discourse model (see Figure 3-4). To some extent, my scenario, and my agenda for using it, blinded me (us?) to an obvious design innovation in Allen's assignment sheet. In the "Overview" section, the assignment specified that students would "respond to questions and comments" about their presentations. I didn't notice this explicit speech act category, which we could have reified in our design by adding a button for posting questions—probably because I was anxious to work through the new scenario.

1. Mark divides the students into groups of 3 (22 groups)
2. Mark assigns each group a Topic that is controversial or debatable.
3. Over a 3 week period, the students:
   3.1. Research the topic
   3.2. Formulate a Scenario relevant to that Topic
   3.3. Formulate a Position with respect to the Scenario
   3.4. Write-up the Topic and their Position and turn it in
   (Turn it in on diskette or paper?)
   (What is the format of their Write-Up: just a single page textual report or hyper-linked pages with pictures, etc.)
4. Over the next three weeks, the projects are converted to HTML (by Mark, Stuart, and student volunteers).
5. Throughout the 5th grading period, the students read and discuss the on-line projects:
   5.1. They attach Agreements and Disagreements to groups' original Positions (and to other student's Agreements and Disagreements).
   5.2. They attach New Positions to Scenarios.
   5.3. They post Opinions about the actual Write-up (quality of presentation, etc.).

**Figure 3-4: Peer-Discussion Scenario**

This scenario played a different role than those from previous sessions: it served more as my personal checklist than as a shared conversational prop. This was not my intention. I gave a copy to Allen but he shortly put it aside (to my mild annoyance) and simply spoke directly to me. I continued to step through the scenario, paraphrasing steps aloud and checking if that was what he wanted:
As this excerpt illustrates, the scenario, even in this check-list mode, did stimulate a new design idea: a third speech act (in addition to Agree and Disagree)—the neutral Comment. This idea would in fact be realized in the final implementation. I believe that the scenario’s narrative form facilitated this innovation by providing a natural sequence for stepping through this concrete specification. It is entirely likely, however, that we would have also proposed the speech act Question as a new design feature had we stepped through Allen’s assignment sheet (an expository rather than narrative text) at the same level of detail. (I incorporated both the Question and Comment speech acts into the network application I used in my own teaching; see chapter 5.)

Figure 3-5: Structural Diagram used with the Peer-Discussion Scenario

This session also revealed that a textual, narrative scenario is sometimes insufficient for representing and communicating structural aspects of a design. In writing the scenario, I had envisioned a structural separation (which the system would reify as separate WWW pages) between what Allen, in the assignment sheet, distinguished as “issues” and “sides on issues.” (My scenario text further divided “issues” into the two terms, “topic” and “scenario”; it used the term “position” for “side.”) Furthermore, step 5.2 in the scenario proposed that students could “attach New Positions” (new sides) to another group’s issue—i.e., reviewers could “take their own side” (an idea I borrowed directly from the On-line Debates). Reading this step aloud prompted the following exchange. In this passage, I spontaneously resorted to an abstract, structural diagram in order to resolve the question raised in the concrete, narrative scenario.

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8 I also observed this phenomenon in the collaborative design of the On-line Debates; see chapter 2, Designing System Structure for a Paper-less Library.
L: Are they also going to attach new Positions ... can they take their own side, or do you see that as part of the agreements and disagreements.

B: Do you mean defend their own paper; what do you mean?

L: No, here's a group's paper [looking at the assignment wording] ... with the side they took. Now, what do the other students do? They go in and they attach agreements, disagreements, and neutral comments.

[I draw a structural diagram at the bottom of my Scenario sheet (see Figure 3-5); he is saying "Yep, um hum ..."]

L: ... There's some topic too, right? [I add a topic level above the group's issue level in the tree] Are we going to separate the Topic from the group's Position, or is that all rolled together?

B: No. [pause]

L: Statement of the issue...

B: I consider that to be the Topic part ...

L: It also has which side they take, so really you have all this being one thing.

B: I consider that the highest level.

L: [I draw a circle around the two levels, Topic and Group's Issue reflecting Allen's decision.]

3.2.4.2 The System: Graphical Representations

In the previous meeting, I had suggested that we work on, "the overall plan," (the activity) and postpone "more concrete design" (structure and presentation) until the following session. In the field notes I made in preparation for this next session, I stated that my intention was "to design the look-and-feel [of the] system ... actually design screens ... use the black board."

This meeting did not proceed as I had envisioned—even less so than the previous scenario/assignment meeting—and I was extremely frustrated, even angry, after it. There were technical problems (when I tried to demonstrate the On-line Debates software) and interruptions (Allen was distracted by other work and interruptions from colleagues). My post meeting field notes were dismal; in fact, I titled this transcript: "Really Bad Design Meeting." When I suggested that we needed to make the system design more specific before we could start implementation Allen expressed frustration saying, "I don't know what you want me to do." I was troubled by this statement (which I had heard once before). Did he really need me to do the design? In my conception of the design process (which I brought from my prior professional experience) we needed to create a detailed, persistent representation of the system—finalize the design—before we could begin implementation. I think Allen did not see this as necessary, did not know exactly what I meant, and just wanted to go home (it was near 5 p.m. after a full day of teaching). Nonetheless, at my direction, he began to sketch WWW pages on the board.
The structure and presentation of the software artifact (the screen layout, buttons, and their interconnections—hyper-links) were the main referents of design in this meeting. Chalk-board drawings were our primary conversational prop and I recorded these in my field notebook (see Appendix 3.3, page 140). These included more concrete sketches illustrating the presentation of the WWW pages (right side), as well as a more abstract structural diagram (left side). We used the more abstract graphic to finally resolve the nested comments issue: that comments could be posted both to the projects (issues) and to preceding comments. We had talked about this distinction many times before but did not resolve it until I drew the structural diagram in this session. Both diagrams helped resolve a second activity-determining structural issue: how to implement the "post-it notes" idea. The following exchange occurred immediately after I drew the diagram:

B: Did we talk, did you, is the way you’re writing it up [writing the software] going to be, “attach one comment for the whole document” or is it possible to attach for each page?

L: That’s exactly why I put this up here as a question. I can write it up however you want.

B: I’d like to do each page.

L: Including this one? [I point at the top level issue page.]

B: Yes. Something posted on the issue page would be a general comment about the whole paper, whereas something posted on a support page would be a comment about that specific support statement. Or if they just wanted to say you’re references are horrible, they can put a specific comment on the references.

L: OK. In all four cases the comments could be agreement, disagreement, or neutral comment?

B: Yes.

The utility of these abstract diagrams, and the similar one from the previous scenario meeting, support two observation about collaborative design: First, although these design questions (nested comments and post-it notes) were raised and explored through mock-ups, demonstrations, and scenarios—concrete design representations—these more abstract diagrams facilitated their final resolution. Second, even though Allen was not a professional designer, he could readily use and understand these representations. (I will strengthen the latter observation in chapter 2 where my middle school collaborators, teachers with no background in computer science (recall that Allen had some), used similar abstractions.)

In retrospect, although this meeting was frustrating for both of us, we accomplished a lot. I later refined the WWW page sketches that we made on the chalk-board in this session. I used a computer drawing package to do this and filled in some detail. I also completed the representation by including a drawing of each type of page that would be used in the application. This ended up being our final system design

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9 Allen described this in terms befitting the mood of this meeting: “It just grows into a recursive hell.”
representation and it was very close to the system we actually implemented (see Appendix 3.4 and 3.5, pages 143 and 142).

3.2.4.3 Implementation: Dividing Labor and Ownership

Our last full-scale meeting occurred after the students had turned in their projects. Although Allen's assignment required that they turn these in "on disk," they had done these projects (about 25 or 30 of them) on various types of computers and word processing programs (a couple even used a very old Tandy word processor). We were now faced with a mixed bag of formats—conversion to HTML would be long and difficult.

The conversation in this session focused on the refined WWW page drawings that I made based on our chalk-board sketches (and, to a lesser extent, screen dumps of two actual pages from the On-line Debates, which I also brought). I expected that we would use these props to fine tune the system's design, particularly its presentation (the layout of buttons, fields, etc.). Contrary to my expectation, however, the dominate topic of this meeting was the implementation process—in particular, how to divide the labor between us. The few occasions where our conversation moved to technology were motivated by the pragmatics of the implementation task, not curiosity or playfulness. We were no longer exploring the technology for fun, rather, for a purpose. The following exchange, when I first presented the drawings, began this transcript:

L: This is what we decided last time [I refer to the drawings].

B: I guess my question is ... have you made a template?

L: No. It hasn't made anything, any HTML specific to this project, what I'm worrying about is the code that runs on the server side,

B: Right

L: that handles when they want to enter a grade or a comment.

B: I can get my student to start putting templates, so we can just paste [the projects] in ... he can do that. he's really good.

...

L: Let's look at one of these report pages; let's start at the beginning. Here's the top-level page for an issue, OK?

B: Exactly [a short inaudible segment].

L: This is what was on the board last time, basically. Now the thing is, really everything from here up is static. OK? So you can give this to David to code in HTML. ... ¹⁰

¹⁰ David was a student who Allen had recruited to work on this project, even though he was not in any of the classes that participated in the issues On-line activity. Allen had alluded to this student previously saying, "I've got one or two students who'd be happy to do it for us [convert the projects to HTML], do it for free, wouldn't even ask for a grade."
Allen's first statement was about coordination of the implementation effort, not design. Who would create the "template" needed to convert all those projects to HTML. Likewise, his brief superlative, "Exactly," in response to the drawings, reflected our design convergence. Furthermore, this exchange reveals that we had already divided the implementation work in our own minds: my "worry" was "the code that runs on the server side," his was converting the projects. In this meeting, the most important function of the drawings was making this dividing line more precise: to distinguish what was "static" (hand written HTML) from what was "dynamic" (software generated HTML).

The following excerpt exemplifies this static vs. dynamic negotiation (which was mediated by the page sketches) as well as one of our purposeful excursions into technological issues:

B: There's nothing fancy on, there's nothing dynamic on this page [referring to the home page drawing with the list box].

L: ... You can create this whole page, you're right, but I have to create the code that runs behind it. Every form, the form won't work, when you push on these [referring to the entries in the list box] they're not going to be following a URL.

B: Oh they're not! ... So you click here

L: You click here and then the button, and it runs a program on the server—every form runs a program.

B: OK.

L: But that's fine, you guys can mock up the pages, or you guys can create the pages, and I'll just create code. The functionality that runs in the back of it.

We explored the technological issue that list box entries are not like HTML hyper-links (they don't "follow a URL") because it impacted the development process. As soon as we resolved that a list box requires "code that runs behind it," we shifted our focus back to the division of labor: "you guys can mock up the pages ... I'll just create code." Much of the meeting proceeded in this manner: we worked through all the page drawings, labeling each page, or portion of a page, according to who would implement it—whether it was static or dynamic.

About six weeks transpired (2 March—17 April) between this last full-scale, face-to-face meeting (where we divided the implementation effort) and the actual use of the Issues On-line application. During this time we worked on the implementation independently. Allen and his student converted the projects to HTML; I finished the programs that would allow people to read and comment on them. We now interacted only for coordination and integration and we accomplished most of that via the network. Throughout the entire nine month project, Allen and I exchanged about 100 electronic mail messages; almost one half of those, about 45, were sent during this six week period. This was significant in two ways. First, it was only possible because the design work was indeed complete: this impoverished communication channel (e-mail) was adequate for coordinating the implementation process, but would
not have sufficed for collaborative design. Second, it reflected Allen's new mastery of and access to the network. This is particularly significant for this study of participatory design because the network was also the raw material of the application we were developing.

I perceived, during this period, that Allen was taking a more active role in the project, expressing a more vested interest than he had earlier—I referred to this as "ownership." Throughout this project (as well as the one in the middle school) I had consciously tried to promote the educators' feeling that the application was their own. In design, a feeling of ownership comes from the power to shape the product. Although I had tried to empower Allen via accessible design materials like chalkboards and scenarios, I don't believe that he felt empowered without the ability to directly shape the implementation itself.

Two things (not of my doing) finally gave Allen this power: first, David (his student) provided HTML expertise and the man-hours needed for "coding"; second, the BEV project provided a "filebox." On the World Wide Web, power (publishing power) comes from having other pages point at your pages. The high school already had a set of Web pages on-line that the BEV's "Education Center" page pointed to. Since David had developed these pages, Allen was in a good position to publish on the net. He could now put his own Web pages on-line by putting them in his filebox and pointing to them from the high school pages. Because this meant the BEV also pointed to these pages (indirectly) and because the BEV was (and is still) a focal point on the Web for our community, this was real power indeed!

The technology both supported and hindered Allen's access to the materials of design. However, the filebox strongly supported it. At Allen's initiative, this became the medium through which we integrated our work. As David and Allen converted projects, they would place them in the filebox where I would retrieve them and then put them on-line under "my" WWW server. As I said above, this allowed Allen to work directly and independently on the product enhancing his ownership of the project. I cite evidence of this in my field notes from one of our three meetings:

Ownership is not a problem here. When I told him I'd send the io_home page back with updated URL's, he seemed a little annoyed, saying that he could change the URL's ("just paste, boom, boom, boom," pointing at the URL's on the screen... He really feels on top of this now, I think. (I want this page to live on his side so that he can use it for announcements, etc.)

I reminded him that once the discussion began, the project HTML files would live on my side. I described this as unfortunate, but we'd just have to go with it for now.

In this instance, I suggested that I fix up the "home page" for the Issues On-line system, in response to a change, and send it back to him through the file box. His reaction was assertive: he could do that himself,

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11 This is a frequently cited benefit of participatory design, often called "stakeholder buy-in."

12 Using the File Transfer Protocol, this made them accessible through one of the BEV's Web servers.
it was easy! This is a sharp contrast to his statements earlier in the process like, "What do you want me to do?!"

Unfortunately, the nature of the core supporting software (which was my doing—I had developed it for the On-line Debates) worked against my efforts to empower Allen. The architecture of this software required that the HTML pages for the students’ projects “live on my side,” under my password protected account on a University computer. Hence, once Allen and David had completed their initial conversion to HTML, the pages were moved through the filebox from their domain into mine. Although this frustrated me, Allen never mentioned it as a problem. I think that if the Issues On-line project had not been cut short, however, this deficiency may have become more salient to Allen. (A similar situation in the On-line Debates project was indeed problematic.)

3.2.4.4 Constrained Access, Constrained Activity

The modem, PowerMac, and filebox that Allen had received from various sources had greatly increased his access to the net. The situation was different for his students, however. We had recognized for some time that student access to the network for the Issues On-line activity was an open problem. At one of our brief face-to-face meetings during the implementation process, I asked Allen about this. He said that the T1 line was in connected to one computer in “the back room of the library,” but he added, “You know how the library is ... they don’t want anyone in there.” I had encountered this ironic situation several times in my two public school projects. Computer equipment was a scarce, coveted commodity and individuals were extremely territorial about it. Allen proposed that students would probably have to work at home, in his room (he said he would give them class time for this), or in the library (outside the high school).

A week later, I received the following e-mail message (emphasis added):

Date: Tue, 28 Mar 1995 07:27:09 -0400
To: "Stuart Laughton" <laughton@cgrad.cs.vt.edu>
From: abrowne.bev.net@vt.edu (Allen Browne)
Subject: meeting ...

Somehow my hairs got crossed ... are we meeting today? Please let me know.

Also ... I have found a solution to the lack of network access. I have reserved the library’s media lab for three sessions to take each of my three classes over there in mid April. Each of the students will have access for about an hour and a half.

How does that sound? I know it’s four weeks from now ... but it’s the best I can do. They have strict requirements for field trip guidelines here.

Let me know ...
Allen

This “solution” had a substantial impact on the design of the Issues On-line activity. The on-line discussion that we had been envisioning (in our conversation, the written assignment, and scenarios) as weeks in duration, was to become “an hour and a half.” This shocked me because I considered the technological mechanism that we were building upon to be better suited for long-term, asynchronous discourse. Allen understood this, as evidenced in the following excerpt from my field notes, but we were again constrained by the technology; this time, by lack of access to it:

I asked his intentions on the field trip: Training or Access? He said both. He said for many it would be the only access they would get. I brought up the Asynch vs. Synch issue. He understood, said, “Something like this is more for the long term.” He then added perhaps part of the assignment would be to make postings after the training period. He drew an analogy to research projects where the students are required to go to the library. He said they use the [3University] library all the time ...

3.2.4.5 Control and Recklessness

A tension between constraint and freedom (“control” vs. “recklessness”) also surfaced in connection with the public nature of the Internet medium. From the very beginning, Allen had intended to exploit this feature in order to widen the scope of participation in his classroom activities. At one point (in our last extended face-to-face meeting) we talked about user authentication (entering a user identification and password before posting a comment). Allen asked me how I had done this in the On-line Debates:

L: Ours was set up so that anybody in the world could look, but only when you pushed one of these buttons ... “agree” or “disagree” ... a little box comes up asking for userid and password.

B: I’d still like to have that [the ability to post comments] also open to the public ... [But,] I want to know when my students are posting ... when the thing comes you, “enter your userid,” if it’s a student, they would know to enter their userid, because if they didn’t, how would I know who they were? But other people in the world could post things and they could stay anonymous. If a student entered anonymously, their great, but I wouldn’t know it was them so they wouldn’t get credit.

L: OK [hesitant]

B: Do you think that’s reckless?

L: I don’t know, what’s your goal?

B: My goal is to get as many people as possible to use it and, if they’re my students, to know that they’ve done it; not to control then in any way, just to know that they’ve done it.

Reflecting the project’s peer-review origin, Allen wanted people from the outside world to be full participants—to be able to post comments. Reflecting his liberal pedagogy, he wanted to keep the activity as little constrained as possible—even to “the public.” He did need to evaluate his students, however, and therefore needed to identify them. But, as he emphasized, this was to give them “credit,” not “to control them.”
I was aware of problems where people on the Internet had abused public forums, particularly cases were adults exploited minors through the net. In the spirit of participatory design, I wanted Allen’s pedagogy to be the primary design impetus, but I also wanted him to be aware of the dangers of making the net his classroom:

L: OK, what about controlling the outside world though? You don’t want to control that in any way either?

B: I really don’t. Do you think that’s bad?

L: That’s your call. I’m just the programmer.13

B: Well I want to know your opinion.

L: I would think that it’s dangerous. That means anyone who wants to could come in and post an obscene message.

B: Totally unrelated to the whole project. It’s a shame that the Web doesn’t, that Mosaic doesn’t [say] where you’re coming from.

L: We do know the machine they’re coming from. But what good does that do us; we don’t know who the person is anyway.

[pause]

B: This is a big problem.

Again, we turned to technology, whether “the Web” (the HTTP protocol) identifies the client to the server, but only fleetingly and only in relation to this activity issue. More significantly, we realized that a property of the technology, the public nature of the Internet, has constrained the freedom inherent in Allen’s pedagogy: it’s “a big problem.” At this point, we agreed that both outsiders and students should authenticate themselves before posting comments. In perhaps our last major design decision, we decided to post an invitation to outsiders (on the Issues On-line “home page”) instructing them to send us e-mail if they wanted to participate actively (i.e., post rather than read). Unfortunately, we had no takers. Although my log file showed that many “outsiders” did look at our invitation, none actually requested to be admitted. Nonetheless, the public nature of the Internet, the fact that outsiders could even observe the activity, would have a profound effect on its outcome.

3.3 The Issues On-line Experience

13 In this speech act, the “voice of design” defers this decision to his “voice of practice.” While the tenets of participatory design truly motivated this utterance, it carried additional meaning. At this point I had been working on this and my middle school project for about eight months and both I and my collaborators (the teachers) were frustrated. These projects had consumed a lot of our time and had proceeded more slowly than we had hoped. Furthermore, I had increasingly sensed that in both cases the teachers thought of me as “just the computer guy,” there to plug in cables and write software—“just a programmer.” In my own perception, from my professional background, I conceived of myself as a “software engineer,” and now, from my research activities, as an “ethnographer” participating in the development of new tools for pedagogy. My utterance had a sarcastic component—a bit of resentment that they were not according me the same participatory spirit that I tried to give them by treating them as designers.
3.3.1 Field Trips for Peer-Review, Access, and Training

On consecutive days in mid April, Allen took his three senior-level Physics classes on "field trips" to the University library’s media center. This was his "solution to the lack of network access," which he had proposed in late March. He had a second purpose, however: training. Allen had made a new instruction sheet for the students, titled "Peer-Review," that specified what the students should do during the on-line activity.\(^{14}\) This sheet had four sections: Introduction, For Experienced BEV People, For Inexperienced BEV People, and Evaluation.\(^{15}\)

The first paragraph of the introductory section divided the students into two groups:

As you know, the assignments you worked on for a project grade are being posted on the Internet. For some of you, that will mean very little because you have never had any exposure to the Internet and may not even have any idea of what it all is.

The section for experienced people (students who had "played with the BEV") gave "simple and basic directions" to the projects on the Web so they could begin the peer-review on their own. The section for inexperienced people emphasized formal learning about the technology itself:

Since most of you are not Internet people, we need to formally go together to a place where we can work on the Internet together. ... Using their [the University library's] 20 computers, you can have a chance to work through the learning phase of using the Blacksburg Electronic Village to review and comment on the work of your peers. (emphasis added)

During the field trip, the students would learn to use the Issues On-line system and have an opportunity (be required) to post 5 comments to other students' projects. After this, they could (should) return to the library independently and respond to the comments that others had made about their own issue.\(^{16}\) Allen's pedagogical goal for the field trips went beyond both training the students to use the Issues On-line system and teaching them about peer review and issues in science; he also wanted them, especially the "non-Internet people," to learn about the Internet in general.

The Issues On-line activity that was realized in these field trips appeared quite traditional—more so than what we had envisioned early in the design process. The media center was laid out like a traditional classroom. A teacher's computer occupied a distinguished position at the head of the room facing back towards 20 student computers, which all faced the front. The student computers were set atop long tables (2 or 3 per table), which were arranged in four rows and two columns—a single isle down the middle. The teacher's computer could be projected onto a screen at the front of the room. Allen began each of the

\(^{14}\) The original assignment, which specified the format and topics for the reports, had been titled "Issues On-line."

\(^{15}\) The evaluation section broke the grade into three parts: 70 points for "your original issues project," 15 points for "meaningful comments on at least 5 other issues," and 15 points "for responding to comments posted by other people about your project."

\(^{16}\) They might also do this from home, if they had access, or from the computer in Allen's classroom.
three classes by demonstrating (with his computer projected) how to start the Web browser and navigate to the home page for Issues On-line. He then demonstrated how to navigate between the pieces of a single project and described how to post a comment. Finally, he specified the primary requirement of the activity—to post 5 comments:

Find yours [your project] first, but when you have a feeling, you read something and it bugs you, ... you can post a comment. ... Everything you post will have your name on it ... don't be mean ... be intellectual ... anybody in the world can read it. ... When you are ready to post your first comment, call me. ... You can comment on comments ... kind of a slow debate. ... Your assignment ... you have to post to 5 projects ... today. ... We'll be here another hour and five minutes.¹⁷

The students then began to work. Several had difficulty logging in to the system—some simply forgot their password—but within 15 minutes, roughly half of them were composing their first comment. By my quasi-quantitative measurement, the students spent about half their time reading the issues and half writing comments. The ratio of the total number of postings to the number of students indicates that most met the quota. For the most part the students worked silently and "individually," although they did interact face-to-face on several occasions.

The appearance that the students were working quietly on their own was of course deceiving. Even when they were typing or reading at their computer they were not working alone—there was a "slow debate" going on. Besides this computer-mediated interaction (which we designed into the system) the same-time same-place setting (which we introduced by necessity, not design) allowed unmediated interaction. Furthermore, the fact that the students were members of a "real-life" community—the high school—affected both mediated and unmediated interaction. For example, on at least one occasion a student asked Allen to look-up which project a friend (in one of the other classes) had written.¹⁸ In another case, a student writing a comment looked around the room, apparently searching for the author of the target issue, saying out loud, "Where is he?" Students also orally referred each other to interesting comments. In one case, Allen gently instructed a student, who had been summoned by another to look at a comment, to return to his own computer: "You can look at it on yours."

A similar juxtaposition of traditional and non-traditional pedagogy (between control and freedom) was evident in the content of the learning activity as well as its social structure, outlined above. Although ostensibly the content consisted of the social issues in science, at times, the technology itself became the focus of the activity. A mundane example was Allen's explanation, in his introductory lecture, of how to use scroll bars and windows. A more interesting interaction between the technology and the curriculum

¹⁷ This is a compilation of quotes (recorded in my field notes) across the three field trips.
¹⁸ The authors' names were not included on the index WWW page that listed the 45 projects; they did appear on the four pages of the projects themselves, however.
resulted from the open, global nature of the Internet and World-Wide Web. The activity (the assignment) was traditionally constrained—post 5 responses—but the space in which the activity took place was much less constrained than the traditional classroom, or textbook. Several times in each of the three days I observed students “leaving” the Issues On-line-space, venturing off to other “places” in cyber-space. This extracurricular activity (“wandering,” as I called it in my field notes) included students going other “places” on the Web, at least one instance of a student connecting to a BBS at another nearby University (via Telnet), and several cases of students sending and reading e-mail. In one case, a student asked Allen (near the end of the session) for permission to wander. Allen said if he had already posted 5 comments and had looked at his own it was OK. Later in that same session, I saw Allen actually helping students to browse other parts of the Web. Allen was able to balance the traditional constraint he prescribed in the assignment with the non-traditional freedom offered by the technological medium of the activity.

In addition to offering new social structure and pedagogical content, the technology also excited and motivated the students. One student, upon first entering the media center and seeing the rows of powerful computers, exclaimed. “Wow!”; several asked about the future of such computing facilities in the high school; and, as Allen told me in the last field trip after getting feedback from the other two classes. “[They’re] on fire ... [they say] this is the best thing we’ve ever done!”

The students did have some problems using the Issue On-line system. Some of these were generic user interface issues; for example, some students expected the HTML input form to automatically word-wrap and typed entire comments as a single line. Other usability issues concerned specific features of the Issues On-line application. The most salient of these was confusion about structure. First, some students found it confusing that they could enter comments in four different places within a single issue (the issue’s home page, the supporting and opposing evidence pages, and the references page). Second, in at least one case, a student was confused about the nesting of comments; he was concerned about an agreement he had attached to an existing disagreement. As it turned out, the student had done this correctly. “it just didn't look right [to him] in the hierarchy,” Allen said after helping him. In sum, however, the students were able to use the system effectively—they met their 5 posting quotas within a short period of time, and for the most part, engaged in meaningful discourse.¹⁹

The way that Allen addressed usability issues during the field trips supports the viability of the participatory design process. At one point, a student asked Allen how to use the posting form. Allen explained the form to him and then asked why he found it confusing. After this, Allen told me that

¹⁹ In fact, when Allen specified the 5 posting requirement in his oral instructions on the last day, he was confident enough to add. “That's not going to be a problem at all.”
“physical things [like] tabbing between fields” were the greatest source of confusion. He was aware of and trying to optimize usability—he participated in both the design and the usability testing of the system. This is not surprising: diagnosing and correcting problems with understanding, the essence of “usability testing,” is, of course, fundamental to teaching also.

Although Allen began each session in a traditional lecture mode, his overall role in the activity was minimal. Much of the time, he sat at the rear of the room, not participating at all. At one point, he even commented jokingly, “I’m bored ... they don’t need me ... I’ve been reduced to a technician.” This again reveals a disparity of the technology (at least our design). On the one hand, the technology freed the students from the traditional teacher centered mode of instruction—they didn’t need Allen. It constrained Allen’s ability to monitor his own classroom—his power had been reduced. A “slow debate” was taking place in Allen’s “classroom” those three days, but he was not in control or even fully aware of its content.

### 3.3.2 Analyzing the Discourse Record

In this section I analyze the Issues On-line activity by examining the record of structured discourse that it left behind. In this analysis, I present quantitative results that are based on my classification of the students’ postings. Although I report exact numbers, the reader should be aware that this categorization is qualitative and subjective and that some counts are approximate.

The majority of the Issues On-line activity consisted of discourse that was relevant to the issues and most of this was of good academic quality for 12th grade students, particularly with the 1.5 hour time constraint. There were problems, however. First, there was some significant “flaming” as well as other kinds of inappropriate content and use of the system. There also were some usability problems, both with the user interface and the conceptual structure of the system.

#### 3.3.2.1 Vacuous, Inappropriate, and Constructive Postings

<table>
<thead>
<tr>
<th>Table 3-1: Issues On-line Posting Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuous</td>
</tr>
<tr>
<td>(Inappropriate) Horsing Around</td>
</tr>
<tr>
<td>(Inappropriate) Flaming</td>
</tr>
<tr>
<td>Neither Vacuous nor Inappropriate</td>
</tr>
<tr>
<td><strong>Total Postings</strong></td>
</tr>
</tbody>
</table>

A total of 45 projects were available for discussion and a total of 447 comments were posted by approximately 60 students. Of these comments, 74 did not contribute relevant information regarding the issue they were posted under—I categorized these as vacuous. These included degenerate agreements or
disagreements, probably posted simply to meet the student's quota. The following two were typical of this category:

From: Daniels, Jerry  
Date: Wed Apr 19 12:14:01 1995  
Issue: Endangered Species Act  
GOOD ISSUE  
I agree

From: Nesbit, Pat  
Date: Mon Apr 17 09:34:18 1995  
Issue: Physics and GOD  
Evidence: Physics and GOD - Supporting Evidence  
Comment: Where's the evidence supporting this theory?  
HE'S RIGHT  
After reading her supporting evidence and david's comment, I have to agree with David. Where's the evidence?

A total of 57 postings included some kind of inappropriate content, which I characterized as either horsing around or flaming. The following social invitation typifies the horsing around category:

From: Holland, Robert  
Date: Wed Apr 19 09:42:22 1995  
Issue: Cloning Research  
Comment: We got it use it!  
HEY YOUSEFF  
I'm just trying to see if the comment thing works on Mr. Browne's computer. Let's go to the soccer game tonight. Also, I disagree with this comment.

The majority of these postings were also vacuous. On the other hand, many of the flaming posts, even the most extreme, contributed relevant information to the discussion. For example, in the following, the author of a project defends his research methods, but in a personal and violent manner (emphasis added):

From: Reese, Richard  
Date: Mon Apr 17 10:41:07 1995  
Issue: Value of the Internet  
Evidence: Value of the Internet - Opposing Evidence  
Comment: Obviously, this opposing evidence is weak.  
COME SEE ME  
thank you very much, but I know plenty about the services. Obviously you think you are some kind of computer genius. You are arguing with the facts, stupid. The info I used to oppose this came straight from newspaper articles and magazines, so
if you think you know better, go see them. But, if you ever insult my intelligence like that again, I'll kick your ass.

Some students became so upset by the flaming (see the Women in Space Flame, page 119) that Allen ended the issues On-line activity early and removed the discourse record from the network. Because flaming had such a significant effect, I was inclusive in categorizing postings as flames. More than one third of the flames were mild, simply including phrases like "get a grip" or "get the facts straight."

By this classification (see Table 3-1), over three quarters of the postings were not vacuous and were free of any inappropriate content. Of these, many were instances of "social construction of knowledge" [Scardamalia, et al. 93] (see chapter 1, Educational CMC: Social Knowledge Construction— Learning in World 3): i.e., students collaboratively creating objectified (vs. personal) knowledge within the network application (see the discussion of CSILE in the related work section of chapter 1). For example, the following posting (an agreement) builds on the issue/position (not shown) that it was attached to (a response from the issue's author follows):

From: Cummings, Shane
Date: Tue Apr 18 10:30:35 1995
Issue: Aluminum and Alzheimers

SOME THOUGHTS...

Obviously there is a connection between aluminum and Alzheimers as evidenced by the quantities of the metal found in the 'specimens' brains. I am no medical genius, but could the problem caused by aluminum not be caused by the aluminum itself but by the problems a specific body has with it. Just as diabetics have problems with the metabolism of sugars, maybe Alzheimers prone bodies cannot handle the presence of aluminum. With an increased amount of aluminum in the body, normal function and reproduction of brain cells could become a problem. Maybe the current Human Genome Project will isolate a piece of DNA which is connected with a body's inability to handle aluminum. Besides, what would life be without the incredibly useful aluminum foil?

From: Woods, Mary
Date: Fri Apr 21 14:21:52 1995
Issue: Aluminum and Alzheimers
Comment: some thoughts...

GOOD POINT

That's a great comparison you made about diabetics. I never even thought about that!!!
3.3.2.2 Structure

During the design process, after the discussion format had emerged as a design feature, Allen and I had worried whether the students would indeed engage in discussion (interaction) or simply post comments directly to the pieces of work. As it turned out, there was a lot of interaction: about 30% (137/447) of the postings responded to a previous comment and more than one third of these (46/137) were nested more than one level deep. There were 33 instances of the author replying to a comment on their own issue.

The structure of the Issues On-line system was fairly complex. As described previously, each issue project consisted of a home page, which stated the issue and the author's position, two evidence pages (one supporting the other opposing) and a references page. Participants could post comments on any of these four pages and could choose from three comment types: agree, disagree or neutral. Nesting of comments further complicated the logical structure of the collaboratively constructed discussion.

<table>
<thead>
<tr>
<th>Cloning Research – Henry Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>...Cloning for many years was a touchy subject and put off to future generations to deal with, but not any more. Many scientists and ethicists have been asking themselves and each other if cloning research should be going on. I personally think that this type of research has no place in our society today.</td>
</tr>
<tr>
<td>[X] I think the proper restriction it should be presued.</td>
</tr>
<tr>
<td>[X] I disagree with this comment and think that cloning of humans should be banned.</td>
</tr>
<tr>
<td>[✓] I agree that cloning should be banned.</td>
</tr>
<tr>
<td>[✓] Cloning is bad stuff</td>
</tr>
<tr>
<td>[ ] Star Trek territory</td>
</tr>
<tr>
<td>[X] We got it use it!</td>
</tr>
<tr>
<td>[X] Hey Youseff</td>
</tr>
<tr>
<td>[✓] Cloning, if used wrong, could be desastrous.</td>
</tr>
<tr>
<td>[ ] Cloning may help in space exploration?</td>
</tr>
</tbody>
</table>

**Figure 3-6: A Typical Issues On-line Home Page**

The issue home page shown in Figure 3-6 was typical. In this project, the author takes a con position on the issue of cloning. The first comment, a disagreement, states that with proper restriction cloning is OK. The next (indented) comment disagrees with this disagreement, it counters that all human cloning should be banned. In this example all the comments fit logically into the structure (except the "Hey Youseff" horse-play comment, which was cited above). The two neutral comments are each tradeoff analyses—this was the most common use of the neutral comment type. (These are just the "subject lines" for the comments, clicking the mouse on them produced a new page with the full comment text.)

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20 In these figures [X] indicates a disagreement, [✓] an agreement, and [ ] a neutral comment. In the actual system, bitmapped icons, a red x, a green check-mark, and a blank blue field, respectively, indicated these comment types.

21 I omit the majority of this issue statement for the sake of brevity.
There were 72 cases of postings that had problems with logical structure. By far the most common structure problem (41/72) occurred on the opposing evidence pages, which received a minority of the total postings (93 compared to 274 on the issue home pages). The project assignment given to the students described the opposing evidence page as, "a series of paragraphs explaining the evidence which supports the opposing side of your issue." Almost all of the authors followed this prescription correctly, citing evidence contrary to their chosen position. The assignment further stated that agreements (disagreements) should express the respondent’s support (non-support) "for something written in the project." Double negatives on the opposing evidence page confused many students, however. In the 41 erroneous postings on opposing evidence pages, the respondents selected the agree comment type for comments that actually disagreed with the opposing evidence (or vice versa). Presumably they made this error because they agreed (or disagreed) with the author’s stated position (back on the issue home page).

The idea of posting comments on each page was inspired by the post-it note metaphor: the idea was to enable students to make comments about specific parts of a project and place them close to their referent. This concept was not adequately conveyed to the students, however, as the structure problem above attests. Rather, it appears that many students read the pages of a project until they decided to agree or disagree with the author’s position and then placed the appropriate (in their mind) type of comment on whatever page they happened to be on. The fact that students posted 11 comments on references pages, only two of which actually commented on the references, supports this hypothesis. The discrepancy between the number of “incorrect” comment types on the supporting vs. the opposing evidence pages also supports it: only 3 incorrect comment types were attached to supporting evidence pages, which had the same “logical polarity” as the author’s position, even though the total number of postings was comparable between these two page types.

For the most part, however, the students did use the comment types effectively, posting 110 neutral comments, 109 disagreements and 228 agreements. They were able to handle double negatives in nested comments correctly: of the 137 nested comments, only 11 had structure problems. I believe that double negatives was not a problem in nested comments because the students were well aware when they were addressing a different person than the author. The students also made good use of the neutral comment type. The majority of these comments contained arguments that involved a tradeoff, both pro and con.

22 One of these was from the teacher himself; the other was a horse-play response to that one.

23 For example, if you agree with the author’s position you might disagree with a prior disagreement to it; the first two comments in the preceding example illustrates this.

24 I categorized 56 postings as being especially personal in tone, such as addressing fellow students by name, or even by nickname.
There were other inventive uses of the neutral comment type, however. For example, one student used it as a mechanism to extend and elaborate on his own prior agreement.

3.3.2.3 The Women in Space Flame

Unfortunately, the most salient feature of the Issues On-line discourse artifact, at least from the point of view of the educator, was the flaming. By my inclusive categorization, 10 of the 45 projects contained at least one slightly inflammatory comment; only 3 of these involved significant interaction or strong language, however. One issue, “Women in Space,” was far and away the worst. (The complete statement of this issue and its discussion thread are presented in Figure 3-7 page.121) This “flame war” was initiated in its first posting (from the first field trip), which immediately transformed it into a debate over feminism:

From: Reese, Richard
Date: Mon Apr 17 10:00:56 1995
Issue: Women in Space Programs

WHO CARES?

Mabey women are not a significant part of the space program at NASA, but it seems that NASA is doing just fine without them. I don't feel that this is an area that is controversial. The only people this issue is controversial to is you two. Why really did you write this? I wish women would stop crying about descrimination, because they have no real argument. Just because more men do this job does not mean that women are left out because they are women, it simply means that men are better at this than women. It's not descrimination, just accept the facts.

After one male classmate agreed with this comment (about 13 minutes later), a female student retaliated with a strong disagreement (emphasis added):

From: Klein, Darla
Date: Mon Apr 17 10:44:50 1995
Issue: Women in Space Programs
Comment: Who cares?

WHAT ARE YOU RUNNING YOUR MOUTH ABOUT????

That is such an ignorant statement-how can you imply that women aren't as "capable" of doing the job in this day and time? I believe that we have proven ourselves numerous times to you 'MEN' that we can do whatever you guys can do, sometimes better. I think you're having some sort of inferiority complex. Shutup.

The male instigator “returned” that afternoon (outside of school hours) and posted the disagreement titled “make me.”
The following day, during the second field trip, a third party (male) attempted to extinguish the flame with the following neutral comment (certainly an appropriate use of comment type!):

From: Smith, Randy
Date: Tue Apr 18 10:26:02 1995
Issue: Women in Space Programs
Comment: Who cares?
Comment: What are you running your mouth about????
Comment: make me
WHY DON'T YOU BOTH SHUT UP.

Both of you need to lighten up and swallow some pride. There are things that men can do better than women, maybe extreme physical labor, and their are things that women can do better than men, like negotiating and compromising. I’m sick as hell of male bashing as well but I’m also sick of people telling women that they are somehow inferior to men. Why don’t people realize that neither sex would be here with out the other and start looking at people AS people and not as men and women.

Three agreements, posted during this same field trip, supported this appeal for peace. Unfortunately, during the third field trip the comment “Feml-nazis SUCK” rekindled the flame. As the pattern of comment nesting indicates, this flame went through two more waves throughout the week. The original instigator was involved in each of these, posting his comments in the evening, probably from home.

Although Allen was aware of some inflammatory content during the field trips, neither of us predicted its result: a premature end of the Issues On-line activity. Furthermore, the technology, the mechanism that we had designed, did not support us in detecting or controlling it—witness Allen’s previously cited statement about “not being needed ... being reduced to a technician.” During the second field trip, Allen said to me, “They have no trouble expressing themselves at this age ... [some of the postings from yesterday] were a bit harsh.” Also in the latter two sessions, he explicitly instructed the students, “keep a gentle tone ... don’t be mean, be intellectual,” adding, “Anybody in the world can read it.”25 These instructions did not eliminate the problem: 15 of the 26 postings that I categorized as flames occurred during these two field trips.

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25 During the design process we had discussed the public nature of the Internet and we hoped that including student’s names on their postings would encourage them to use an appropriate (academic) tone in the on-line discussion.
WOMEN IN SPACE PROGRAMS – BINDA NATHUR & SARAH LAUGHLIN

Sally Ride, Roberta Bondar, Mae Jemison: we know these names because they are among some of the first women to make recognizable advances in space technology. Yet in NASA, women and minorities have only been publicly acknowledged for these few initial achievements. Where do they fit into the big picture of space technology? We know that there is a plethora of talented engineers and scientists that is as of yet untapped. Since as early as 1992, the aerospace/aviation industry has been making attempts to recruit more women and minorities into the space program. But in our research we found very little information that specifically related to this subject. We are in search of more answers to our research needs. These are a few questions that would aid our research:

NASA and the space program has claimed in the past that they would like to hire more women and minorities in high-level positions. Do you feel that NASA has made satisfactory efforts in recruiting this untapped labor force?

What are some ways that NASA could encourage more woman and minorities to enter the field of space technology?

Any additional information regarding this topic would be greatly appreciated.

[*] Who cares?
   [✓] I totally agree
   [✓] What are you running your mouth about???
   [✓] make me
   [✓] Why don’t you both shut up.
   [✓] Randy Smith, my hero
   [✓] randy’s da man
   [✓] Amen
   [✓] Fem!-nazi Suck
   [✓] YOU TELL ’EM, BOB’!
   [✓] Why not improve all women by all women improving themselves?
   [✓] Read the project before you label anyone.
   [✓] You just can’t passify a woman
   [✓] LARRY IS A GENTOUS

[*] I think women have the inferiority complex.
   [✓] Feminists make me puke.
   [✓] A person should obtain their job by merit.
   [✓] Thank you, read this Darla
   [✓] Richard Reese is a stupid contradictory pig.
   [✓] Aw, Stanely wants some attention!! 00:12:45 (R)
   [ ] out of hand 00:18:30 (D)
   [ ] hey diz 00:19:50 (R)
   [✓] *cackle* 00:42:54 (D)
   [✓] of course 00:46:20 (R)
   [✓] amazing... 00:54:02 (D)

   [✓] Qualifications are what matters
   [✓] Righto!
   [✓] Effective action??
   [✓] You missed the point diff.
   [✓] Just A guy...
   [✓] Good job!
   [✓] The issue is...
   [ ] let’s just fight it out!! 00:16:59 (R)
   [ ] fightin’ words 00:20:33 (D)
   [ ] well, mabey 00:28:27 (R)
   [ ] har har 00:45:10 (D)
   [✓] *Yep 00:48:36 (R)
   [✓] the Internet 00:58:26 (D)

[ ] Women and minorities are gaining more access to NASA.
[ ] Richard & Stanley: did you read first?

Figure 3-7: The "Women and Space" Flame
3.3.2.4 Reinventing the Application

Flaming was not the only type of “inappropriate” content. Another common (mis)use of the system was for personal communication (the soccer game invitation, cited above, exemplifies this). The most noteworthy (mis)use of this type was also located in the “Women in Space” discussion (again involving the flame instigator). The deepest comments in both the second and third waves of this discussion were actually a quasi-synchronous, late-night conversation between two male students. All of these comments occurred on the night (just after mid-night) of the last field trip. I’ve added the time and sender’s initial to the subject lines in Figure 3-7. This reveals that the students were simultaneously engaged in two interleaved conversations that were “located” in different parts of the structure. I present the last three comments from the second conversation below in Figure 3-8 (I’ve omitted most of the headers).

```
From: Darwell, Harry
Date: Thu Apr 20 00:45:10 1995
HAR HAR
hey rich, i feel like we’re sitting here havin’ a chat in physics again...--Daz
```

```
From: Reese, Richard
Date: Thu Apr 20 00:48:36 1995
YEP
except this time, we are sitting at our computers in the middle of the night,
worthlessly loosing sleep over a REALLY cool way to chat.
```

```
From: Darwell, Harry
Date: Thu Apr 20 00:58:26 1995
THE INTERNET
i think this should be moved to your thing on “is the Internet really necessary?”
“grin”--Daz
ps—to those of you reading this and thinking we’re worthless pondscum for taking
up your time, sorry, it’s late, and we’re just down-right nuts.
```

Figure 3-8: A Creative use of Issues On-line

These students (creatively) reinvented the application. Allen and I had designed the software mechanism to support the Issues On-line activity at any time or place. Here, these students applied this same freedom to a different activity: “chat[ing] in physics [class].” The post script in the last comment indicates that they were (as Allen and I had hoped) aware that the “world was watching.” At least after the fact—this was the final inappropriate posting. Obviously, this was not enough to control their behavior to the extent that we desired, however.

3.3.3 The Students’ Perspective
During the last field trip, Allen asked me to come and talk to the students. On the Friday after the field trips, I went the high school and met with each of the three classes that had participated. Allen dedicated the entire 45 minutes of those Friday classes to this. I began each class by briefly describing my research interests: using the network for communication (vs. information retrieval); and the idea of teachers designing their own educational software. I then asked them how they liked the field trip; the response was overwhelmingly positive (this was corroborated in the questionnaires). In general, I got little oral response when I asked for comments or questions, but the 56 respondents did say a lot in the open-ended written questionnaire I administered at the end of each session (see Appendix 3.6, page 143).

<table>
<thead>
<tr>
<th>Table 3-2: Students' Perception of the Issues On-line Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. How did you like having people make comments about your project and commenting on other peoples' projects? Did you like using computers and the Internet to do this?</td>
</tr>
<tr>
<td>Liked</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Comments</td>
</tr>
<tr>
<td>CMC</td>
</tr>
</tbody>
</table>

As Table 3-2 indicates, the students enjoyed the Issues On-line experience: 49 students indicated that they liked exchanging comments, 45 reported that they liked using the Internet to do this, only 2 students were negative in either regard, with the remainder expressing their opinion as a trade-off, seeing both good some bad aspects. Several of the students did conceive of the experience in terms of play as Allen had hoped: 15 students described the experience using the terms “fun,” “enjoyable,” or “entertaining” in response to this question. About 10 others indicated that the computer/network technology itself either made the activity more engaging or was itself the most interesting part—another of Allen’s goals.

3.3.3.1 Candidness, Time to Think, and Feedback

A minority of students’ comments (18) reflected well-known experimental results regarding the social psychological effects of CMC. This number is significant, however, because the responses were spontaneous: they reflected the students own categories, not those introduced by the questionnaire (or an experiment). This also illustrates the level of engagement and insight that these high school students had with respect to this activity. About 10 students expressed the idea that CMC facilitated “candidness” in discourse, citing this as a positive effect. For example (emphasis added):

T-5: I thought it was a good candid way for people to make criticism. I think that using the computer was the way to add the candidness of the commenting part of the project.
T-9: I think it's better to have people comment on your project and vice versa, because this way you can say exactly what you want without holding anything back.

T-20: I think computers take the stress of face-to-face comments away and make it easier in general.

Several students expressed a tradeoff between face-to-face and computer-mediated communication. For example one student liked having more “time to reflect” but acknowledged the “loss of immediate feedback”:

T-4: Writing is a better (thought out) form of communication. Ideas can be represented and thought out clearly on the BEV, but it does not substitute for communication. Yes, I liked it.

Another compared candidness to feedback:

W-6: It was interesting. You gain being able to communicate freely w/out hurting someone, but lose being able to get feedback.
This would be a good way for teachers to grade students’ work.

These were commonly cited categories: 5 students mentioned the (negative) loss of quick feedback; 4 the (positive) ability to reflect on what they said.

3.3.3.2 Construction, Controversy and Freedom

Responses to the fourth question, “Why did you select particular places (projects and other comments) to make your comments?” also revealed the students’ conception of this activity. When I formulated this question I was particularly interested in the personal nature of the interaction, the fact that these students were members of an existing community. I was surprised that only 3 students responded that familiarity with the author (or commentator) motivated where they posted comments. By far the most common response, about half the students, was that they simply selected issues and comments that were “interesting”—this doesn’t reveal much. Several responses were more specific, however: 8 students reported that controversial topics attracted them; while 7 said that they looked for places where they could contribute:

T-6: ... I commented where I felt my comments would shed light on a subject.

T-20: ... I did not post anything on projects I had read for the first time as I did not feel I had enough information on them.

Responses of this type align well with the concept of social knowledge construction.

The following is the paradigm for those responses that reflected motivation by controversy:

T-8: I think that one of the main magnets of commentary are controversial issues and comments. This is true of my situation, and those themes which were controversial got the most attention from me, as well as my peers.
In addition, 3 students specifically said they liked the fact that they were free to choose where to make
their comments; e.g., T-3: I selected what was interesting to me. That is a luxury, no doubt, to be able to learn about what I please.

3.3.3.3 Structure

Table 3-3: Students’ Perception of the Issues On-line Structure

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Equivocal</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

Several students (8) interpreted question four differently from my intent. They answered in terms of structure not content—reporting how they selected a page within a project as the place to attach their comment. Most of these students said that they would prefer a less complex structure:

W-8: The fact that most students command that only one multiplicity would be a single comment place would be less dizzying.

The next item on the questionnaire, question 5, specifically asked about structure. As Table 3-3 indicates, a majority of the students expressed unqualified satisfaction with the structure; 17 of these described it as “user friendly,” “simple,” etc. I coded a response as a “No” if it indicated dislike for any of the structural features (several of these said they did like other features).

Half of the negative responses suggested unification of the on-line projects or the location of comments, for example:

T-4: Rather than have the project cover both of the viewpoints only one should be discussed, and the comments should cover the rest of the area of discussion.

T-2: The structure was very easy to deal with (especially for semi-literate computer user.) It would be useful to put all the comments in one place rather than spread around the files.

Only 2 of the negative responses were targeted at the explicit comment speech acts; in fact several responses that proposed unification of the projects specifically lauded these:

W-5: I liked the three kinds of comments, but I think it would have been better if the entire paper was in one place instead of split up into supporting, opposing and references.

26 Again, although this is a small number, the fact that the students introduced this concept without prompting is significant.
In total, 6 responses were explicitly in favor of the speech acts:

M-1: I did like the structure a lot. It made it easy to categorize how I felt, as well as easy to present the ideas in my own project.

W-4: The Agree, Disagree, Supporting, Opposing, etc. were very helpful and made it easy enough to understand to the point a fifth grader could use it.

In other interesting responses, 4 students requested the ability to go back and edit their comments after posting them and 2 said that commenting on comments (nested comments and double negatives) was difficult.

3.3.3.4 Publicity: Pride and the Right to Expression

Table 3-4: Students’ Perception of the Issues On-line Publicity

<table>
<thead>
<tr>
<th>Like</th>
<th>Dislike</th>
<th>Don’t Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>5</td>
<td>24</td>
</tr>
</tbody>
</table>

6. Do you like, dislike, or not care that your project and comments are visible to the general public on the Internet? Why?

My interest in question 6 was how the students conceptualized the public, global nature of the Internet with respect to their own work. As Table 3-4 indicates the students were approximately split between liking or not caring about the publicity—very few disliked it. Of the 5 negative responses, 2 mentioned the flames ("...people were having arguments with each other ..."); "... some comments were unnecessary."); the other three expressed the students' reluctance to publish their own work (e.g., "I did not like my project ..."). Among the positive responses, 27 said that they liked the idea of getting feedback from the outside world (unfortunately this did not occur) and 3 said that it positively affected their work:

M-15: It makes me a little self-conscious of what I wrote but helps me in being objective.

T-20: I liked the fact that my project was visible to the general public because I had to really understand what I was saying.

T-13: I like it because it made me work harder while doing it.

Other researchers, e.g., [Bruce et al. 93] and [Cohen and Riel 89], have also reported positive effects when they include a "real audience" in school writing assignments.

The most common sentiment regarding publicness was either that it was good for the public to see the students work (15), or that the students had a right to display their opinions in public (7). (I categorized most of the former as "I like it", the later as "don’t care."). For example:

27 Including several "I don’t care" answers that also expressed positive effects of publicity.
M-3: I really like it and think it’s really neat how so many people can see my own work.

M-12: I don’t dislike or like that my project and comments are visible to the general public because I can express what I think and not be embarrassed about it. [original emphasis]

Anonymity was also a salient concept for the students: 3 wished they could have been anonymous; 4 thought that they essentially were anonymous (because either no one knew them, no one would find their projects, or no one would care—for these students, the publicness issue was moot). I present an example of each of these two cases:

W-1: I liked it [the publicness], however, I think you should have been able to make your comments confidential.

W-2: I don’t really care because most of the general public does not know me. Plus most people would not be interested in our projects.

3.3.3.5 Unmediated Discussion: Secluded Together

As I described above, lack of network access, rather than pedagogy, caused the official Issues On-line activity to become same-time, same-place.²⁸ In question 7 I explored the students’ perception of this apparent (to me anyway) contradiction: the mechanism was asynchronous, it isolated the students, but the setting made face-to-face interaction possible.

Table 3-5: Unmediated (Face-to-Face) Interaction regarding Issues On-line

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>No (wanted/plan to)</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Activity</td>
<td>28</td>
<td>14</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Outside Activity</td>
<td>25</td>
<td>25</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

As Table 3-5 indicates, a small majority of the students either did interact face-to-face or else wanted to during the sessions at the media center. Among the students who said they did not talk and did not want to (as well as 1 other who did talk, but claimed not to have really wanted to), 6 specifically said that the “seclusion” offered/imposed by the mechanism was desirable. For example:

M-1: [I talked a] minimum amount. Things like, “Oh I commented on that one too.” etc. I really just wanted to be secluded so I could use all the time to read and post.

T-7: I saw this as a quiet opportunity to critique without interaction with other people.

T-11: No. I thought I should write from my own opinion and not anyone else’s suggestions.

²⁸ In item 1 of the questionnaire, approximately 20 students, about 1.3, reported that they did have home access to the Internet through BEV.
W-3: No. I was completely absorbed in the computer. And, in essence, I was talking with other people in the center through my postings.

Among the students who talked or wanted to, 4 said they were helping each other with the system or with spelling, 10 said they were directing each other to “places” of interest, 19 were actually discussing the issues off-line, of this latter group, 3 said they were clarifying things that they had read on-line.\textsuperscript{29} For example:

W-2: Yes. I talked to people about reading the comments I posted, so I knew someone would read them. [directing]

M-19: No ... I would have liked to discuss some of the comments w-others—I probably could have started an argument. [discussing]

T-9: ... I did want to talk to other people who commented on my project, because some people didn’t really say how they felt. [clarifying]

Question 8 also addressed face-to-face interaction as a supplemental activity to Issues On-line; this time outside of the “official” activity in the media center (again, see Table 3-5). The responses to this item were terse—yes/no (unfortunately, I did not ask what they talked about). The students were approximately evenly split. Of the 8 responses that added detail, 3 indicated that they continued to discuss the issues off-line, 2 said they directed others to interesting places, and 2 espoused the “seclusion” feature (only the student of the second quotation, also mentioned this in item 7):

M-4: A few. I prefer not to, and let the comments speak for themselves. [seclusion]

W-3: No. I let my typing speak for me. It’s almost as if there is a dichotomy of self—the me on the net and the me that everyone else I personally interact with sees. [seclusion]

3.3.4 The Teacher’s Perspective

Allen and I met twice after my visit to the high school: on the Monday following the field trips and about three weeks later (16 May). The atmosphere in these meetings was quite different: the first dealt exclusively with the flaming problem—an immediate concern; the second was more positive—both reflective and forward looking. In between these two meetings, Allen decided to end the Issues On-line activity and remove the discourse record from the network.

3.3.4.1 Responding to a “Computer Emergency”

Allen called me at work on the morning of Monday 24 April with “a computer emergency.” He said that some of the Issues On-line discussion was becoming a “violation of Title 9.” He did not define this precisely but said something about ethnic slurs—he mentioned “legal problems now.” He was very upset

\textsuperscript{29} 2 said they talked about irrelevant subjects: “chit chat,” “weekend plans.”
and asked me to take the whole thing off-line. We met later that afternoon so that I could bring him hard-copy of the entire discussion, for him to study and decide what further action to take. I also wanted to interview him about the situation: exactly what did he consider inappropriate; had he anticipated it at all; and what might we do to prevent the problem in the future?

Allen described the flaming comments, particularly the male side of the *Women in Space* flame, as “an abuse of the assignment,” but not something that he could “discipline”.

> It’s an abuse of the assignment. I mean it is just expressing opinions, and those opinions might be offensive, but about all I can do about it is say, “You abused the assignment; you didn’t do what I asked.”

On the other hand, he described “a drawing line” between “offending a group of people” and “a direct insult to a person” and he explained the “legal limit” of Title 9:

B: But there’s a certain legal limit, which is the Title 9, which says that when it gets to the point where it has an effect on education then it’s against the law. And I’m starting to see that, which really scares the crap out of me.

L: How do you see that?

B: I have, the main offender, this person, who’s name comes up a lot, is in the same class as the four girls; they sit here and he sits there. They [the female authors] do not feel like they can walk into my classroom anymore—they are so upset.

The predominant theme of this discussion was what Allen, as an educator in this situation, was *allowed* and *responsible* to do on-line (emphasis added):

B: I’ve been advised... [that] by cutting it off, those guys won... [rather] the girls should take the opportunity to research rational responses to what they [the boys] said... and get it out there...

*Or can I do that?* Can I leave that stuff out there that’s going to offend people? These are High School kids.

L: Have you considered going out there and responding to some of these?

B: Oh yeah.

L: Have you done that?

B: No... The one *responsibility* that I definitely do have, is I have to individually confront these students... I’ve got to let [them] know the results of what they’ve done. And I don’t know if it’s right for me to do anything that would cause the whole debate to grow. I would hate to say something that just caused it to get worse.

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30 This was the first time in our nine month collaboration that this traditional schooling concept emerged.

31 By a senior colleague in the Science department.
3.3.4.2 Teacher-Control or Student Self-Control

The striking thing about this situation is that Allen felt tremendous responsibility to do something to control the situation, but he was not in control on-line: if he joined the on-line discussion he might “cause it to get worse”; and “by cutting it off, [the] guys won.”

When I proposed a technological mechanism to increase the instructor’s on-line control, however, Allen suggested an purely instructional alternative:

L: I know one thing that you absolutely need is a better way to monitor this thing ... the instructor needs better tools for monitoring what is happening ...

B: Maybe all it takes is for me to better anticipate something like this and really have some live discussion with the kids in advance.

Likewise, when I suggested that the teacher has more control in a live classroom discussion, he instead emphasized face-to-face instruction to increase the students’ on-line self-control:

B: The kids tell me that it [flaming] happens in classrooms.

L: The big difference is there you [the teacher] are, you’re right there.

B: You [a student in a live classroom] lack that perceived anonymity. Whether your name’s on it or not [referring to the on-line forum], it surprises me that it doesn’t seem to matter to them. They feel, “If I can just get it out, I’ll be glad I said it.” ... The students who have offended so much have not been told by me yet, what the feelings were about this. [emphasis added]

His concern about the student’s self-control also emerged in regard to the inappropriate discussion, which he categorized as “just garbage” (emphasis added):

B: One thing I’ve an exceeding amount of is just garbage out there ... like, “What are you doing this weekend.” ... Stupid meaningless non-sense that soils the whole system. What these kids need, and I think this would actually help, they need e-mail—they don’t have it ... These are the kind of people who need like IMS phone.

L: So I mean it’s kind of resourceful of them actually.

B: It’s amazing that they could use it that way ... amazing that they would ... That they would think that that would not be the right way to use this.

Again, Allen expressed surprise at the effect of the medium on the student’s self-control. Further, he considered both the “flames” and the “garbage” to be serious problems, “[it] soils the whole system.” This time he proposed an excellent technological response (e-mail or phone) but, again, a solution that targeted the students’ behavior, not the teacher’s on-line control.

In Issues On-line, Allen had courageously tried to free the students from the constraints of traditional science education, not only by using the network medium, but also by broadening the subject matter. The later was revealed in the following exchange:
L: Have you ever had this kind of problem in discussion in class?

B: I don't think I've ever had this kind of discussion in class; at most we're debating whether the ball's going to go that way or that way ... Nothing that touches the heart that tightly.

In this meeting, Allen was deeply troubled about the flame problem (at its start he told me, "They [some students] came to me in tears!") but he was also emphatic that he would try it again—and without injecting direct teacher control into this new classroom space.

3.3.4.3 Lessons Learned: People not Science

Between the 24 April meeting and our last one (16 May), Allen's intention for the Issues On-line went through three stages: first he intended to put it all back on-line (otherwise, "those guys won"); later, in an e-mail message, he said he would "remove the offending material and leave the rest of it available for viewing," but not allow further posting; finally, on 10 May (again in an e-mail message) he said he had decided to end the project and requested that I remove the links to it (which had pointed to an "under construction" message since 24 April). At this point we scheduled our last meeting to close the project out.

At the start of this final (primarily interview-like) meeting, I asked Allen why he had changed his mind about the fate of Issues On-line. He gave two explicit reasons: "that [student] interest had waned" and "it was so close to the end [of the semester]." Shortly after this, not in direct response to this question, however, he described a talk he had with the students the week after the field trips (in which he used the discourse record for corrective instruction):

B: ... I pulled out examples and I censored them for content and for names, and we really talked as a class, they were so scared of me, because they've never seen me mad. ... I think I really winged 'em, really, really. They got a clear message from it, and

L: Which was?

B: This is really wrong.

L: Um

B: why those comments were wrong, why they shouldn't have been there, and I think one message I really made clear to them ... which is sort of selfish for me, they needed to hear really [pause] how much it hurts me ... what possibly could happen to me as a result of this ...

As in our previous meeting, Allen's convictions about his rights and responsibilities as a teacher were prominent. The mood of this final meeting was not somber (like the previous one), however, and when I asked if the students now had negative feelings about the experience Allen replied:

Some of them really got upset, but they loved the experience. Nobody said ... "we should have never done this; this is terrible, I hate this." They ended up getting mad at other people in the class. ... Universally, as far as I know, people loved the assignment.
While some students blamed each other for bad behavior, they did not blame the technology, or our application of it.

This discussion was evenly split between evaluation of this (now past) experience and plans for the next one—between evaluation and re-design. When I asked what had been learned, Allen articulated four lessons. First, he said that he had “learned a little about doing these kinds of things” (in fact the entire latter half of this discussion addressed things he’d do differently next time). The remaining lessons were for the students. In the second, Allen said, “about the negative side of it [the flaming], they learned a little bit about themselves ... the nature of their comments.” In the third, the students learned about other people:

B: ... the students said to me ... they learned more about people in the classroom, who in the last 12 years, had never really been a part of the classroom ... these students now had a voice that could not be yelled down. I mean you’ve got to go through their comments just like any others.

L: The students actually said this?

B: Yes they did. ... Somebody who normally would be an active part of the classroom was saying, ... “I didn’t realize this person who was sitting next to me for twelve years, could make ... so much sense, and was so smart.” ... I think that was really to the benefit of the kids.

This was a very positive result—particularly because students “finding their voice” had been an explicit design goal.32 On the other hand, Allen discounted the actual science the students learned, other than the Internet technology itself:

I don’t think there was really that much content benefit because we didn’t really translate the content into any kind of an assignment. It was more of an experience ... My biggest main goal in this whole thing, if I get down to the most basic thing, was to get them on the Internet.

... Even though I had some students [in the field trip] actually brows[ing] in other areas, and I said to some of them, “you need to work on the assignment,” ... I was still thinking to myself, “this is good; they’re out there playing.”

This lesson, in which Allen taught his own “playful” attitude towards technology, was well learned: he added, “You go in that library, they’re [the students are] ‘Netscaped’ to that screen. Its so great!” Nonetheless, Allen hoped to address the “translation” problem in the future—to better integrate the Internet “experience” with the Physics “classroom.” This was one of several areas of change—re-design—that dominated the remainder of the discussion.

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32 In the previous meeting, Allen had also said the students learned about each other through this activity, although in a less positive context: the Women in Space flame. He said that the authors were “shocked” to learn that “they [the perpetrators] would feel that way about women, or minorities.”

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3.3.4.4 Re-design: Technology for Freedom; Instruction for Control

When I explicitly asked about “plans for the future.” Allen’s response echoed our “original design”: he wanted to make it less constrained, both temporally and geographically:

I want to do it ... more along the lines of ... the original design ... more asynchronous ... more long term, not bound to any grading period.

... even though it was on-line it didn’t need to be, because it was very tightly focused to the interests of the class ... so I’d like to make it more general interest ... more likely that people out there would step in and participate ... Those qualities I can’t yet fully describe.

... The only benefit there [having the past activity on-line] was that the students could do it from home.

Limited access to the network had imposed the temporal constraint Allen referred to in the first comment. This was no longer a problem. Over the past three weeks, many of the school’s computers had been connected directly to the Internet. In the two latter comments Allen showed characteristic insight by distinguishing two kinds of geographical effects (first and second-level, respectively): freedom for the same students to work from different places (“home”); versus, freedom to form whole new learning communities (“people out there participating”).

Twice in the latter parts, this meeting took on the characteristics of my idealized participatory design process: pedagogical goals leading to design features. In one case, Allen described a new Physics curriculum that included tasks for the students that “are actually tangible things, projects built,” but “also a lot that are just writing.” He first invokes our original design, the “peer-review type of thing,” as appropriate for the latter category, and this leads to further discussion about a re-designed activity and mechanism. In the other instance, we were talking about solutions to the flame problem. Allen first suggests an activity change (re-design) to address this:

I said to them, “remember what you say and write has your name on it, that’s why you have a password, and is readable by anybody in the world.” That’s not enough. It has to be more, “now this is not the kind of thing to do.” I’ll ... give them more scenarios of things that they might possibly have a mind to say but that they shouldn’t say.

He followed this with an additional, technical solution:

... [maybe] an on-the-side chat system, running in a parallel program where they can call somebody up and ...

This led us into our first technology-implementation dominated design conversation since the middle portion of the project—an enjoyable and appropriate way to end our first collaboration.

3.4 Summary and Discussion

3.4.1 Collaborative Design
In retrospect, the collaborative design process that produced the Issues On-line application is best conceptualized as a search for an assignment. Once Allen wrote the assignment, design was essentially complete. The category “assignment” was Allen’s but, in this context, is essentially equivalent to my own “application” category. The interesting question is, where did the assignment (application) come from? My prior conception of collaborative design envisioned a process that combined the educator’s pedagogy and the technologist’s possibilities to create a new, unique application. This was naive. The On-line Debates (itself an “assignment”—a prior fusion of pedagogy and technology) was at least as influential in this design of Issues On-line. This was not my intention. I meant to use the On-line Debates application to demonstrate a technological possibility—a mechanism for posting comments; in the process, however, I also introduced a feature of its pedagogy—structured discussion.

This design process was truly collaborative: Allen and I both shaped Issues On-line. But, the design relationship was not as symmetrical as I had expected (or as participatory design mantras such as “mutual learning” and “experts working with experts” indicate). Allen liked computers. he conceptualized working with them as “play” and he was certainly able to envision possibilities for them—i.e., design. Furthermore, my effort to put him directly in the designer role was fruitful. For example. I found that he readily revealed his pedagogical goals in the act of designing system components. But this language itself reveals our asymmetric relationship: I was controlling the design process—deciding the roles. This lead to some frustration for both of us. While Allen could design, at times, it seemed he did not want to, at least not within my process and methods. In particular. I created and maintained all of the persistent design representations—the conversational props (scenarios, drawings, mock-ups, etc.). This gave me greater power to influence the design.31 But a collaborative design process requires persistent representations and, if I had not made them, there would have been none and, perhaps, no application. This situation is problematic in general. In my experience, even many professional designers (who are getting paid for it) are reluctant to spend the time and effort to create such representations. It’s not surprising, therefore, that public school teachers, under extreme time constraints, working after hours, and without the training and experience that emphasizes design representations, would be reluctant to do so also. This asymmetry does not invalidate the ideals of collaborative design, but it is a reality that all parties should be aware of.

The collaborative design process made Allen an owner of the Issues On-line application rather than just a user. This was largely a result of his involvement from the beginning of the design process: the fact that

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31 I believe that this asymmetry was a major reason for the extent of influence that the On-line Debates had on this project—features of this application often appeared in my design representations.
we started with his own peer-review idea and the fact that he could shape and monitor the design evolution through accessible "low-tech" materials—textual scenarios, chalk-boards, etc. I noticed a strong increase in ownership, however, after he gained direct access to the materials of the "real" system implementation—HTML and the network (i.e., after he gained the power to publish on the WWW).

The use of scenarios as a design representation was a primary interest in this case study. As in the Online Debates case. I used these representations to reflect my interpretation of prior design conversation, reified as a proposed activity, back to my collaborator. Again. I found this to be an effective technique, not only to check our shared vision, but also to stimulate new design ideas and to elicit pedagogical goals.

I also found further evidence that structural and presentational aspects of the system design require additional representation—e.g., structural diagrams and pictures. Furthermore, I discovered that the type of conversational prop largely determined the referent of design conversation. In particular, although the early design conversations I had with Allen tended toward general technology, scenarios effectively maintained the focus on our specific application. I also found, however, that the referent changed as the design process proceeded. Early conversations frequently involved playful exploration of general technological features and mechanisms; later conversations focused on the application, seldom referring to technology independently of its effect on the activity.

3.4.2 Asynchronous Structured Discourse in Education

The students' experience with Issues On-line was quite positive overall. They liked the application: both the peer-review (discourse) activity and the mediating system. The CMC technology affected the activity in several ways: it altered the traditional social structure of the classroom (in particular, Allen was not in direct control of the discussion); it engaged the students (many indeed saw it as "play," as Allen had hoped); and it became additional content for the learning activity (Allen wanted the students to learn about the network itself). The peer-review activity itself went well overall: the students were able to use the system to complete the assignment and over three quarters of the postings were of good quality. A minority of the discourse involved "flaming" and other inappropriate content, however and the educator viewed this as a serious problem.

Most of the students liked the discourse structure in the Issues On-line system. Some aspects of this structure were problematic, however: several students complained that the multiple places to post comments (the 4 pages of each issue) was "dizzying"; and several had problems selecting the correct speech act type (Agree/Disagree) when posting to the Opposing Evidence page. Other aspects of the structure were quite successful: the students liked the three explicitly typed speech acts, saying they added clarity and organization. The students were more likely to Agree than Disagree and they employed the
Neutral comment effectively for expressing trade-offs and other idiosyncratic uses. There was a significant amount of interaction in the postings and few errors (< 10%) in selecting the correct speech acts for these nested posts.

Even though the network access problem caused the issues On-line activity to take place in a seemingly traditional classroom (students seated at desks, facing front, same-time/same-place, etc.), the application departed from the traditional classroom social structure. Many of the students' categories indicated that this application offered them more freedom than traditional assignments. For example, they perceived the CMC medium as lowering inhibitions and giving them more time to think about their responses (they viewed both of these second-level effects as positive); they lamented the loss of quick feedback, however. The ability to choose where (which issues) they would post to was also liberating for some students: "the luxury to learn what I please." And, the public nature of the Internet gave students the "right" to express themselves. Some students even saw the "seclusion" at separate terminals (seemingly contradictory within the same-time/same-place setting) as liberating. And, perhaps most importantly, the students' carried on their discourse without direct mediation (control) by the teacher.

This application also promoted a move towards the World 3 learning context [Scardamalia and Bereiter 93] (see related work, chapter 1). Many students liked the persistence and publicity of their discourse (many others didn't think it mattered; very few actually disliked it). Some took pride in publishing their thoughts and said the publicity improved the quality of their postings. Several said that they welcomed feedback from the outside world. Even though most of these students knew each other, very few said they selected places to post based on personalities. Rather, many reported looking for interesting or controversial material, places where they could contribute constructively. In examining the discourse itself, I found several instances of high quality collaborative "knowledge construction" [Scardamalia and Bereiter 93].

Allen's view of the application was basically positive—he did want to do it again—but he was seriously troubled by the "flaming" and other inappropriate use of the system (particularly, students reinventing the application as informal chat). This situation was a dilemma for Allen: he felt a pedagogical, even a legal responsibility to do something but did not know what. He was reluctant to enter the "flames" himself for fear of making it worse, but felt that taking it off-line would make the instigators the winners (this would also contradict his philosophy and earlier contention that he would never "censor" the discussion). Here, the public and persistent nature of Internet-mediated discourse together with the "liberating" effects of CMC (allowing students to express what they might not in class) had curtailed Allen's control and ultimately defeated his philosophy: he did censor the discussion, totally.
Allen did not envision the solution (for the next time) as building more teacher control into the system (the technology), rather, he wanted to build more self-control into the students through instruction. Likewise, he suggested providing non-persistent, non-public CMC channels as a sanctioned outlet for the students' "aberrant" behavior: technology for freedom; instruction for control.
Appendix 3-1: Floor Plan Project Hypertext Outline

Title

Abstract

Home Page

PROCEDURE

EXPERIMENT

RAW DATA

INTERMEDIATE CALCULATIONS

FINAL RESULTS

DISCUSSION

REFERENCES
Appendix 3-2: Issues On-line Assignment

Physics

Overview...

This project has a number of different characteristics (compared to our recent projects). Here they are:

1. You may work with one other person. Of course, you may also work alone.
2. You will be addressing an issue relevant to science and society by researching the sides and taking a side.
3. You will be presenting your issue on the internet, through the World Wide Web, as opposed to a class or on paper. In fact, you will only turn in a disk.
4. Your presentation on the internet will be reviewed and critiqued by your peers and anybody else in the entire world who wants to look in and read.
5. You will respond to the questions and comments that others have regarding your presentation.

Description...

Either working by yourself or with one other person, select an issue to research and present. As hinted earlier, the structure of your project will not be like the traditional research paper. In fact, it will be a little easier to put together. What you will do is compile your information into four "pieces." On your computer disk you should turn in four files, each corresponding to one of the following pieces:

1. Statement of the issue. This is a small paragraph briefly explaining what the issue is and which side you take.
3. Opposing evidence. Series of paragraphs explaining the evidence which supports those opposing your side of the issue.
4. References. Description of each of your references used in the research including where you obtained each one.

It is not necessary to cite your sources in the text of what you write. However, if anybody requests your source, you should be ready to produce quickly.

Evaluation...

As you may be able to tell, this is not a minor project but also not a major deal either. Depending upon our schedule, we may be able to do the part with working on internet this grading period ... maybe not. If not, your grade will be based on the completion and content of your project alone. If we are able to work with the computers, your grade will also include an assessment of how active you were in reading and commenting on other projects.

Wednesday, February 27 is the due date for the disk.

Some Possible Issues...

Is nuclear power worth it? Should we be doing cloning research? Should we be trying to artificially create life? Is there a link between high voltage power lines and health problems? Do we need the Endangered Species Act? Should the US be involved in the multi-national space station project? Should the SSC (Super-conducting Super Collider) have been scrapped? Should it be worth it for the US to move to High Definition TV? Should space flights use people or robots? How reliable is DNA fingerprinting as evidence in court cases? Is there a need to eliminate dust mites (coal power plants)? Is it really possible to develop and market an electric car? What accountability should companies have for their emissions and wastes? Should we go to Mars? Can we really save our beaches from erosion? Is there any value in the Biosphere project? Do we need to worry about light pollution? Is there really a crisis with the ozone layer? Is there really a crisis with global warming? Do we even need a space program? Is there any link between aluminum cans and health problems?

These are just a few of the many, many scientific issues being faced by various parts of our society. Regardless, you absolutely must sign up with Mr. Freeman for your idea by Friday, February 17.
Appendix 3-3: Chalkboard Structure and Presentation Sketches

I drew this early. Grade?

Agree/Disagree/Neutral?

I said I would start. I drew this hierarchy, and put the two questions on the board as outstanding issues.
Appendix 3-4: Refined Sketches Used to Divide Implementation
Appendix 3-5: Final System Implementation
Appendix 3-6: Issues On-line—Student Response Questionnaire

1. Do you use a computer at home? Are you (or your family) a member of the Blacksburg Electronic Village (BEV)?

2. How did you like having people make comments about your project and commenting on other peoples' projects? Did you like using computers and the Internet to do this?

3. Have you used the Internet to show your project to anyone outside of school like your parents or friends? If not, would you like to?

4. Why did you select particular places (projects and other comments) to make your comments?

5. Did you like the structure of the Issues On-line system? For example, the three kinds of comments (Agree, Disagree, and Neutral) and the structure of projects (Supporting, Opposing, and References)? Can you suggest changes?

6. Do you like, dislike, or not care that your project and comments are visible to the general public on the Internet? Why?

7. Did you talk to other people (students) while you were posting comments in the media center? If so, what did you talk about? If not, did you want to?

8. Have you talked to other people in person about their projects or comments?

9. Did you think that the system was difficult to use? If so, how? (For example, was it hard to make a comment or hard to find people's projects?)

10. Other comments?
4. CASE STUDY 3: ON-LINE MULTIMEDIA MAGAZINE (MIDDLE SCHOOL SCIENCE/LANGUAGE ARTS)

4.1 Introduction

This chapter describes a third case study of collaborative design in which I worked directly with educators to apply Internet technology to their teaching practice. In this case, my collaborators were a pair of middle school teachers, Debbie and Sharon, who regularly “team taught” across the subject areas of General Science and Language Arts. This project began before all of the others that I studied in this research. I present it as the third study, however, in order to contrast it with the design process of the high school Issues On-line case, presented in the previous chapter. In the following analysis, the design process is my primary interest. The product of design, the application itself, is less relevant to my thesis because it differs in fundamental ways from the structured asynchronous discourse applications of the other three case studies. On the other hand, the manner in which the process led to these differences is relevant to my study of collaborative design.

Exploring the tenets of collaborative (participatory) design was my foremost motivation for undertaking this design project; nonetheless, I came to the project with a prior design position. First, I wanted to utilize the Internet as the technological basis of whatever application we designed. Second, I hoped to use this technology to support communicative activities as opposed to information retrieval or publishing—both of which would be important, competing categories of network use. (I was not yet focused on the specific mechanism of structured asynchronous discourse that was central to the other projects, however.) Finally, at the outset, it was important to me that we develop customized software in this collaboration. I did not want to simply observe and analyze existing network-based activities, for example, prepackaged e-mail based lesson plans. As it turned out, although there was a substantial design effort in this project, we did not develop new network mechanisms or software, per se.

There were two major differences between the collaborative design process of this project and that for Issues On-line. First, in Issues On-line, the network technology was primary, both for myself and for the educator—our design goal was finding an “assignment” to utilize the technology. In the present case, the educational activity (as an idea) predated the idea of using the network—our design goal was finding a role for the technology within that assignment. Here, the technology was marginal and, to a some extent, the implemented activity remained independent of it. The second difference was the educators’ relationship with computer technology in general. In the Issues On-line project, technology, independent of our application, often became the focus of design conversation (at times I even considered this a
problem). In that project, at least in the early stages, Allen Browne and I viewed working with computers, including the problems we encountered, as "play." This was never the case for my middle school collaborators. Although these teachers were comfortable and confident using computers in their teaching (in fact they already did this more than Allen Browne), we never approached the technological vagaries and recurring problems that we encountered as "play." On the contrary, there were many instances where glitches or (in my mind) slight delays caused significant frustration and a complete loss of focus on the technology. This led to a tension throughout this project. On the one hand, these educators, like myself, did want to create something new, to learn how to shape the technology (e.g., to create WWW pages), as they saw some of their colleagues doing. On the other hand they also (quite understandably) lamented the amount of effort and, more importantly, time that this required. On several occasions they contrasted what we were doing (creating a new application) to using ready-made educational network resources—resources that are "all there already." "something we can use right now."

4.2 A Student Authored Multimedia Magazine

The educational activity that became the focus of design in this project involved students in five combined Science and Language Arts classes compiling a multimedia magazine (MMM) about their local county in Virginia. Prior to meeting me, Sharon and Debbie had won a small grant for this project, which they used to buy additional computer equipment: a digital camera, disk drive, and new (non-networked) hypermedia authoring software. Their plan was for students to gather information about areas and topics of the county (for example the history of a particular town) through various sources—interviews, telephone calls, library research, etc. The students would then compile this information and author multimedia "articles" (the original vision included still pictures and sound clips) as part of the overall magazine. In this project, the educators' wanted the students to learn the social and research skills required to gather information for the MMM as well as learning the information itself. This distinction between skills vs. content learning was important to these educators, who emphasized the former in this project. Learning the skill of working in groups was especially important. Sharon and Debbie also strongly believed that all students should work directly with the computers, not only the "gifted and special needs kids," and that computers motivated the kids to work harder.

This sort of project—its technology, process, and goals—was not new to these teachers. They had regularly engaged students in "I Search" projects where individuals would research topics of their own choosing (gathering information through multiple means) and present their results in hypermedia. They already had several computers in their classrooms (approximately eight), which they used for this activity (they had acquired these through other teaching innovation grants). Both their equipment infrastructure
and computer expertise were far more advanced than the average in this school system and they had acquired both through their own initiative. But they were apprehensive about this new project. In one early conversation they quoted a colleague as saying, "Most people start small and work up; you guys start with everything at once!"; in a later design meeting, they also expressed some trepidation that they had bitten off too much for the students, "How are we going to do this [the MMM project] ... plus an I Search paper? These kids—if we thought they were ready to mutiny this [past] year!"

When I first met these educators, the MMM project was not well defined. During the summer of 1994, however, in our first few "design meetings"1 Sharon and Debbie (with some of my input) rapidly defined a structure for this activity, which included process phases, student roles, and a preliminary topic structure for the magazine itself (this was preliminary because they wanted the students to design this themselves). All three of these structural dimensions, which they defined independently of the network technology, would both shape and be influenced by the technology as the design process unfolded.

The original vision for the MMM cast the students as authors throughout. In the first phase of the MMM project the kids would form groups by class period and information topic. Debbie and Sharon team-taught five periods (they combined their two classes in each period), each of which would be responsible for one geographical area of the county (e.g., a town). Within each period (area) student sub-groups were responsible for specific topics (e.g., local economy or recreation) and would gather that information for the magazine. After the data gathering phase, the groups would compile their information, both editing the text and designing the multimedia presentation (using a story boarding technique that the educators had developed for the I Search projects). In the final phase, the students would create their multimedia presentations on the computer and combine them in the final magazine.

Figure 4-1 visualizes the Multimedia Magazine application using the model introduced in Figure 1-1 (chapter 1). Unlike the other three case studies of this research, the system component in this application was not an asynchronous structured discourse (ASD) mechanism. Nonetheless, the MMM application does fit the same activity/system model I used to visualize these other applications. This model is particularly useful in this case to visualize the important interaction between the MMM and I Search activities. The MMM activity began with students forming groups based on geographical areas of the county and defining topics for the information they would gather from the people in the local community. Next, the students gathered this information through a variety of media, including the e-mail/WWW-page hybrid system we implemented in this project. Finally, the students and teachers edited and published the

1 These might actually be better described as brainstorming sessions, in which, among other topics, we explored how the network and my agenda could fit into their curriculum.
magazine in a separate set of WWW pages. This activity/system visualization is particularly useful in this case to illustrate the interaction between the MMM activity and the separate I Search activity. The students participated in both activities over the school year: in the MMM, playing the role of group member; in the I Search, as an individual author. Scheduling and managing these concurrent activities was a major design problem in this project.

![Diagram](image)

**Figure 4-1: Visualization of the Multimedia Magazine Application**

### 4.3 Designing the Multimedia Magazine

In my post hoc analysis, the design history of this project consisted of six phases, each marked by a critical transition, see Figure 4-2. Like the issues On-line case, the first design problem in this project was finding a place for the network technology and myself within the existing context of the middle school. Unlike Issues On-line, however, the scope of this search was quickly narrowed to a single, prior assignment—the MMM. Ironically, this goal was inverted in the second half of this collaboration, where we aimed our efforts directly at removing the need for my presence.
4.3.1 Finding an Activity

When I first proposed a collaboration at the middle school (June 1994) I was interested in studying design: I viewed the educational work setting and network technology as convenient vehicles for this research. My interest in any work practice, not just teaching, was manifest in the first design representation of this project: a two-page outline that I brought to my initial meeting with middle school educators. In this I proposed three broad domains of “possible use” for the network: “lesson plans,” “the library,” and “administration.” In addition to my categorization of application domains, this document also proposed concrete examples of network use within each of them. These representations were not scenarios (under my definition, which requires a narrative sequence of concrete steps); rather, they were expository descriptions. The lesson plan example (see Figure 4-3) was the most detailed: I used single phrases, e.g., “on-line student progress reports,” “on-line encyclopedias,” etc., for the administrative and library domains.

**Long-distance Writing**

- Students are paired between two classes and exchange business letters via E-Mail.
- In this example, only the teachers have electronic mailboxes so they manually combine and separate the writing of the individual students.
- We can better support this with BEV since all students can have their own electronic mail box.
- We can still route students’ messages through the teacher electronically before being sent, if desired. With customized software, we can maximize ease of use and control.

**Figure 4-3: Proposed "Lesson Plan" Design Project**
Like a scenario, the Long-distance Writing proposal was an activity-oriented design representation. Its first bullet actually does propose a "microscenario" [Neilsen 95] with the remaining bullets adding detail, critiquing, and finally re-designing the activity. The last bullet in this proposal emphasized a major theme that I brought to this meeting—creating "customized software." In this conversation, and using this prop, I tried to explain my participatory design ideals, pointing out that I offered the ability to reshape the technology to fit their needs but stressing that "you [the teachers] know what is useful to you, not I."

The outcome of this first meeting was the selection of "lesson plans" as the domain for the project and Sharon and Debbie as my collaborating educators. But it was still not clear what the application would be—what lesson plan (assignment) would use the network? Unlike the Issues On-line project, however, this question was quickly resolved. In the next three meetings, we began to develop a shared background in both technology and pedagogy for our subsequent design. I visited their computer lab where they explained their current non-networked hypermedia teaching activities. Likewise, they visited my lab at the University, where I demonstrated the WWW and a Daedalus classroom (see Chapter 2 for a description of Daedalus).

![Diagram of Discourse and Information Access and Retrieval]

**Figure 4-4: Representation of Communication vs. Information Retrieval**

One of these meetings (before they visited my lab and the Daedalus classroom), was centered around a series of schematic representations illustrating various types of network activities. Figure 4-4: Representation of Communication vs. Information Retrieval shows the first of these, which I hoped would convey my distinction between communication and information access. Several specific examples followed, e.g., the WWW for information retrieval (and compiling multimedia presentations) and the Daedalus system for communication. This went well: the educators understood my distinctions and were interested in the array of technological possibilities. But, we still faced the question—what specifically would we do with the network?

S: Hum. ... so this is a lot to think about. ... To keep this moving forward, what do you see, what do you need, what do we need to do ...
L: [I suggest the WWW demonstration and Daedalus classroom visit] ... [then] you guys design a lesson plan, and I can help you out with the technical side of that, what’s feasible, how we put it together, that kind of thing ...

D: I would like to link it, to link it with this project [the MMM] that we ...

S: Yea. I would too. I think that would be the best way.

This critical exchange set the activity that would be our focus. It also illustrates one of the major differences between this and the Issues On-line project: here a prior pedagogical activity (which the educators had conceived independently of the network and would have implemented without me) took precedence over the new technological possibilities that I offered.

4.3.2 Envisioning a Role for Technology: The MMM Data Gathering Vision

The second phase of this project both defined the MMM activity and established the initial role for the network (and me) within it. The phrase order in the preceding sentence reflects the educators’ priority at this stage: As Debbie put it early on, “We have to do this [the MMM activity] anyway.” The network was still only an interesting possibility; their obligation was to fulfill the grant proposal. This phase of the project included roughly ten meetings over a three month period (July-September) and involved several critical design representations.

The conversation in the first few meetings was primarily a dialogue between Sharon and Debbie as they planned both the MMM and I Search projects for the coming school year. They defined the phases and structure of the MMM project during this period. They also worked through several complex scheduling problems in order to combine their classes and the two projects. Throughout these meetings I made suggestions about possible uses for the network, asked questions about the projects, and answered questions about the technologies (e.g., about HTML and real-time chat systems).

The role of the network did frequently become the focus of conversation. We agreed early that it should be useful for the data gathering phase but we remained undecided about the possibility of using it (particularly HTML and the WWW) for the “final product”—the magazine. On the one hand, they had already purchased new multimedia authoring software for the project, and although they had not used it yet, it was more familiar to them (conceptually similar to the package they used in I Search) than the WWW. On the other hand, this hypermedia package was not networked:

L: When you talk about two different phases of this thing, one’s like data gathering where the students interview people and get some data, and then later there’s the phase where they’re actually going to put together the MMM, OK? So that first phase is kinda independent of [the multimedia authoring package] ...

D: Yes it is.

S: That’s true.
L: and it really lends itself to the network.

D: Yes, right.

L: and it may come in for the actual magazine construction phase.

S: I think it'd be really neat, rather than us making a million copies of this then sending them to all the schools and saying, "Here," you know "here's our thing you might want to look at this," I think it'd be great for the people to be able to just get on, get on Gopher, or whatever.

D: Oh! [agreement]

Figure 4-5: Mock-up of WWW Data Gathering Pages

After the structure of the data gathering activity became clear, and we had agreed on the network's utility for it, I created a mock-up. This consisted of a set of WWW pages (matching the group and topic structure of the MMM activity) that invited people to contribute information to the MMM Data Gathering effort through e-mail, see Figure 4-5. This mock-up made a big impression—at first Sharon mistook it for a mock-up of the final product itself—and we all enthusiastically agreed that this would be one of the channels the kids would use for gathering data. Two aspects of this mock-up changed in the actual Data Gathering pages that we put on-line: we eliminated the sub-topics level and we never re-posted the (very few) contributions we received via e-mail (although the students did base some of their magazine articles on these).

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2 This figure illustrates the structure of the WWW page mockup; the figure itself was not used as a representation in the actual design process.
As the design process continued we explored other network channels that the students could use to obtain information. One of these was an on-line conference on the Virginia K-12 educational network. (Conferences in this network were structured as pavilions, which contained discussion groups.) This network technology was "lower tech" than the WWW, but was more accessible: connecting to it only required a character cell terminal and many educators already used it actively. In one meeting Debbie made a sketch for how an MMM Data Gathering conference might be structured on this network, see Figure 4-6. As it turned out we were not able to construct this—creating pavilions required special privileges. Nonetheless, this diagram is interesting as the first of several instances where these non-professional designers spontaneously and effectively used abstract representations as props in our design conversations.

![Diagram of online conference structure](image)

**Figure 4-6: Debbie's Representation of an On-line Data Gathering Conference**

By late September (after approximately fifteen meetings) I had accumulated a substantial amount of information in the form of field notes, transcripts of design conversations, and artifacts like Debbie's discussion groups sketch, in addition to my memory ("head notes" [Jackson 90]). At this point I spent a day working alone with this data, interpreting the essential categories both in the teachers' pedagogical activities and in our developing vision for the network technology. I then wrote a scenario describing my vision of the data gathering activity that the students would engage in, see Figure 4-7. I brought this concrete representation to our next meeting hoping both to check my vision against theirs and to provoke new ideas.

I describe the development, use, and effects of this scenario in more detail in a later section; here, I'll simply point out that the meeting was a turning point in the design process—we finally had a concrete shared vision of the technology's role. Debbie and Sharons' reaction to the scenario was enthusiastic:

S: The first paragraph is exactly what we are doing!

D: Right on the money!

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A student working on the multimedia magazine (MMM) arrives at her second period class on Wednesday. This is her scheduled Science class but it has been designated as the period in which her group, the Blacksburg Local Government group, will work on the MMM. (In her fifth period, scheduled as her Language Arts class, she will work individually on her I Search project.)

Since this student’s group is not scheduled to use the network at the beginning of class, she meets with her group members at a table in the Science room. (Some members of the group are scheduled for Language Arts in this period, but they also use it to work on MMM on Wednesdays; they will work on I Search in their Science period.) In this meeting they discuss some new information for their topic in the MMM; they obtained this during the previous week.

They talk about how to include this information in the on-line Mosaic presentation of the MMM. This presents the MMM to the community as a work in progress, showing the structure of the eventual magazine as well as the information gathered so far. It also solicits community members to contribute information to the effort by sending Email.

There is a Mac with a modem in both the Language Arts and Science classrooms. The respective teachers have established a SLIP connection to the Internet through the BEV modem pool on both of these computers before first period: these remain connected all day. They have also opened a Mosaic window to the MMM home page, and connected a Telnet window to the VaPEN MMM discussion group at that time. Between each class period on Wednesday, the teachers will connect a Eudora mail window to the mailbox for that period’s geographical area (disconnecting the previous period’s).

About half way through second period, the Blacksburg Local Government group has their turn on the network connection in the Science room. The members of this group begin by browsing the Blacksburg mailbox. They find 1 message for their topic (the topic appears on the subject line) and they download it onto the group’s diskette. Next, they go to the VaPEN window to check for contributions to their topic in the discussion group. They find 2 new contributions there and download these also.

After downloading the new contributions, they start the task of posting contributions that they received in the past weeks to the Mosaic presentation of MMM. One of these came from a live interview, 2 from the BEV mailbox, and 1 from the VaPEN discussion group. All of them have been edited into a simple standard format: the first line in the file contains a one line description of the contribution, the second line contains the name (and possibly the Email address) of the contributor or interviewee, and each paragraph of the text is separated by a blank line.

The students post contributions to Mosaic by mailing them to a person (Stuart Laughton) responsible for converting them to HTML and linking them into the Mosaic MMM (this will be completed by the following Wednesday). They mail these from the Blacksburg mail account and specify Local Government on the subject line: this directs the contributions to the appropriate part of the Mosaic structure.

Finally, the students open the Mosaic window to check that the contributions they submitted to Mosaic the previous Wednesday appear correctly. They spend the remainder of their time on the network browsing the contents of other geographical areas and topics.

When the network time for this group ends, they return to their editing activities for the remainder of the class period.

Figure 4-7: MMM Data Gathering Scenario

4.3.3 Real Technology; Real Problems

The design meeting in which I used the Data Gathering Scenario as a conversational prop went very well—one of the best meetings of the entire project. Debbie and Sharon were in good moods coming in: their previous MMM classroom session, in which the kids “brainstormed” topics for data gathering, had gone well.3 We all perceived the scenario to be a specific, concrete, and realistic envisionment of the future. After we walked through it, Sharon contrasted it with the “really general stuff” that they had discussed in a recent Virtual Schools (VS) project meeting. (In this meeting, the sponsoring researchers had asked the educators to envision potential uses for the network to include in a grant proposal.) Likewise, Debbie suggested that we send the scenario itself to the VS people so “they could see what we were doing.”

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3 The MMM activity consumed one full school day of each week.
The next step was to make this concrete envisionment real. I began by installing the various network software components that we needed: SLIP software (for connecting to the Internet through a modem) plus E-mail, Telnet, and WWW clients. The session in which I installed these components was telling. I ran into a few glitches (as I’ve learned to expect) and spent about an hour on this task. At several points Sharon and Debbie (who were busy grading unrelated student work) expressed surprise and impatience, with statements like, “Do you have to do this every time?” and “This takes a lot of time!” I told them that the installation process was a one-time thing\(^4\) and it would be easier in the future. From this point forward, however, technical problems (particularly with the SLIP) would be a major factor in this project.

I brought two new scenarios to the following meeting. These were written from the perspective of a person contributing information in response to the students’ on-line invitation (see Figure 4-8).\(^5\) I suggested that we first work through the fourth paragraph of the original Data Gathering scenario (in which the teachers set up the computer), however, using the software I had installed last time. Although we did this without any particular technical problems, this exercise revealed the true complexity of the software—the amount of effort and learning that lay ahead. The effort of working with the real technology was in sharp contrast to the ease of reading the scenario text. After this, when we sat down to walk through the new Data Contribution scenarios, there was a sense of suspicion—perhaps the narrative made things look too good, too easy: Sharon commented, “This is the way we wished things would go”; I replied (only half joking), “perhaps we should call these ‘best-case’ scenarios.”

During the period from late September to early November we put the first level of data gathering pages on-line. So far, there was one page for each geographical area, each of which corresponded to one class period (e.g., Sharon and Debbie’s combined 4th period classes represented the town of Blacksburg). Both the structure and presentation of these WWW pages came largely from my original mockup. I wrote the HTML for these pages and I put them on-line on a UNIX based WWW server (in a filebox that the BEV project supplied). I was careful to always vet paper versions of these pages with Debbie and Sharon first—I wanted them to own the design. The next critical incident in this design process led me to doubt the educators’ ownership, however. This occurred when I proudly described a VS project meeting (Sharon and Debbie did not attend this one) in which the potential for the schools publishing (vs. “retrieving”) information on the WWW was a topic. I told Sharon that I had shown the VS sponsors our pages and told them, “we are already publishing.” She replied, “You are.”

\(^4\) Even this turned out to be untrue as these public domain software products “expired” and had to be replaced.

\(^5\) This scenario narrates an individual responding to the WWW Data Gathering pages. A second scenario (not shown) envisioned a response to the Data Gathering conference on the Virginia K-12 network.
1) An employee of the Blacksburg city government has heard about the MMM project from a friend who’s son is friends with a student working on the project.

2) She is a fourth generation Montgomery county resident and knows a lot about civil war events in this area. She thinks she may be able to contribute some information to the project.

3) She has used Mosaic on one of her office computers that has a network connection through BEV and she has browsed the BEV home page. Her son told her that the MMM project is “on BEV” so she begins looking for it there.

4) She starts at the BEV Welcome page—this is in the HotList of her Mosaic window as received from BEV. She see the announcement of the MMM project there and follows the hyper-link to the MMM home page.

5) She reads the introduction to the MMM data gathering Home page; she then browses the geographical areas. She notices the topic History/Geography under each of the areas.

6) She knows an interesting anecdote about a minor Civil War skirmish that occurred near what is now the town of Rhiner. She decides to contribute this to the Rhiner History/Geography page.

7) She returns to the Rhiner Mosaic page. There she reviews the instructions for contributing information.

7a) She does not have Mosaic 2.0: She composes her contribution in her text editor and e-mails it to the Rhiner group. (The e-mail address for this group is given in the Rhiner Mosaic page.)

This mail is later received and edited by the Rhiner group students. They post it to the appropriate Mosaic page.

7b) She does have Mosaic 2.0: She goes to the History/Geography topic from the Rhiner page, presses the Contribute button, and types her contribution into the resulting Mosaic form.

The contribution is automatically posted to the Mosaic page.

Figure 4-8: MMM Data Contribution Scenario

4.3.4 Collaborative Design becomes Lessons

The exchange between Sharon and me regarding who was doing the publishing was a revelation. At that point I realized (as I had in the Issues On-line project) that these educators would not feel true ownership for the design until they could affect it directly—in the actual network materials, not just “low tech” representations. I consciously decided, and Debbie and Sharon agreed, that we should concentrate on their mastery of the technology, in particular, learning to write HTML and learning to use the network software (SLIP, e-mail, etc.). During this phase of the project, and the next, our meetings began to resemble lessons more than collaborative design sessions.

During this period (November and December) we concentrated on producing the students’ “questionnaires.” These were lists of questions that each student group (e.g., the Blacksburg History group) compiled for publication on the data gathering pages. I wanted to change the division of labor for these pages: my goal was for Debbie and Sharon to mark-up the questionnaires in HTML, then I would put them on-line. We did eventually achieve this, but it was difficult. But even this goal was ironic: in contrast to the educators’ prior pedagogical philosophy that all the students work with the computers (not

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* In this step of the scenario, I envision an HTML forms mechanism (like that in WIT) for contributing information to the magazine. This mechanism was not implemented in this project. Steps 7a and 7b explore the two possibilities for people who did not and did have a forms-capable WWW browser, respectively.
just the gifted or special needs), in this case essentially none of them worked directly with the network—it was difficult even for the teachers.

While we worked on these pages—while I taught them HTML—our primary mediating representations were the pages themselves, both on the computer and in paper form. On several occasions I printed a formatted page and its source HTML as a model for formatting similar pages. We also frequently employed more abstract structural diagrams, for example see Figure 4-9. We all drew these spontaneously during design conversations and lessons to clarify structural issues.

![Figure 4-9: Example Abstract Representation from Design and Lessons]

### 4.3.5 Communication becomes Publishing: The MMM Final Product

In our last meeting before the Christmas break (a month long hiatus from the project) we, at my suggestion, reviewed the original *Data Gathering* scenario. This conversation was a postmortem of our data gathering vision: I prefaced it, “Let’s look back on our original vision and compare with reality.” Problems with the technology had prevented students’ hands-on use of the network for receiving e-mail contributions—there had been very little response from the network community, anyway.\(^7\) We all agreed in this meeting that the WWW would turn out to be more useful for publishing the “final product” than for gathering information. Giving up on the network for the two-way communication (data gathering) was due to lack of response; the rationale for using the WWW as the publishing medium was two-fold (from my field notes):

1. It puts it out there [in public view, on the Internet];

2. It’s too late to learn [the new hypermedia authoring software].

\(^7\) Among the handful of responses we did receive, several, rather than supplying information, offered to help construct the magazine. Another response practically scolded the kids, insinuating that their requests for information were symptomatic of laziness (this message did offer some useful information as well).

... Now, for a bit of advice: Folks on the Internet are generous and eager to assist students when it is evident that these students have exhausted all local resources. However, these same generous souls do not want to do your work for you ...
The second reason again illustrates how I (not entirely willfully) subverted the educators' original plans. (I had also done this by introducing the On-line Debates to Allen Browne in the Issues On-line case study.) We had spent so much time and energy learning the WWW technology that there was none left to learn the authoring software they had bought (before I joined them in the project) specifically for constructing the magazine.

Throughout this phase of the process, the HTML lessons continued. We now focused on putting the students' articles—the final product—on-line, however. Most of the content of these articles had come through non-network channels: live interviews, phone calls, libraries, etc. Some students had used the digital camera to take pictures of County landmarks and we (the teachers and I) were able to include these in the final product WWW pages. There was still some design to be done, however.

![Diagram](image)

Figure 4-10: Collaboratively Constructed Design Representation for the MMM “Final Product”

I was determined that these pages, the “content pages,” not be my creation to the extent that the data gathering pages were; nevertheless, the influence of my very first WWW page mock-up continued. In our design sessions for the content pages we considered two alternatives: a sequential “magazine” metaphor or the hierarchical “tree” metaphor (like the data gathering pages). To my surprise, Debbie and Sharon preferred the tree. In a truly collaborative design session the three of us worked together to create the representation in Figure 4-10. Here, I added the arrow buttons to allow horizontal movement (like a magazine) through the hierarchical structure that the teachers specified. This design was implemented as the final product.
The public nature of the Internet had a much more significant effect on the educators than the students, in this project (similar to the Issues On-line situation). The students' role in the magazine construction largely ended after they typed their articles into a word processor. Sharon and Debbie said that many of the kids did understand the idea that the network made their work visible to the entire world and some were anxious to use the network more often. Unfortunately, the technical problems and time constraints (particularly the problem of maintaining a SLIP connection) made it difficult for them to incorporate the network directly into their classroom activities. On the other hand, the teachers were very aware of the potential audience for the magazine. I noticed that they were careful to correct and reword the student's work before we converted it to HTML—i.e., they did the final edit. This appeared to contradict their pedagogy and I asked who did the final editing on the non-networked multimedia presentations for the I Search projects. Sharon replied indirectly, "If we were going to publish them, we'd want to get them all perfect [too]."

4.3.6 Access and Competence brings Ownership

With the structure and presentation of the final magazine settled, our meetings, more and more, became focused on production. Once each week or so, I went to the middle school after the final class period and, for one or two hours, acted as a technical consultant while Debbie and Sharon converted the students' articles to HTML. The division of labor had changed—I no longer did the conversion for them—and I noticed an increase in their ownership of the product (for example, they overruled my design suggestions much more frequently now). But this process was frustrating for all of us. There was a lot for them to learn and our brief, infrequent meetings (because we were all spread thin in our schedules) caused us to lose ground between each lesson. We all expressed this frustration openly and at one point I offered to return to the old process, where I did the conversion on my own time. In my field notes, I worried:

I am beginning to feel like I am just torturing them (and myself). Perhaps I should just conclude that the current state of the technology: SLIP, modem, HTML via text editor, FTP, etc., is not feasible for use by full-time classroom teachers.

They did not want to do that. Amidst the frustration, they also expressed envy of other teachers in the county who seemed to be putting more material on-line than they were. They were determined to master this technology.

A turning point in the process occurred when Debbie, Sharon and a technical specialist in the county schools spent an entire Sunday, not in production, but upgrading their software tools and their mastery over them. Perhaps the technical specialist was a better teacher than I (Sharon said that was not the

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8 I had little direct contact with the students in this project.
difference; rather, a continuous six hour block of time, when they were not already exhausted from a full
day of teaching, was), in any case, the next time I saw them they were upbeat, saying, “It crystallized ... it
[converting to HTML] is easy—like you said!” Just as important as their new confidence in HTML mark-
up, however, the technical specialist had installed an FTP client on their classroom computer and the
BEV project had supplied them (and several of the other county schools) with a filebox. Up until this
time, after HTML conversion, I had taken the articles with me, on a diskette, and put them on-line via a
computer at the University. With these new tools we could do everything from their classroom. This
made a big difference in ownership; as Debbie exclaimed several times in this first “fully empowered”
session: “For now on, we’ll do all the work here!”

From this point on (about three more meetings) my role had changed dramatically. Incidents of technical
problems continued (“hung” WWW browser, SLIP disconnects, etc.) but, as I described it in my field
notes. “During all of this, I am sitting passively”— they could now resolve these problems themselves.
There was still some irritation when the technology became “stressed out” (Sharon’s perfect description of
these inscrutable problems) but there was also pride in their new found confidence and competence with
the network: Debbie quoted the technical specialist as saying, “We (Sharon and Debbie) are the only
teachers, not supervisors [like the specialist], that know what we are doing.”

One afternoon, early in May, I checked the on-line magazine from my computer at the University. It did
not look the way I expected it to: the e-mail addresses in the home page had been changed from italics to
bold (Debbie and Sharon had preferred the latter formatting from the very beginning but I had never
changed it for them); furthermore, the old Data Gathering pages (my pages) had been removed altogether!
At first I almost felt hurt—they hadn’t consulted me on these changes! But of course this was what I had
wanted: Debbie and Sharon now truly owned the magazine.

4.4 Representations in the Design Process

In the course of this project, the object of design shifted from an application (an activity and mediating
system) to a system alone.9 Technical problems, the complexity of the network software, and the lack of
response to the on-line data gathering mechanism essentially defeated our envisioned data gathering
application. Instead, the central technology-mediated activity in this project quickly became the teachers
using HTML and the network tools to produce WWW pages. At that point we were no longer designing
an application; we did no more activity design; we simply designed the WWW pages, a technological

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9 I use the term “system” for the technological artifact produced in the other projects. I continue to use it here, even though it is less
appropriate for the simpler WWW pages we produced in this case.
artifact. This transition is clear in the evolution of our design representations. In the beginning we used a mixture of activity and system representations; in the end, these were limited to structural system representations alone. Nevertheless, the use of scenarios, particularly the Data Gathering scenario, did produce interesting results in this study.

All the scenarios that I used throughout this research were “rich” rather than “narrow,” in the sense described by [Kuuti 95]. In other words, they included aspects of the social and organizational context of the activities they envisioned; they were not limited to interactions (transactions) with the mediating computer system (in contrast to the use-cases of [Jacobson 95]). This was especially true of the MMM Data Gathering Scenario. My main goal in writing this scenario was to explore the use of the WWW as a data gathering mechanism. But, based on our prior design conversations, I knew that there were several aspects of context that were important to this sub-activity: e.g., the other phases of the MMM project (editing, authoring), the individual I Search projects, the combined classes (team teaching), and the other data gathering media (phone, face-to-face, etc.). The Data Gathering scenario that I wrote reflected my understanding of these categories and, in some cases, proposed my solutions to the constraints they presented (e.g., scheduling the I Search and MMM within the combined classes. see paragraphs 1 and 2 of Figure 4-7, page 153). In this sense, I used scenarios (similarly to [Kyng 95]) to present design hypotheses to my collaborators, not to represent “fixed requirements” (as Kyng describes Jacobson’s use case scenarios [Jacobson 95]).

One important use of the Data Gathering scenario was as a mutually accessible representation of the shared vision we had developed through less structured conversation, demonstrations, etc. This was the case for the method we envisioned students would use to re-post edited contributions to the data gathering pages. I described this procedure (my understanding of what we all decided) in paragraphs 6 and 7 of the scenario. As we walked through this section we simply confirmed that this was what we all had in mind. But this scenario (like those in the other design projects) also provoked new design ideas and revealed additional contextual constraints that we were not aware of.

The most dramatic instance of the scenario producing a design revelation came as we walked through its fourth paragraph. Here, I proposed that the teachers connect the SLIP before the first class and leave it connected throughout the day. I knew that making this connection was a time consuming, trial and error process and that class periods were only 40 minutes long. My reasoning was sound but I was unaware of a significant technical constraint within the school organization itself, as the transcript from this design meeting illustrates:

L: [referring to paragraph 4] You can set most of this up in the morning, but you have to switch ... the different mail boxes between each period.
S: ... There are certain times of the day, [pause] this thing about getting on the modem and keeping [it] hooked up all day long!

D: We only have an hour on [the Virginia educational network].

L: [I point out there is no time limit on the BEV Internet connection.]

S: [clarifying her point] When we are on all day, we have tied up one of our [the entire school's] six lines all day. I'm just saying I don't think that is a possibility.

L: You just have six phone lines? Isn't the phone line in this room a dedicated phone line?

S: No

The point is that in our nearly fifteen previous meetings, with many hours of conversation about the project, we did not recognize this constraint until we worked through a concrete envisionment of the activity, laid out as a temporal sequence in context. In this case the scenario didn’t solve the problem but gave us advanced warning of an organizational issue that needed attention:

L: Do you think you can get those 2 lines all day?

S: ... Maybe ... [she narrates a hypothetical conversation with the principal to smooth this over] ... The thing is, as soon as we get in here we need to dial up because, if we wait, we may not be able to get on when we need to ...

The second paragraph led to a similar design revelation. Here, my proposal that each group spend half a class period on the computer appeared unworkable to Debbie and Sharon. Based on their previous experience with kids using computers in class they decided that half a period was not long enough and changed the design; they scheduled groups for the entire class period on alternate weeks. Here again, the temporal sequence and contextual richness of the scenario forced me to make an explicit design hypothesis, which led to a revised activity design requirement.

This session showed that the narrative format of design scenarios works well as a conversational prop among designers with different backgrounds. In addition to confirming our shared vision, and making new contextual issues visible, this scenario also began the transfer of the network technology into the educators’ practice. The scenario-based “cooperative design” process, described by [Kyng 95], like my own research, uses textual scenarios in combination with mockups and prototypes. Kyng emphasizes that a textual description alone can never be complete and rich enough to evoke an adequate understanding of the technological possibilities and realities; this requires direct experience with the technology (or a suitable mock-up) in practice. Like Kyng, I expected that the educators would not understand all of the concepts I included in the Data Gathering scenario, but that the scenario would provide an orientation for later hands-on experience with the technology. My suspicion was confirmed as we walked-through the scenario:

S: We've got two ways to go with this ... We either need you to help us to find the best and fastest way to make use of that, or we need you to come work with one group at a time.
D: Yeah, because I don't know what you're talking about when you say, "the teachers will connect a Eudora mail window."
[referring to paragraph 4]

L: [I say that I did not expect them to know these terms and embellish this paragraph with a more detailed verbal scenario.]

The scenario did a good job of setting the technology within the context of the larger activity. It set the background for the next few meetings in which we would try out the network software, hands-on, with an shared, envisioned purpose. What the scenario could not fully express or anticipate (reflecting Kung's hermeneutic argument about text and meaning) was the effort that would be involved in learning to use this software and the educator's intolerance of that.

4.5 Summary and Discussion

4.5.1 Collaborative Design

Unlike Issues On-line, the network technology did not spawn a new pedagogical activity in the MMM design process, rather it was incorporated into a prior activity. Nonetheless, the technology had significant effects: it added the Internet as an additional medium for the data gathering effort and, more significantly, it shaped the structure and replaced the original medium for publishing the final magazine. The network largely failed as a two-way communications channel—very few "outsiders" replied to the data gathering WWW pages. The process of designing these pages and the activity they were supposed to mediate dramatically altered the course of the project, however. In particular, the Data Gathering scenario and WWW page mockup created a concrete shared vision of using the network, early in this project. The time and effort involved in trying to make this vision real was in part responsible for a commitment to the technology that spilled over into the publishing phase. (Of course the advantages of the WWW over the single user hypertext package were also significant.) These two early design representations, which I created and owned, were indeed powerful.

My relationship with the educators in this project was different from the one I had with Allen Browne. For much of the MMM project I served as a teacher to the teachers and a general "computer guy" (as they referred to me on occasion), installing modems, network software, etc. While Sharon and Debbie had more experience using computers in their classrooms, they were less experienced in creating new systems and were not engaged by the technical vagaries of the network technology, like Allen was (in fact they were irritated by these). On the other hand, they were able to participate fully in design, making use (in fact creating) both abstract and concrete design representations. In fact, they showed more willingness to work with persistent representations than Allen did on occasion.
Scenarios were useful in the MMM design process. The Data Gathering scenario, in particular, helped solidify a shared vision and, as a prop for design conversation, identify needed activity changes (allocation of computer time per group) and organizational issues (tying up shared phone lines). This scenario was also seductive in that it made some processes appear easier than they would actually be when the educators worked directly with the technology. The focus of design changed over the course of this design process and so did the representations we used. As the "system" (the WWW pages detached from the encompassing activity) became our sole object of attention, scenarios were no longer useful—structural and presentation representations were.

As in Issues On-line, I found that these educators did not assume a real sense of ownership for the application until they were able to affect it directly. Again, low-tech mediating design representations did not adequately substitute for manipulating the real materials. This project was different, however, in that the application did not include executable "code," which served as a clean division of ownership and labor in Issues On-line.

Finally, the technology in this case study affected Sharon and Debbie's pedagogy—defeating it in some ways. First, because of the complexity of the technology, the students had very little direct contact with the network. In particular, they did not author the final magazine as Sharon and Debbie had envisioned before the network became part of the design. Second, due to the publicness of the WWW, the educators did the final edit of the students' work, unlike the non-networked I Search projects.
5. CASE STUDY 4: ON-LINE DISCUSSIONS (COLLEGE PROGRAMMING)

5.1 A Self Study Course in C Programming

This chapter describes an application of the network in a undergraduate Computer Science class that I taught at Virginia Tech. Like the On-line Debates (described in chapter 2), this application was set in the context of the Educational Infrastructure (EI) project. The present case study differs, however, in that I alone designed and implemented the application; hence, this chapter has nothing to say about collaboration in design. Rather, this chapter focuses on the situated use of the network. This will include the pedagogical context of the class (particularly my goals for using the network within it), the observed (recorded) network use, and the students’ perception of their experience (primarily as reported in open-ended questionnaires). This chapter also presents a comparative study of three different modes of network use within this class, including, delivery of course information and materials, teacher-student communication, and student-student interaction. Nonetheless, like case studies 1 and 2, it’s primary focus is an application of WWW-based asynchronous structured discourse to support many-to-many computer mediated communication (CMC). This CMC mechanism was implemented in the same technology and core software as the preceding cases, but prescribed a more elaborate discourse structure. In addition, this application differed from the preceding two in that the teacher was a direct participant in the network activities.

The name of the course studied in this chapter was *Self Study Programming in C*. Despite the “self study” label, this class included both a lecture component and scheduled office hours. The purpose of the course was to introduce students who already had basic programming skills (typically in PASCAL or FORTRAN) to the C programming language. Nonetheless, the course material necessarily included several deep computer science concepts that were new to many of the students (pointers and dynamic memory, in particular). The class met only once per week for fifty minutes and the students received only one credit-hour for taking it. Nevertheless, the class covered a volume of material commensurate with a three credit-hour course; hence, students were responsible (on exams) for material that was not thoroughly covered in the classroom. The course was also relatively large: in a typical semester, I taught two sections with about 60 students in each.

5.1.1 Classroom Dynamics and Programs as Text
The combination of many students, little classroom time, and a large amount of material left me little choice other than to adopt a traditional lecture-homework-exam model of instruction. Each week I presented the highlights of one or two chapters from the text book. Although I did not like it, the only way I could cover even the most essential parts of the material was to stand at the front of the room and do almost all of the talking. I did try to create an active role for the students, however, using two techniques. First, I presented the lecture material on a blackboard vs. pre-written, static over-heads. I reasoned that this would involve the students, at least cognitively, in a dynamic process—the creation (or recreation) of instructional materials. Second, I employed a quasi-Socratic method (or inquiry method [Collins 85]) of teaching. I asked questions at critical steps in the process of composing materials on the board. Some of these questions were shallow, e.g., “What are the type and value of this expression?”; others involved “deep reasoning” about mechanism and causality, e.g., “What is missing here?” or “Why does/doesn’t this work?” [Graesser 93]. My intention was to prompt students to answer these questions “in their minds,” and, more importantly, to learn the skill of asking themselves the right questions when reasoning about C programs. Although I also encouraged the class to answer these questions out loud, time and population constraints precluded real discussion or individual inquiry.

Borrowing a metaphor from Batson [Batson 93], the students and I took turns “performing” for each other. I performed in lectures and they, in turn, performed for me by writing four short programs (“labs”) and taking two in-class written exams. In all cases, I assigned the same task to all students (a necessity in order to handle the grading load for over 100), which they would complete and submit individually. This was also philosophically unpalatable to me. My experience as a professional software engineer told me that software development in most “real-life” situations was a social (not individual) activity. In particular, I knew that the result of executing a program on a computer is not the only, or even the most important, aspect of software quality. Just as importantly, a program is a text that must be read and understood by people. While this idea is obvious for the prose documentation that accompanies a program, it also holds for the program “code” as well.

5.2 Pedagogical Goals and Network Mechanisms

I augmented the Self Study Programming in C course with the network in the Spring and Fall semesters of 1995.¹ Both my pedagogical philosophy and the constraints of this particular course affected the way I applied the network. This application included three network mechanisms: WWW-pages, E-mail, and structured asynchronous discourse. The goals that I hoped this application would serve included both

¹ I had taught this class without the network in two prior semesters.
first-level (technological efficiency) and second-level (social system) concerns [Sproull and Keisler 91]. The different network mechanism varied in the extent to which they served these different levels.

5.2.1 On-line Lecture and Office Hours

At the first-level, the network technology offered time and space efficiency. Indeed, I used both the WWW pages and E-mail to increase my contact with the students beyond the fifty minutes of class time and three office hours I held each week. For example, I extended my lecture time by posting announcements and course materials (assignments, etc.) on the WWW pages or by broadcasting them to the students via an E-mail mailing list. Likewise, I increased the amount of tutorial interaction, typical of office hours, by engaging in one-to-one E-mail communication with students. Indeed these mechanisms did alleviate the time constraints of this course by affording teacher-student contact from a distance, asynchronously and outside the time periods officially allocated for the class. When I described this to an interested faculty member, she replied that the entire university was looking for ways to do more with less, amidst the budget cuts and rising enrollment. It’s important to note, however, that these first-level effects primarily allowed me to do more of the same (lecturing and tutoring) with less. And, that less refers to official course time—my personal time expenditure was increased.

The first-level effects were significant. In fact, some began to transcend simple efficiency—e.g., I now could immediately announce new or forgotten information through E-mail, rather than wait a week for the next class. Nonetheless, I believe that the most important and interesting effects of this application were second-level. These involved a departure from the previous (traditional) social structure and dynamics of the classroom. My primary motivations (especially for the structured asynchronous discourse mechanism) were to change the status and power relationships within my classroom, and to promote student agency within the learning process.

5.2.2 The “Heavy Presence of the Teacher”

Trent Batson, a writing teacher and a founder of the ENFI concept (see chapter 2), described the traditional classroom configuration as “vertical” (or “hierarchical”) and in opposition to his goal that students write “horizontally.” In other words, students should not consciously write for the teacher, assuming the shared context of understanding and the power relationship (the teacher assigns a grade), which is the vertical reality. Rather, they should “pretend to be writing to some vague [‘surmised’] audience out there who doesn’t know about the story [they’ve] just read” [Batson 93]—a horizontal fantasy. Likewise, in the programming assignments I gave, I wanted students to write their code and documentation in such a way that “others” could understand it. My conspicuously authoritative posture in
the classroom, however, coupled with the fact that the only thing students did with their programs was submit to me for a grade, made the idea of “others” seem artificial, even irrelevant.

The physical configuration of a traditional lecture classroom (like mine) supports this vertical relationship between the students and teacher. In my lectures, I stood at the front of the room, above (“both literally and figuratively” [Batson 93]) the seated students, free to move about the room, while they were confined to their desks. This configuration leaves students in a passive, almost submissive, position with respect to the teacher. It also promotes a situation where all communication is mediated (if not initiated) by the teacher, the one person whom all the students face, and presents the teacher as the single authority in the classroom. Even if the physical arrangement is changed to a more egalitarian circle (which was not an option in my classes of 60 plus students) the “heavy presence of the teacher” as expert remains [Batson 93].

5.2.3 Equalization in CMC: Status Differentials and Power Relations

Like the proponents of ENFI, I hoped to create a “place” in the network that would not be dominated by the teacher’s authoritative figure. At times I was successful, especially with the E-mail and asynchronous structured discourse mechanisms. Nonetheless, even within these CMC forums, the “heavy presence of the teacher” persisted, as did the traditional behavior patterns of both students and teachers. Many researchers have observed that social boundaries and personal inhibitions are lowered in CMC compared to face-to-face interaction resulting in new kinds of interconnections among people (formation of new groups) and more equal participation among group members (see [Sproull and Kiesler 91] for a review).

In a critical analysis of this body of research, Spears and Lea focus on the claim that the reduction of social context, particularly, the reduction of “status cues,” within CMC is the reason for these phenomena [Spears and Lea 94]. In their critique they draw a clear distinction between “status differentials” and “power relations” pointing out that most research demonstrating “equalization” within CMC have manipulated the former (e.g., graduate vs. undergraduate students) rather than the later—situations where “there is some explicit relationship of dependency ... [where] one party has some degree of control over the other’s outcomes.” They claim that simply limiting social context cues (e.g., the teacher’s dominant posture standing in front of the class) will not neutralize participants’ perception of the extant power relationships—e.g., the teacher-grades-student relationship.

5.2.4 Students as Teachers and Authors

In addition to reducing teacher dominance, I hoped the network would produce the complementary second-level effect of placing the students in new, more active roles. In particular, I hoped to cast students
both as instructors and as authors of course materials. The application of asynchronous structured discourse (ASD) that I used in this class, the On-line Discussions, served this goal (to a lesser extent, my E-mail/Mail-Bag mechanism did also, see below). My motivation for casting the students as instructors—having them teach their peers—originated in my own initial teaching experience. When I taught my first class, after five years of professional programming in C, I was astounded at how much I learned in the act of teaching. This resulted partly from a thorough review of the language, including features I had not used much in practice. It was more than that, however. My learning-through-teaching experience gave me a more sound and complete conceptual model of the C programming language. This resulted, I believe, from breaking down my tacit, operationalized, knowledge of C programming, which I had developed over years of daily practice. The exercise of putting my practice into words—explaining, step-by-step, how and why I did what I did—transformed that practice and enhanced my understanding of it. I hoped that the On-line Discussions would, likewise, give the students an opportunity to not only do the assignments but also to explain to others what they had done and why. I hoped that this exercise would benefit the students in the same way it had benefited me.

The network also allowed students to serve as authors of instructional material in this class. Because discourse within the On-line Discussions was structured and persistent, it reified the on-line "conversations," both question-answer exchanges and design explorations, as artifacts that other students could use as instructional resources. Furthermore, because these conversations were set in a textual medium, the participating students were actually writing, not talking. This served two pedagogical goals. First, like the teaching-to-learn concept, I believe that putting algorithms and other programming concepts into writing breaks down and clarifies the author's understanding. Second, as I mentioned above, I believe that the skill of textual communication, writing programs that are readable by "others" is of primary importance in software development. The On-line Discussions allowed students to practice this skill in a naturally motivated context—i.e., writing "for a real audience" [Bruce, et al. 93], writing "horizontally," not just for a grade.

5.3 The Network Application

5.3.1 Resource or Requirement

The network activities in this application were not assignments. This contrasts with the On-line Debates and Issues On-line applications, which required students to participate. In this class, I offered the network application as a resource rather than a requirement. In fact, I emphasized that participation was optional and that a student could do well (i.e., make an 'A') without it. Although I encouraged students to use the application I did not include instructions on how to use it as part of the official class (I did offer tutorials
in my office hours, but virtually no one accepted). In fact, I seldom mentioned the network activities in class once they were underway. Essentially, the non-networked components of the class proceeded just as they had in the prior semesters when I did not use the network.

![Diagram of System, On-line Discussions, Course Material WWW Pages, and Activity]

**Figure 5-1: Visualization of the Self Study Programming in C Application**

The network’s marginal position within this class raised issues of motivation and fairness. First, if the network activities were not requirements, why would students engage in them? I will analyze student motivation more fully below, but simple quantitative data from the Fall 95 semester shows that the students did indeed use the application. Daily accesses (reads and posts) to On-line Discussions were typically above 100 and on 17 days exceeded 300. Likewise, the students took advantage of E-mail—I received approximately 160 student-initiated E-mail messages in the Fall 95 class. Second, if the network indeed provided a valuable resource, was it fair for me to present it on the margin—did this put the students who lacked network skills or high quality network access at a disadvantage? I addressed this issue in the student response questionnaires and also will analyze it more fully below. At the time, however, I justified these inequities by analogy to another. In this and other low-level programming classes some students owned their own computers and were already familiar with its operating system and development environment, other students had to use lab machines and/or learn a new environment. Although this gave some students an advantage over others, I did not consider the situation to be unfair (nor had I ever heard students or other instructors express this opinion)—these students were merely leveraging previous learning effort (and monetary expenditure). Furthermore, in the case of the network,
every student did have an opportunity to participate—E-mail addresses were available to all students free of charge and they could use lab and library computers for network access.

Figure 5-1 visualizes the network application I used and studied in the *Self Study Programming in C* course. This visualization follows the application model introduced in Figure 1-1 (chapter 1). This application encompassed three network mechanisms: ASD (for the On-line Discussions), e-mail (for on-line office hours and announcements), and WWW pages (for delivering course materials and grades). The discourse structure of the On-line Discussions was the only structure in this application; otherwise, the activities were not explicitly defined and were not required. In particular, there were no explicit phases or roles in these activities. Nonetheless, within the On-line Discussions, regular patterns of use emerged: phases formed around the periods of the four programming assignments (see Figure 5-7, page 176) and the students adopted roles; e.g., as Lurkers, Askers, and Answers (see page 195).

### 5.3.2 Application Components

![Computer Science 2304 -- Fall 1995 Self Study Programming in C](image)

Figure 5-2: *Fall 95 Self Study Programming in C* Home Page

In the present case study, I will analyze multiple network mechanisms. These include WWW pages, E-mail and an application of asynchronous structured discourse called *On-line Discussions*. While other EL
project classes employed multiple mechanisms (in fact the *Professionalism in Computing* class described in chapter 2 used these same three), I am uniquely positioned to compare them in this case because I was both the instructor and the ethnographer. I describe these components, both the mechanism and activity for each, in this sub-section. I present them as a progression from first-level (i.e., efficient delivery of information and material) to second-level (i.e., changed class room roles) effects.

5.3.2.1 **WWW pages: Delivering Course Materials**

The most visible component of the network application in this class was the course "home page." This WWW page looked much like those employed by the other EI courses containing links to various on-line course materials, such as the syllabus, course calendar, and course assignments—see Figure 5-2. This mechanism was an effective alternative to handing out paper in class. After the first few weeks, some students began to decline my paper hand-outs, saying they would "get them off the Web." Although I was able to decrease the number of copies I made, the class was not "paper-less"—approximately half the students still took the class hand-outs, and those who got it off the WWW tended to print the assignments (I saw many paper copies of these WWW pages in my office hours and in the labs).

5.3.2.2 **E-mail: Broadcast, Q/A, and the "Mail Bag"**

E-mail supported two distinct activities in this course: on-line announcements and on-line office hours. In the first case, E-mail allowed me to broadcast class announcements outside of the weekly fifty minutes of live classroom time. As Figure 5-2 illustrates, the course home page also had a link to an "Announcements and New Information" page—E-mail announcements were a sub-set of those posted on this page. The reason for duplicating some messages was two-fold. First, some students did not give me E-mail addresses (roughly 20/150 students in the Fall 95 semester) and in the interest of fairness I wanted all students to have access to this information. Second, as some students in the *Professionalism in Computing* class reported (see chapter 2), the WWW is a "passive" medium—students have to take the initiative to periodically check pages, such as my announcements page, for changes. In contrast, because many computer science students log on and check their e-mail as part of their daily routine, they tend to view that mechanism as a more active information delivery mechanism—the information comes to them automatically. For this reason, I sent especially important announcements as E-mail and posted them on the WWW pages—more students were likely to read them that way. In the second case (the second E-mail supported activity), the students and I used E-mail as an on-line extension of my office hours. I define this category to include E-mail exchanges between myself and individual students (two-way interaction vs. one-way broadcast) that were initiated by the student. This was the most frequent use of E-
mail in the class (in the Fall 95 semester, students initiated 14 E-mail conversations compared to my 16 broadcast announcements, see Table 5-3, page 179).

CS 2304 Self Study: C Language Programming
Lab 1 Mailbag

Some good questions (and my answers) asked via e-mail about Lab 1. Send your questions to cs2304@ei.cs.vt.edu

(I will get the rest of the mail on-line soon. s.c.l)

1. Can we just e-mail you a copy of our code?
2. Problem with hyphenated word "left-hand"
3. Does C have Sets like Pascal?
4. Can we use our own output format?
5. Punctuation in words
6. Downloading from Mosaic
7. My first broadcast message
8. How do I do I/O Redirection
9. Modularity, Output format

Figure 5-3: Spring 95 Lab 1 "Mail Bag" WWW page

Subject: Re: sets & the 'in' statement...
To: spowers@ei.cs.vt.edu (Stan Powers)
Date: Thu, 2 Feb 1995 06:15:40 -0500 (EST)
From: "cs2304 class account" <cs2304@ei.cs.vt.edu>

> Hi -
> >
> > In your finite state machine, you check for punctuation marks like this:
> > if (ch == '.' || ch == '?' || ch == '!' )
> > if I were programmer in pascal, I would say
> > IF (ch in ['.' ',?!' ])
> > which isn't really less complex in this example, but is usually
> > preferred to lots of "THIS or THIS or THIS or THIS" type statements.
> > Is there anything similar to
> > IF (value in [dataset])
> > for C? I'd rather use that type of expression then lots of "or" expressions.
> but I can't find anything about sets or an expression related to 'in' in
> the C text.

No. C does not have sets.

One alternative is to hide the complex logical expression in a function that
you write; e.g., int isInt( int ch ) that takes a character as an argument and
returns "true" if that character is a sentence terminator. Of course
the complex logical expression would be used inside that function.

Figure 5-4: Item 3 from the Spring 95 Lab 1 "Mail Bag"

Early in the Spring 95 semester, I combined the E-mail and WWW page mechanisms in a way that, for the first time, cast the students as co-authors of the course materials. When I received questions from individual students that I thought were of interest to the whole class, I first answered the individual
directly via E-mail, but also posted the question and my answer on a WWW page. I placed an additional hyper-link near the link for each assignment that led to these posted E-mail exchanges—I called these Mail Bags. I was careful to include the E-mail headers that identified the student who initiated the exchange; I was also careful to ask these students' permission before I posted their questions. Figure 5-3 and Figure 5-4 illustrate a portion of one of these mail bags for Lab 1 in the Spring of 1995.

For the most part, the effect of the mail bag was first-level—it saved me (the teacher) the inefficiency of answering the same question many times. Although, this mechanism did inject the students' voices directly into the on-line course materials, the students' role as knowledge consumers (vs. producers) remained: the students asked; the teacher answered. Furthermore, the mail bag maintained the vertical structure of the classroom because the teacher mediated all communication. The second-level effects that I desired would emerge to a greater extent in the final component of the network application used in this class: the On-line Discussions. In fact, when the Lab 1 mail bag question, "Are there sets in C?" (see Figure 5-4) was again posed in the Lab 3 On-line Discussion, later that same semester, it produced the richest incident of students collaborating to produce knowledge (instructional materials) free of teacher mediation. (I describe this instance below). Unfortunately, the social and discourse structure of the traditional classroom (which the mail bag reified) would tenaciously persist even in the On-line Discussions.

5.3.2.3 Asynchronous Structured Discourse: On-line Discussions

In the later half of the Spring 95 semester and throughout the Fall of 95, I provided a forum for the students to "discuss" their lab assignments and exams on-line, without teacher mediation. (This completely replaced the Mail Bag.) I implemented these On-line Discussions following the WIT paradigm (see chapter 2) and employing the same core software that I used in the On-line Debates and Issues On-line projects. The discourse structure of the On-line Discussions was richer than these two applications, however.

The On-line Discussions served my pedagogical goals in several ways. First, by removing the teacher from "the loop" it created a horizontal (on-line) classroom—students directed utterances (questions, comments, etc.), at least in theory, to the discussion, not the teacher. Secondly, the medium forced students to express their utterances in text. I hoped this (and the asynchrony of the forum) would encourage students to put more time and thought into how they expressed C programming concepts. As I described above, I believed that putting thoughts and utterances into text would both improve the students' communication skills and clarify their own understanding. Finally, I intended that the explicit structure and persistent record of discourse in this system would encourage students to break their knowledge into
discrete, functionally cohesive units (each expressing a single idea or question), while simultaneously providing an organizational framework that would integrate these units, contributed by multiple students, into a meaningful whole. Hence, the result of the discourse would not only add “bottom line” knowledge to the course materials, but preserve the path to that knowledge—its rationale.

![Figure 5-5: The Fall 95 On-line Discussions Discourse Structure](image)

Figure 5-5 illustrates the discourse structure for all On-line Discussions areas in the Fall 95 semester. In the first level of each discussion area (e.g., in reference to the Lab 2 assignment, or the mid-term exam), participants could post Ideas, Questions, or Comments. The system allowed the four speech acts Agree, Disagree, and (second-level) Question and Comment in response to first-level Ideas and Comments. It also allowed these four acts, recursively, in response to any second level or deeper posting type, except Question. The system only allowed Answer and Comment in response to Questions. For example, a participant could agree with an Answer to a top-level Question or could ask a question about a deeply nested Disagree. Figure 5-6 shows a portion of the root WWW page for the Fall 95 Lab 2 assignment discussion. It also shows the Question page for that discussion’s second posting (the posting “tree” at the bottom of this Question page shows that it received one Answer and one Agreement with that answer).

The system’s enforcement of a pre-defined (teacher defined) discourse structure can also be interpreted as a contradiction to my pedagogical philosophy, however. On the one hand, I wanted to free students from an already highly structured, normalizing classroom environment but, on the other hand, I had built a highly structured CMC environment that was explicitly designed to normalize discourse. This contradiction is represented in the system design itself—the fact that the relatively non-specific Comment speech act was available everywhere as an escape from the structure of explicit speech acts.

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2 There were eleven separate discussion areas in the Fall 95 semester; they are described below.

3 The system did not allow Comment responses for Questions below the first level due to a programming oversight.
Figure 5.6: Fall 98 Lab 2 Discussion and Example Question Page

Question You can also respond to answers in the list below.
Use the button at the bottom of this page to answer this question.

Suggestion: Click here for instructions. Also, see the new discussion.

Lab 2 Assignment Discussion

CS 234a: Project Planning
Table 5-1: Fall 95 Student Postings by On-line Discussion Area

<table>
<thead>
<tr>
<th>Discussion</th>
<th>Posts</th>
<th>Discussion</th>
<th>Posts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab 1 Assignment</td>
<td>55</td>
<td>Lab 3 Assignment</td>
<td>52</td>
</tr>
<tr>
<td>Lab 1 Solution</td>
<td>1</td>
<td>Lab 3 Solution</td>
<td>0</td>
</tr>
<tr>
<td>Lab 2 Assignment</td>
<td>45</td>
<td>Lab 4 Assignment</td>
<td>31</td>
</tr>
<tr>
<td>Lab 2 Solution</td>
<td>0</td>
<td>Lab 4 Solution</td>
<td>0</td>
</tr>
<tr>
<td>Exam 1</td>
<td>4</td>
<td>Exam 2</td>
<td>3</td>
</tr>
<tr>
<td>General</td>
<td></td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 5-7: Fall 95 Total Student Accesses to all On-line Discussion Areas by Date

I created separate On-line Discussion areas for the exams and lab assignments, plus, in Fall 95, an area for general discussion. Figure 5-2 (page 170) shows the hyper-links leading to each of these areas from the course home page. I opened a new discussion area about two weeks prior to each of the two exams. I intended that students use these both before and after the in-class examination, while studying and in reaction to their returned papers and my published key. The lab discussions were more structured: I opened one discussion area for each lab when I made the assignment and a second area when I published my solution (after the final deadline for turning in late assignments). By far, the most activity occurred in the lab assignment discussions—in fact the lab solution and exam areas were virtually unused. Table 5-1 compares the activity (measured in postings) across the eleven discussion areas used in Fall 95. Figure 5-7 shows the pattern of participation (measured as all accesses: both reads and posts) for all areas throughout the Fall 95 semester. Here, the “teeth” in this “saw-tooth” curve correspond to the periods just
before the due dates for the four assignments (the flat area in Nov. includes a week between assignments and the week of Thanksgiving break).

5.4 The Network Experience

In the following analysis of the experience and results of applying the network to the Self Study Programming in C class I concentrate on the On-line Discussion and E-mail components of the application—I say little about the WWW pages. In this analysis, I combine quantitative and qualitative data as well as key anecdotes both to describe the experience in general and to investigate how well the application supported my pedagogical goals. Almost all of the data come from the Fall 95 semester (the only full semester in which the application was in place); some anecdotes come from Spring 95 (during which I developed the application and used it in the latter half). I also explore the students’ conceptualization of the experience based on their responses to an open-ended written survey—again, this is limited to the Fall 95 semester.

5.4.1 Conversational Analysis of On-line Discourse

I employed a simple conversational framework to analyze the discourse that was mediated through and recorded in the E-mail and the On-line Discussion mechanisms. I first coded each top-level posting to the On-line Discussions (i.e., Question, Comment, or Idea) and each independently initiated E-mail message (i.e., messages that were not replies to previous messages) as most characteristic of a single conversation type. I derived these types empirically by studying the recorded discourse (keep in mind, however, that the structure of the On-line Discussions predisposed certain conversation types). I interpreted six qualitative conversation types in the Fall 95 data:

1. Question and answer—information seeking (Q/A)
2. Comments or suggestions for change (Comment)
3. Requests for action (vs. requests for information, i.e., questions) (Request)
4. Announcements and comments—information delivery (Inform)
5. Consensus seeking (Consensus)
6. Conversation for design (Design)

In addition, I assigned one or more codes to each conversation that represented what the conversation was. I interpreted six primary referents:

1. The assignment—e.g., clarification of wording, requirements vs. suggestions, etc. (Assignment)
2. Grading criteria—e.g., penalty for specific errors, late penalties, etc. (Grade)
3 The network itself—e.g., what is appropriate to discuss on-line, errors in the WWW pages, etc. (Meta)

4 Class procedure—e.g., due dates, how labs are submitted and returned, etc. (Procedure)

5 Programming concepts—general C Language concepts and specific issues regarding the lab assignments and programming environments: e.g., how to compile a multi-file program on a PC (Programming)

6 References to the output of lab programs or answers to exam questions. (Solution)

Finally, I characterized the participants (interlocutors) for each conversation in the On-line Discussions. Using the pre-defined categories student (S) and teacher (T), I coded each conversation according to who initiated it and who (if anyone) participated after initiation (the code 0 indicates no respondents). This resulted in the following seven codes:

1. Student initiated, no one responds (S-0)
2. Student initiated, only students respond (S-S)
3. Student initiated, only teacher responds (S-T)
4. Student initiated, both students and teacher respond (S-B)
5. Teacher initiated, no one responds (T-0)
6. Teacher initiated, only students respond (T-S)
7. Teacher initiates, both teacher and students respond (T-B)

The following tables summarize the discourse within the Fall 95 On-line Discussions (all areas) and E-mail using these categories:
### Table 5-2: On-line Discussion Conversation Frequency by Participant Type

<table>
<thead>
<tr>
<th>Teacher Initiated</th>
<th>Student Initiated</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-0</td>
<td>S-0</td>
</tr>
<tr>
<td>T-S</td>
<td>S-S</td>
</tr>
<tr>
<td></td>
<td>S-T</td>
</tr>
<tr>
<td>T-B</td>
<td>S-B</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

### Table 5-3: E-mail Conversation Frequency by Participant Type

<table>
<thead>
<tr>
<th>Teacher Initiated</th>
<th>Student Initiated'</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Individual Student</td>
<td>29</td>
</tr>
<tr>
<td>Broadcast to Students</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

### Table 5-4: On-line Discussion Conversation Frequency by Conversation Type

(partial breakdown by Q/A referent)

<table>
<thead>
<tr>
<th>Teacher Initiated</th>
<th>Student Initiated'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q/A (Socratic)</td>
<td>Q/A (prog./assign.)</td>
</tr>
<tr>
<td>Inform</td>
<td>Inform</td>
</tr>
<tr>
<td>Consensus</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5-5: E-mail Conversation Frequency by Conversation Type

(partial breakdown by Q/A referent)

<table>
<thead>
<tr>
<th>Teacher Initiated</th>
<th>Student Initiated'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q/A (prog./assign.)</td>
<td>41 (28)</td>
</tr>
<tr>
<td>Inform (Individual)</td>
<td>1</td>
</tr>
<tr>
<td>Inform (Broadcast)</td>
<td>2</td>
</tr>
<tr>
<td>Request</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5-6: On-line Discussion Conversation Frequency by Referent

<table>
<thead>
<tr>
<th>Teacher Initiated'</th>
<th>Student Initiated'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming</td>
<td>Programming</td>
</tr>
<tr>
<td>Assignment</td>
<td>Assignment</td>
</tr>
<tr>
<td>Procedure</td>
<td>Meta</td>
</tr>
<tr>
<td></td>
<td>Grade</td>
</tr>
<tr>
<td>Solution</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5-7: E-mail Conversation Frequency by Referent

<table>
<thead>
<tr>
<th>Teacher Initiated'</th>
<th>Student Initiated'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming</td>
<td>Assignment</td>
</tr>
<tr>
<td>Procedure (Individual)</td>
<td>Procedure (Broadcast)</td>
</tr>
<tr>
<td>Procedure (Broadcast)</td>
<td>Meta</td>
</tr>
<tr>
<td>Meta (Individual)</td>
<td>Meta (Broadcast)</td>
</tr>
<tr>
<td>Grade</td>
<td>Other</td>
</tr>
</tbody>
</table>

---

1 All student E-mail was directed to the teacher; no student-student E-mail data were available.

2 Some conversations received multiple codes.
5.4.2 Network Support for Pedagogical Goals

5.4.2.1 Increased Teacher-Student Contact

From: Laughton, Stuart  
Date: Fri Sep 8 08:27:19 1995

Return value/type of the main function.

In class, I said that the main function could be type void  
(return no value). This was wrong. In ANSI C,  
the main function must return an int.

I updated the example programs: caps.c and fill.c to show  
how this is done.

The example programs have this general form:

```c
#include <stdlib.h>

int main(void)
{
    /* the body of the program goes here ... */
    return EXIT_SUCCESS;
}
```

This program returns EXIT_SUCCESS (an int value defined in stdlib.h)  
to the operating system. This tells the operating system that the  
program executed successfully.

[?] I did void and no errors detected.  
[*] See the answer to the question below. [teacher]
[?] void return value for main  
[*] This is confusing, isn’t it! Don’t worry about it, but ... [teacher]
[*] You’re using the wrong compiler

Figure 5-8: Example teacher-initiated, informative On-line  
Discussion conversation

The conversational analysis presented in the preceding tables indicates that the network application did  
support all of my pedagogical goals—both first and second-level. At the first-level, the network extended  
my contact with the students. In total, 23 of the teacher-initiated on-line conversations (7 On-line  
Discussions and 16 E-mail broadcasts) effectively increased my lecture time. All of these, except the 2  
Q/A-Socratic discussions, like traditional classroom lecture, involved primarily one-way information  
transmission from the teacher (myself) to the students as a whole. Figure 5-8 illustrates the “home” page  
for one of these information transmitting conversations—a Comment 1 posted in the Lab 1 On-line  
Discussion. This teacher-initiated informative posting was unusual for that type, in its large number of  
responses. The first Question attached to it (“I did void and no errors ...”) illustrates that even this  
primarily first-level use of the network had a second-level effect—students could asynchronously  
experiment with teacher supplied information and then “question” it. The 2 teacher-initiated Q/A-

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4 In this and subsequent figures, I’ve added the tag [teacher] to indicate my own responses—these did not appear in the actual application.
Socratic conversations also emulated one of my lecture techniques. (I will discuss my Socratic use of on-line Questions in the section Resisting Traditional Q and A, page 188, below.)

The network also extended my one-on-one contact with students, supporting a form of on-line office hours. The majority of student-initiated conversations within both the On-line Discussions and the E-mail mechanisms involved question and answer. The On-line Discussions, in particular, were dominated by students asking for help on the programming assignments: I coded 70/80 student-initiated On-line Discussion conversations as Q/A with reference to programming concepts or assignment clarification. Unlike face-to-face office hours, however, I did not feel compelled to answer every question that a student posed within the On-line Discussions—other students could, and did, answer these also. In fact, I only participated (as a respondent) in about half of these (36/80). Within the E-mail forum, there was greater variance in both the type and the referent of student-initiated conversations: only 41/114 were Q/A in reference to programming or the assignment; 40/114 were Requests—mostly in reference to class procedure and the network itself (e.g., “please post my grades on-line”). Of course, all of the E-mail mediated Q/A and Requests were addressed directly to me and I was obliged to answer each of them.

5.4.2.2 Reducing the Teacher’s “Heavy Presence”

Perhaps the most obvious trend in the conversation frequency tables is that the majority of conversations (within both mechanisms) were initiated by students. Of course the populations were skewed: there was 1 teacher and approximately 120 students. Nonetheless, these same relative populations existed in my live classroom where this trend was reversed (to an even greater degree). This quantitative result alone provides weak evidence that the network helped me to achieve one of my second-level goals: to reduce the “heavy presence” of the teacher. I also found qualitative evidence of this effect in the language of several questions posted to the On-line Discussions. First, several of these questions were explicitly addressed to the on-line community at large, illustrating that many of the students did not conceive of this forum strictly as a channel between themselves and the teacher. For example (emphasis added):

L2-Qst13: I don’t really understand when we are supposed to use the "extern" declaration for files and or variable names. ...
Could someone please explain this?

L3-Qst9: Can anyone explain this code: ...
L4-Qst4: Could someone tell me the output for LookupString: ...

Likewise, I found several instances where postings referred to me in the third person (emphasis added):

L1-Da3: ... I am sure he won’t count off for putting in extra testing, Spend your time however you want ...

L1-Ans1: I used the following code: ... I think I found it in the book, or in one of the programs our teacher gave us.
Again, even though the students surely were aware, at some level, that I was “there” (running and monitoring the discussions), their utterances were directed to other students, with less regard for the teacher’s presence as mediator, compared to the live classroom.

| From: Doe, Mitch  
| Date: Mon May 8 10:52:33 1995 |
| Complex questions on final |
| I felt like I knew the material very well and had studied adequately for the final exam. However, I walked out of the exam wondering whether I’d missed 0 or 4-5. It seemed difficult to be sure of the answers. This is of particular concern because the way the grading system was set up, each question on the final exam represented 1.5% of each student’s final grade. |
| I believe the reason for this uncertainty was that each of the questions on the final seemed to actually consist of a test of multiple concepts. For example, one had to know how to dereference a 2D array, how 2D arrays are structured, and what kinds of pointer arithmetic are legal to correctly answer one of the questions. Essentially, this amounts to three questions in one and the student is left engaged in something of a serial process: he/she must correctly process subconcept 1, then subconcept 2, and then subconcept 3. If any of these stages fails, the questions is answered incorrectly and there goes *a* 1.5 of his/her grade. The inclusion of “all of the above” and “none of the above” options serves to confuse this process further. It seemed like most of the questions were like this. |
| As it turns out, I did well on the exam; however, it looks like a number of students weren’t so lucky. I would suggest that, in the future, the number of questions on the final be increased and the complexity of the questions be consequently decreased: the concepts being tested per questions should be reduced. This would make the test more diagnostic, not weight each question so heavily in relation to the students’ final grade in the class, and likely yield a better distribution of test scores. |

[ ] Here’s the distribution [teacher]
[ ] All/None of the above is not confusing. Distribution is reasonable.
[ ] I’ve seen much worse...
[✓] I second that
[ ] All’s fair...
[✓] C deserves some respect
[✓] Get a grip - It’s NOT Stuart’s fault!!!
[✓] Chill out...I’m not blaming anyone...
[ ] Why does the class need to be easier?
[✓] Clarification
[✓] Multiple Concept Questions

Figure 5-9: A Conversation from the Spring 95 Final Exam Discussion

Figure 5-9 presents a conversation from the Spring 95 semester that provides anecdotal evidence of the teacher’s reduced presence in the On-line Discussions. Although the exam discussion areas produced scant activity overall, this conversation about the quality of the final exam was one of the most passionate in either semester. I have never received such a frank critique of an exam (or any other assignment) from a student in the face-to-face medium; furthermore, this student did not approach me through any other channel. But perhaps more important than the liberating effect that the CMC medium had on these students—freeing them to blow off some steam after the exam—was the effect the medium had on me. If a student had addressed this message to me in the live classroom, where I am the conspicuous figure of authority, I would have felt compelled to respond, probably defensively. In this case, the asynchrony of the on-line discourse mechanism allowed me to hold back and let the students play the issue out. (My only response was to post the exam distribution—tagged as a neutral comment—without annotation.) In fact, I
was gratified to see a couple of students post justifications for the exam that aligned well with my own rationale. I expect that these had more impact coming from fellow students than from the teacher, anyway. (In fairness, I must also note that a couple of other students echoed the original complaint!)

There were also indications that my presence as a authority figure persisted within the On-line Discussions. For example, although the students posted a total of 10 Disagree responses in the Fall 95 semester, none of these were attached to my postings. There were three instances, however, where the content of a student posting clearly rejected or expressed doubt about one of my assertions (Answer or Comment). For example, the following text appeared in a student's response to my comment that void is not a valid return type for the function main (the full text of that comment appeared above in Figure 5-8):

L1-Qt2: Uh, I don't think I'm going crazy, but whenever I look in the first four chapters of our textbook, every example program uses a main function with void parameters and return value. Am I using the wrong book (C by Discovery)? Are you sure we can't use a void return value for main? Is the book just oversimplifying the situation? Or am I just living a dream...?

I even ran a test program using Turbo C/C++ out of the book with void return value, and everything ran great. So what's the deal? If we can run the program correctly with a void return value, is that okay?

The student elected to tag (and phrase) this posting as a Question; likewise, in the two similar cases, one was tagged as a Question the other a Comment. In all three cases, the Disagree option was available but the students seemed reluctant, even in this less direct medium, to explicitly contradict the teacher's authority. A second manifestation of my persistent authority, even within the On-line Discussions environment, is reflected in the preponderance of the Q/A conversation type. Some students, especially in the beginning of the semesters, seemed to view the discussions as a mechanism for directing questions to the teacher—maintaining the traditional tutoring roles.

5.4.2.3 Students as Authors and Teachers

Decreasing the teacher's dominant social position was prerequisite to my other second-level goals for the network—namely, to cast the students both as teachers and as authors of instructional materials. Again, I found both quantitative and qualitative evidence for this role reversal. Quantitatively, Table 5-2 (page 179) shows that only 23/87 conversations in the On-line Discussions (all 23 were Q/A type) followed the traditional classroom structure: student asks, teacher responds. On the other hand, 51/87 conversations included students as respondents (44 of these were Q/A type) and, in 36 of these, students were the only respondents. These numbers reinforce the contention that the network reduced my presence as the authoritative figure, relative to the live classroom. Furthermore, in a closer analysis, I coded 68 student
postings\(^5\) as answers to questions. whereas. I found only 35 of my own postings in this category.\(^6\) The students not only had a greater voice within this medium. they also played a non-traditional role—they were teaching.

```
From: Chandy, Kang Rai
Date: Tue Sep 19 22:46:13 1995

ISN'T TRUE POSITIVE AND FALSE NON POSITIVE?

during the first program, I assigned a negative number for false,
ex:
    #define false -2
    int flag = false;

and somewhere in the program I did !flag. I made a mistake of thinking
that it will turn a -2 in to some positive number but the program gave me
0 which is still a false value.

Just wanted to know why? Isn't negation suppose to negate sign bit?
-Sang.

[\*] True and False in C are not really + and -
[\*] what he said...
```

```
From: Andrews, Donald
Date: Thu Sep 21 11:29:18 1995

TRUE AND FALSE IN C ARE NOT REALLY + AND -

This is from my lecture notes so... In C, truth is evaluated such that 0
is False and NONZERO is True

From the book... Chapter 2, 2.3 During execution, the expression is
evaluated. If the value is NONZERO, the expression is interpreted as true
and is evaluated. If the value of the expression is ZERO, the statement
is NOT executed.

Hope that explains it and helps out. If you vana relate to + and -
then both are true (cu: 0 is not positive or negative) so good luck to ya.
-DA
```

Figure 5-10: Student taking the Teacher/Author role (Fall 95 On-line Discussion)

Unlike the live classroom, utterances in the On-line Discussions were textual and persistent. Hence, when students answered their colleagues’ questions (or my own Socratic questions) they were simultaneously authoring instructional material. This material remained on-line and other students, in addition to the individual who initiated the question, could benefit from it. Figure 5-10 is an example of a Q/A. S-S conversation, with reference to C programming (specifically, the notion of "truth" values in C). Here, the responding student assumed the roles of teacher and author beautifully. (This figure shows the WWW

\(^5\) Here, and throughout, the term *posting* refers to a single “utterance” within a conversation. Within this count, several postings may belong to a single conversation.

\(^6\) Here I refer to postings that, in my interpretation, *functioned* as answers. In 12 of the 68 cases, the students explicitly tagged these posting as other speech act types—most commonly, as *Comments*.
page for two of the three postings in this conversation: the initial Question and the Answer to it. A third student posted an Agree to the Answer—this is not shown.) In total, I found 20 postings (all answers) in which the quality of student pedagogy was comparable to this instance.

Answering other students’ questions was the pedagogical role most commonly assumed by students—but it was not the only one. In addition, 5 student postings evaluated the correctness of other students’ answers. I interpret this as even greater evidence of the role change and relaxation of teacher authority that I desired. Even within the on-line forum, I felt obligated (as the ultimate course-content authority—after all, I still had to judge correctness on exams and assignments) to reevaluate students’ answers that were incorrect. To my surprise, some students even took on this higher-order responsibility in my place.

5.4.2.4 Ventriloquation

Although the network application allowed students to assume the teacher’s role, in many cases I “heard” my own “voice” in theirs. This is not incompatible with my goals: in fact, I consider this another positive result. Part of teaching any practice is to introduce students to the language of that practice. Here, I use the term “language” in the sense of “social” or “professional language” as attributed to Mikhail Bakhtin by Wertsch [Wertsch 91], not the formal C programming language. The professional language of C is a natural, English vernacular common to those who practice the C programming “tradition.” It is a way of speaking common to C programmers, both a common vocabulary and a common pattern of phrases. (Of course, my personal conceptual model of C also shapes the way I teach it.)

This way of speaking about C programming both reflects and determines a way of thinking about C programming.7 Likewise, in teaching, I use this professional language as both an instrument for instruction (somewhat like multiplication tables in arithmetic) and as a tool for assessment: I judge the effectiveness of my instruction, to some degree, on the extent to which the students begin to talk like I do. Wertsch, following Bakhtin, calls this latter phenomenon ventriloquiation and maintains that all utterances reflect multiple voices: that of the physical speaker plus those who taught the speaker that language. Both the persistent textual nature of the on-line medium and the increased opportunity for students to speak within it made this professional language more visible. There were 10 student postings (4 questions and 6 answers) that I identified as instances of ventriloquiation—students speaking through my professional language—in the Fall 95 On-line Discussions.

7 See Wertsch’s discussion of “language as mediational means,” which he attributes to L. S. Vygotsky and his colleagues [Wertsch 91].
From: Stalone, Fredrick  
Date: Wed Dec  6 19:44:25 1995 

WHAT WAS THE POINT OF . . . ?

There was a question on the final that went something like this:
printf("place1");
if ( x = 1 )
    printf("place2"); ...

What is the output? Anyway, can anyone tell me what the point of giving us this question was? I've accidentally used "if ( x = 3 )" in my programs and I get a warning. Is this an important thing to know for future C programming?

Fred Stalone

[ ] It's a question about syntax
[ ] It's purpose was to show that in C, assignments have a type and a value.

Figure 5-11: A Case of Student-Teacher Ventriloquation

An example of ventriloquation occurred in the Fall 95 Exam 2 Discussion area (see Figure 5-11). A student posted a Comment that questioned the external validity of one exam item. This item was tricky (perhaps even a "trick question") but tested several important concepts (and in my defense, I including a warning to "look closely"). Again, I decided to defer to the students rather than reacting to this critique directly. I subsequently talked with a different student who had missed this same question on the exam (the only question he missed): I explained the correct solution and my pedagogical rationale for the exam item. Two days later this student posted a response to the critique that conveyed ("ventriloquated") my points beautifully (although, I wish he had posted it as a Disagree to the incorrect response that preceded it). I was especially gratified at this, not because he took my side, but because he couched his explanation in the "professional language" that I had used throughout the semester (e.g., using the terms type, value, statement, and expression with precision).

5.4.3 Are there sets in C?: A paradigmatic conversation for design

The conversation type that I hoped would most effectively cast students as authors of instructional materials was "conversation for design." Unfortunately, as indicated in Table 5-4 (page 179), there were very few of these in the Fall 95 semester. Furthermore, the 2 that did occur were trivial. My hope was that students would post descriptions of the design ideas they used in solving their lab assignments. Further, I
hoped that others would join in, using the Agree, Disagree and Comment speech acts, to explore these ideas, and their alternatives. The On-line Discussions system would reify these conversations as a persistent, structured design rationale. This ideal is quite similar to that proposed for WIT and the On-line Debates (described in chapter 2). While this conversation type was also infrequent in the Spring 95 semester, one paradigmatic case, demonstrating the potential of structured asynchronous discourse for collaborative design rationale, did occur that semester.

Figure 5-12: A Conversation for Design (from Spring 95)

Figure 5-12 shows the “home page” for the best example of a conversation for design that occurred in either semester. (I’ve added tags to identify the interlocutors within the posting tree; these did not appear in the running application.) This conversation achieved my highest hopes for the asynchronous structured discourse mechanism. First it was truly student centered. Although I posted the top Answer to this
Question another student (Mike) proposed a better design idea than I had—one I had not even thought of. More importantly, two students (Mike and Carl) explored this idea argumentatively and, in the process, covered not only the pros and cons (the rationale) of this proposed design, but other design possibilities and several important general C programming concepts (e.g., representation of string literals, portability of character encodings, short-circuiting in logical expressions, etc.).

Furthermore, because of the persistent and structured nature of the On-line Discussions, this conversation was reified as new course material—authored by and delivered to students in the network medium. The student as teacher occurred at two levels here. First, although Carl did not adopt Mike's design, the on-line discussion did reveal a bug in his own, resulting in the following posting expressing his gratitude (tagged as an Agree):

From: Powell, Carl  
Date: Sat Apr 1 01:43:55 1995  
Subject: You are correct, sir!  

I stand corrected. I misread the assignment (and now I have to rewrite a section of my code), so thanks to you for helping improve my grade! :)  

I was also lucky enough to find concrete evidence that the artifact of this conversation helped at least one other student who was not a active participant in it. Juan, a student in Spring 95, approached me after class to say that he thought the lab discussions were a great idea but that he was concerned that "we are saying too much." By this he meant that he was afraid that the students were helping each other too much—violating the University Honor Code. He also told me at that point, that he had used Mike's design idea for simulating sets in C. Later, after returning the graded labs, Juan showed me that he had included a formal citation to Mike for the technique he had used in his solution. He also told me, however, that he and Mike had actually compared solutions and that they were quite different, even though they shared this basic technique. I draw the important conclusion from this anecdote that on-line peer-mentoring can work—and without lessening individual creativity.

5.4.4 Resisting Traditional Q and A

The network extended my contact with the students—I described this above as "on-line lecture" and "on-line office hours." While this was my expectation for the WWW pages and E-mail, I had loftier, second-level, aspirations for the On-line Discussions. At times these goals seemed in doubt, however, as reflected in my journal during these two semesters:

[29 Mar., Spring 95] The Lab 3 discussion has degenerated into Q.A. students ask. I answer. Email with the Mad-Bag, worked at least as well...
[29 Sep., Fall'95] TRYING TO BREAK THE Q-A MIND-SET [journal entry title]

My frustration about getting the students to do more than just ask questions and read others’ questions and my answers continues. I try to wait on answering questions to allow students to do it, but I feel guilty when a sincere question is left unanswered for days.

I don’t want to give credit for answers because that would put me in the role of evaluator within the [On-line Discussions] like I am in the classroom—the opposite of what I am trying to achieve. I plan to add the top-level category “Idea” to encourage students to start threads [conversations] other than questions. I asked a question myself yesterday. Socratic style, to try and demonstrate that my role was not “question answerer.” I got one answer that same day from Keigo.

The preponderance of question and answer type conversations in the Fall 95 On-line Discussions is clearly evident in Table 5-4 (page 179). This is not difficult to understand. Recall that participation in the network activities was voluntary in this course and I did not give “extra credit” for participation. Hence, the network application was truly a resource that most students approached with utilitarian motives: they used it to get help on specific problems they had in performing the tasks I had assigned and did grade. My problem was not so much with Q/A itself (after all, the structure of the On-line Discussions promoted it by offering Question as an explicit top-level speech act). but I didn’t want the on-line forum to be as teacher centered as my classroom was. Rather, I wanted the students to take the role of “question answerer”—teacher and author. My efforts in this direction took two forms: redirecting students’ questions from the E-mail to the On-line Discussion forum; and, trying to maintain a “light presence” within the discussions themselves.

5.4.4.1 Moving Questions On-line

Particularly at the beginning of the semester, students seemed to prefer the E-mail mechanism for asking questions. On occasions, I would answer the question via E-mail but also ask the student’s permission to re-post it and my answer in the On-line Discussions. For example, the following post script appeared in a reply to a Fall 95 E-mail question (about C programming, in general):

P.S. This would have been a very good item to post to the General On-line Discussion. You could have asserted this as a Comment (rather than a Question) because you propose a new idea.

Would you mind if I move your mail message and my answer to the On-line Discussion so that others can benefit from them?

---

8 Figure 5-7 (on page 176) illustrates this graphically. The pattern of access rendered in this graph forms a “saw-tooth” curve whose “teeth” mark the periods of the four lab assignments. The frequency of access begins a crescendo just after each assignment is made and falls sharply to baseline just after each due date. The fall would probably have been more precipitous except that there were two sections of the course in Fall 95: the due date for one was on Monday, the other was Wednesday.
On a few occasions I also broadcast E-mail pleas asking students to use the On-line Discussion. I explicitly grounded this encouragement in first-level efficiency—that multiple students "benefit" from answers in the discussions. I always had my second-level objectives in mind, however. I suspect that many students simply preferred the privacy of E-mail and were more accustomed to directing question to the teacher, but they cited other reasons for not using the discussion. Accessibility was one—a "dumb" terminal was enough for E-mail, whereas, the discussions required an Internet connection and WWW browser. Also, the students were wary of posting solutions (e.g., large sections of "code") in the public domain. I warned them about this in the On-line Discussions instructions (posted in the WWW pages): the university wide "Honor Code" also seemed to prohibit it. Eventually, students did pose most of their questions about programming and assignment requirements to the public On-line Discussion forum. In all, 70 questions posted in to the discussion areas referred to these topics compared to only 41 E-mail questions (see Table 5-4 and Table 5-5, above).

5.4.4.2 Withholding Answers

Getting the questions into the public domain achieved my first-level goal: to reach the second-level, I needed students to answer them as well. Towards this end, I often held back from responding to questions myself, giving the students a chance. On occasion, I even broadcast E-mail messages that pointed out specific "good questions" and encouraged students to answer them. Students did answer (as I mentioned above more answers came from students than from myself) but this tactic was problematic. Marshall Kremers, an ENFI practitioner (see chapter 2 for a description of ENFI), describes a similar dilemma using synchronous CMC as a prewriting exercise in college English instruction [Kremers 93]. He too wanted the network space to be "student centered" and saw it as a welcome relief from the classroom, where he "did almost all the talking." In fact, Kremers went so far as to leave the room during the students' ENFI sessions so they would not depend on him for direction. Although the students didn't complain, post hoc interviews (conducted by a colleague of Kremers') revealed that some felt abandoned, that his absence indicated he did not care. This situation, which Kremers hoped would be liberating for the students, was in fact confusing for some of them. Comparing his traditional classroom activities to ENFI (the courses he described met in both environments), Kremers questions the apparent "contradiction" when "the teacher dispenses knowledge one day and appears to withhold it the next."

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9 On the other hand, students, all too frequently, E-mailed their complete work-in-progress to me, with a question like, "Why doesn't this work?"
5.4.4.3 The Obligation of Authority

There were situations in which I felt obligated to answer questions in the On-line Discussion, and to inject my authority in other ways. For example, a question appeared in the Spring 95 Lab 3 discussion asking if the program's output "had to be printed out in exactly the same order [as the input]." I would have loved it if the students had explored this issue themselves following the IBIS paradigm—posting alternative positions ("alphabetical," "same order as the input," etc.) and exploring these collaboratively through structured argument (using the Agree and Disagree speech acts). On the other hand, within the context of our educational system, this was an understandable request for clarification: the student who posted it surely feared that adopting the "wrong" position in her solution would cost points in her grade. Furthermore, the question did seem to be addressed to me—she asked what was required, not what the community thought was best. In fact, when I failed to respond immediately through the On-line Discussion, this student E-mailed the question to me directly. I answered her in both forums, saying why I thought alphabetic was best but that it was not a requirement. Not surprisingly, however, there was no on-line discussion of my answer—the students treated it as a declaration, not a disputable position. I felt compelled to answer questions about the assignment (like this one) or about grading criteria, but I did so reluctantly, feeling it was self-defeating to assert my authority in this space.

Not only questions demanded the teacher's authoritative response—some of the students' answers also compelled me to assert a heavier presence than I would have liked. In particular, in the cases where students' answers were simply wrong, it was difficult for me to justify holding back and waiting for another student to post a rebuttal. For example, Figure 5-13 illustrates a conversation that went badly. Here a student (Gary) posted an interesting question about a piece of code that did not work the way he expected. (The problem was that the variable vowel was defined outside of the function isvowel and therefore had static duration and was only initialized once. Since the variable was modified in the first call to isvowel, and not reset before subsequent calls, only the first call worked properly.) I had just lectured on the topic (storage classes) that was essential to understanding this "bug" and I hoped that a student would solve the problem. Unfortunately, the first two Answers, "Change the declaration" and "This should help," were wrong. At that point I felt compelled to try and straighten things out, and in the third thread (rooted at my Comment "HINT: ...") I tried, unsuccessfully, to lead the students (Socratic style) into solving the problem. The Socratic method failed in this instance and I finally had to simply explain the bug in my Comment "In your code ..." Unfortunately, by this time Gary had already incorporated the bad advice from the second wrong answer; hence, even after fixing the original "bug," his code did not work. His frustration is reflected in his posting in the last thread ("Not for me ..."); we did not piece it all together until we finally met, face-to-face, in my office.
PROBLEMS WITH char STRING CONSTANTS AND "int ch"

Ok, this code doesn’t seem to work properly and I think I know why but someone else give 2 comment why:

#define END_STR ‘\0’
char *vowel = "AEIOUY";
int isvowel ( int ch )
{
  if( isalpha( ch ) )
  {
    ch = toupper( ch );
    while( *vowel != END_STR )
    {
      if( ch == *vowel )
        return TRUE;
      else
        vowel++;
    }
    return FALSE;
  }
}

The problem lies, I believe, with the ch == *vowel, or does it? I have isolated the problem down to this area and I know my driver program is right.

Gary-

[*] change the declaration of ’isvowel’
  [ ] Gary Here...
  [ ] automatic conversion

[*] This should help...
  [ ] Gary here...
  [x] You need to dereference vowel [teacher]

[ ] HINT: what’s the storage class of the variable vowel? [teacher]
  [ ] Gary Again...
  [ ] In your code, vowel defaults to extern storage class! [teacher]
  [ ] Well... [Gary]

[*] while loop is infinite if ch is vowel...
  [ ] Hold on... [Gary]
  [']' yes it will terminate [teacher]

[*] I made a slight change, and it seems to work [teacher]
  [ ] Not for me... [Gary]

Figure 5-13: An On-line Conversation Gone Wrong

In this case, the structured asynchronous medium and the role reversals within it failed. In regard to the immediate request for help, as much damage was done as good. Furthermore, lest other students be led astray, I was forced to re-assert my “heavy presence” and evaluative role by making two postings to debunk the wrong answers: the Disagree in the second thread and the Agree in the fourth. (In the latter case, Gary’s Comment, “Hold on . . .” actually disagreed with the wrong answer enough that I was able to leave my authoritative mark in a positive speech act.)

The students were aware of this problem. Two students mentioned it in the last item of the Fall 95 questionnaire, which simply asked for “Other comments” (original emphasis):
I used two other techniques in my attempt to prevent the On-line Discussion from regressing into an on-line ask-the-teacher forum. These were, an on-line version of my Socratic teaching method and a new top-level speech act, Idea. An example of the on-line Socratic method appeared in the conversation of Figure 5-13 (page 192). In two other instances, however, I deliberately started new conversations by posting top-level Questions that I believed were especially important for the students to ask themselves. This technique was successful: I received a total of 7 student responses to these questions, which, in both cases, explored the issue and resolved it correctly. The Idea speech act was not as successful, however. I originally intended that the students assert or propose design ideas as well as ask questions (I expected them to use the top-level Comment category for this purpose). I was disappointed. In Fall 95, students explicitly tagged 73 top-level postings as Questions versus 5 as Comments. Furthermore, none of the 5 Comments proposed design ideas. In reaction, about mid-way through the Fall semester, I added Idea as a third top-level category. I also broadcast an E-mail message announcing its addition and urging, “If you think of a really cool C programming technique post it as an ‘Idea’ so that others can try it also.” Again I was disappointed. Only one Idea was posted and it was not a design idea but a recommendation of a commercial C software development tool. As Table 5-4 (page 179) reports, there was only 1 conversation for design in Fall 95 and, ironically, this started as a Question.

5.4.5 The Students’ Conception

I explored the students’ conception of this network application using a six item open-ended questionnaire (see Appendix 5.1, page 211), which I administered at the end of the Fall 95 semester. The students responded to the questionnaire after taking their final exam. Participation was voluntary and anonymous, but I gave 5 points extra credit on the exam for completing it; this resulted in a 100% response rate from 133 students.

5.4.5.1 Activities and Participation

The first item of the questionnaire explored the students’ motivation and participation in the network activities. Specifically, it asked how much they used the network and for what purpose. Almost all of the students reported that they did use the network in this course. This nearly universal participation level is especially significant considering that the network activities were not “required” (neither assigned nor
graded) and that all the information and materials needed to "make an A" were dispensed through
traditional channels. In summary, 123 students reported significant use of the net. 7 reported none or very
little use, and 3 did not respond to item 1. Of the 7 non-participants, 5 cited technical access problems
(lack of modem, Internet connection, etc.) as the reason and one added, "I also work full time, so I didn't
have much time to learn how to use the net." Only 1 of these students indicated that the network was not
useful, saying, "No, I never really had any questions that I could talk directly to others in the class about."

I interpreted four major categories of use—different network activities—from the 123 students who
responded that they did use the net (in item 1):

- obtaining course materials;
- receiving announcements;
- checking grades;
- and, participating in the discussions.

The frequency of responses that referred to each of these four categories was roughly equivalent—about 50
for the first three, a little more for the last. Most responses referred to more than one activity.

I classified a response in the material category if the student indicated that he or she used the network to
obtain ("get," "download," etc.) things that are traditionally handed out in class: e.g., assignments, review
sheets, etc. (getting the lab assignments was by far the most frequent case). I included responses within
the announcement category if they referred to receiving or "checking on" more transient information, e.g.,
checking "class status" or "modified assignments." I used a password protected WWW page to post
course grades on the net and many item 1 responses specifically reported checking grades as a separate
category of network use (frequently in addition to "checking announcements"). Finally, I included
responses in the discussion category if they either explicitly mentioned the On-line Discussions or referred
to objects or actions within them; e.g., "I posted one question" or "I watched the lab questions."

---

10 I posted grades by student ID number, not name, and only for students who gave me written permission to do so. Also, I password
protected the grades pages so that only class members could access them.
5.4.5.2 Getting Help: "Askers," "Answerers" and "Lurkers"

<table>
<thead>
<tr>
<th>Participant Type</th>
<th>No. Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active (post &amp; read)</td>
<td>40</td>
</tr>
<tr>
<td>Lurker (read only)</td>
<td>27</td>
</tr>
<tr>
<td>Non-Participant</td>
<td>66</td>
</tr>
<tr>
<td>Total Students</td>
<td>133</td>
</tr>
</tbody>
</table>

In their responses to item 1 of the questionnaire, many students categorized the network primarily as a way "to get" help—particularly on lab assignments. Some actively sought out "personalized" help on specific problems—i.e., asked questions; others "browsed" for "hints" and "ideas." For example (emphasis added):

f95-8: ... I used it whenever I needed help with a program or I missed class. It was a very convenient way of getting personalized help.

f95-22: Yes. Occasionally to check my grades and to receive help on assignments.

f95-40: ... I used it when I was figuring out a problem with a program ...

f95-100: I used it to read the discussion area on the programs to help answer my questions that I had.

f95-101: ... I used it to check my grades and for hints on the programming assignments.

f95-99: Yes. I used the on-line discussion to ask for help, get ideas when stuck on labs, and help others ...

Most of the students sought help through the On-line Discussions mechanism (a more complete breakdown of activities by mechanism appears in Table 5-10, page 198). I interpreted a total of 68 item 1 responses as reporting some kind of participation in the On-line Discussions. The language in 27 of these implied that the respondent only read (did not post to) the discussions—in net parlance this is called "lurking." For example, the following responses suggest that these students saw the discussions as additional instructional material—more information for them to consume, like my lectures (emphasis added):

f95-13: Yes I used it often to check grades and watch the lab discussions.

f95-33: Yes, for downloading the projects and once or twice for looking at the questions being asked.

f95-36: Yes. I used it to get, print, and read the lab assignments. I also browsed the discussion area for help.

Quantitative data gleaned from the recorded discourse and HTTP server logs aligns well with my qualitative analysis. This "hard" data shows that 40 individuals authored the 201 student posting in the
Fall 95 On-line Discussions (vs. 68-27 = 41, from my interpretation of item 1 responses). Table 5-8 combines both data sources to arrive at approximate numbers indicating that about half of all students participated in the On-line Discussions and, of these participants, more than half were active contributors—i.e., posted to the discussions.\footnote{I could not accurately count the "nokers" in the log file data because the HTTP protocol only records the Internet domain name or number (i.e., the machine name) for real accesses and many students used the same machine. Therefore, I derived this number from my interpretation of item 1 responses and approximated the non-participants by simple subtraction from the known total number of students.}

I only found 4 responses to item 1 that explicitly cited "helping others" or "answering questions" as the motivation for using the net (f95-99, quoted above, is an example). Likewise, a qualitative analysis of the verbs that students used in item 1 indicates that they overwhelmingly perceived of the network as a one-way information channel. With roughly a proportion of 9 to 1, item 1 responses used verb phrases that described information and materials flowing to them, rather than from them, through the net. Verbs such as "to get," "check," "download," "watch," etc., typified this consumptive world-view of the net. About 90 responses were of this type; most of the "help-seeking" and "lurking" responses, quoted above, are examples.

This indicates that the students' conscious motivation (at least upon reflection) for participating in the network activities was primarily self-interest. The discourse record from the On-line Discussions provides a somewhat different view, however. In my analysis of the recorded on-line "conversations" (above), I classified 68 student postings as answers to questions and these answers came from 24 different students. So, even if the majority of students described the network as a resource which offered help, many of them were also active in constructing that resource.

Furthermore, the very act of requesting help in the On-line Discussions, in many cases, ultimately provided help for others. Thus students who asked questions were also co-authors (along with those who answered) of new instructional material. The following responses from both item 1 and item 2 (which asked students to compare the three network mechanisms) illustrate this:

\texttt{f95-22 [item 2]:} ... The on-line discussion was definitely helpful. I was able to view and ponder the problems others were having so I could develop a way to avoid these same problems.

\texttt{f95-70 [item 1]:} Yes, I used [the net] on the projects to see if my classmates were having the same problems. I used it whenever we had projects to do.

\texttt{f95-77 [item 1]:} Yup. I used [the net] about 5 times per program to check to see what everyone else's problems were so I wouldn't make the same mistakes.

\texttt{f95-80 [item 2]:} ... The on-line discussion was very useful, because most of the questions I came up with, were already answered here.
f9/88 [item 2]: ... whenever I had a question somebody had usually already asked it [on the "Web" pages] so I could get an answer right away.

![Graph showing distribution of posts and answers](image)

**Figure 5-14: Postings by Active Participant—Fall 95 On-line Discussions**

While nearly one third (40/133) of the students in the Fall 95 semester actively participated in the On-line Discussions, most of the postings were authored by a much smaller group. Figure 5-14 shows the distribution of all postings and those I categorized as answers across the 40 students who were active discussion participants. As this graphic illustrates, the distribution was highly skewed: two small groups of students (6 in each) authored 50% of all postings and 50% of those postings I classified as answers (these two groups overlapped but were not identical).

### 5.4.5.3 Activities and Mechanisms

**Table 5-9: Comparative Utility of the Three Network Mechanisms**

<table>
<thead>
<tr>
<th></th>
<th>E-mail</th>
<th>WWW pages</th>
<th>Discussions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful</td>
<td>77</td>
<td>101</td>
<td>76</td>
</tr>
<tr>
<td>Most Useful</td>
<td>5</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Not Useful</td>
<td>8</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Item 2 of the questionnaire asked students to compare the three network mechanisms used in the Fall 95 class: E-mail, WWW pages, and the On-line Discussions. Table 5-9 summarizes the students' overall
perception of the relative usefulness of these mechanisms. The first row reports the number of responses that included any positive reference to the utility of each mechanism; the second row reports the frequency of responses that emphasized the utility of one mechanism over the others; finally, row three reports the number of negative comments about each mechanism:

For example, I counted the following response in the *Useful* count for the WWW pages and discussions, but not e-mail; I also included it in the *Most Useful* count for the Discussions:

*f95-12:* Really I did not use the e-mail at all, except to receive those messages you sent. The on-line discussion I sort of think as part of the web page. Without these I definitely would have used the Web pages less, and I think of all three it was most helpful.

Likewise, I counted both of the following responses in the *Useful* category for the WWW pages (student 3 does not mention the other two); I included student 3's response in the *Most Useful* count for the WWW pages (student 5 does not emphasize any of the three); and, I included student 5's response in the *Not Useful* count for e-mail:

*f95-3:* The Web pages were by far the most useful.

*f95-5:* Only the web pages were used (see #1). Most e-mail was not pertinent and I never read the discussions.

Again, these numbers derive from my qualitative interpretation of each response to item 2—they are approximations. I feel confident with two conclusions from Table 5-9, however: first, the students, as a whole, perceived all three mechanisms as useful; second, a small plurality of students considered the WWW pages the most useful of all. With some caution, I also conclude that the discussions were of greater utility (especially to that cadre of students who participated in them actively) than e-mail. I will strengthen this position below.

<table>
<thead>
<tr>
<th>Table 5-10: Types of Use by Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Grades</td>
</tr>
<tr>
<td>Announce</td>
</tr>
<tr>
<td>Help</td>
</tr>
</tbody>
</table>

I could probably have obtained the above results with a forced-choice questionnaire (and with much less analysis effort!). The reward of using an open-ended questionnaire and qualitative analysis, however, is an additional richness of information. For example, with a more detailed analysis of these responses (combined with those to item 1) I could classify the general categories of use that the students assigned to each mechanism. This result is summarized in Table 5-10. Each cell in this table reports the number of
students who attributed each of the four uses (the four activities identified in item 1 responses: obtaining materials, checking grades, receiving announcements, and getting help) to each of the three mechanisms.

This table helps explain the greater utility of the WW pages (see Table 5-9)—that mechanism had the greatest variety of uses. I posted both course materials and grades there, as well as, duplicating my E-mail and in-class announcements. A more interesting (and, to me, encouraging) result, in light of my second-level goals, is that the students preferred the On-line Discussions over e-mail for obtaining help. I'm sure that this is partly an artifact of my deliberate effort to move Q/A conversations from e-mail to this more public forum. Nonetheless, as the quotes from item 1 and 2 responses (offered in the preceding section) illustrate, many students also realized the value added by the discussions: Questions and Answers were persistent over time and available to the whole class.

In addition to these positive responses about the On-line Discussions several students reacted negatively, in varying degree, to e-mail. The following 4 are examples of the 8 negative e-mail responses I reported above:

f95-23: E-mail was useless. The discussion was useful, as was the web pages.

f95-66: ... E-mail was helpful, but I got a bit much.

f95-78: E-mail: I use it tremendously. I didn't really use it specifically for this class much and the mailings were annoying. All the information was available via WWW or newsgroups {On-line Discussions} ... 

f95-104: The web pages and on-line discussion was great. E-mail messages could have been posted on Web.

These responses expressed an aversion to receiving e-mail. But several students were also selective about sending it; they viewed e-mail as a backup for other mechanisms—a "last resort." (I did not count the following examples among the negative e-mail responses.)

f95-58: On line discussion was a necessity. If I didn't get a reply i would e-mail [the] professor.

f95-73: I found the web pages the most helpful and some of the on-line discussion very useful. If the pages didn't exist I would have had to use e-mail more often.

f95-81: I used the pages to check the assignment in case anything had changed, the discussion for help with my program, and e-mail as a last resort.

To represent both sides fairly, I present all 3 of the negative On-line Discussion responses here also:

f95-46 ... On-line Discussion—Dominated by esoteric chit chat.

f95-63: ... the on-line discussion could use some work.

f95-68: ... The discussions provided useful ideas, but I found that few, or none of my questions were answered.
5.4.5.4 Convenience, Efficiency and Empowerment

Table 5-11: Student Preference for Face-to-Face vs. Network-mediated Communication.

<table>
<thead>
<tr>
<th></th>
<th>Face-to-Face</th>
<th>Network</th>
<th>No Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21</td>
<td>66</td>
<td>46</td>
</tr>
</tbody>
</table>

In the third item of the Fall 95 questionnaire, I asked the students how they liked communicating (with their classmates and the instructor) via the network versus the traditional face-to-face medium. I produced a quantitative summary of the students’ preference by coding each response as either not expressing a clear preference or clearly preferring one over the other. This course grain result appears in Table 5-11:

This table indicates that most of the students were comfortable with the network as a communication medium. In addition, I found that many of those who clearly preferred face-to-face, qualified their response, pointing out special cases where the network was a useful complement. As one such respondent put it, “the Web is better than not communicating” (and the latter was a real possibility with only fifty minutes a week in class).

The most commonly cited benefit of the network, relative to face-to-face, was “convenience”—I classified more than 50 responses in category. For example:

957: It was excellent, I could use it at 4 a.m. in my sweats.

9574: I like the net. It was convenient and easy to use.

9577: Web is good because it’s convenient. I emailed you once too. Better than hoofing up 6 flights of stairs.

Many of responses revealed more about the students’ conception of network “convenience,” however. For example, roughly 15 responses referred specifically to the time efficiency or time extension (extended class and office hours) offered by the net:

952: [Net is] much better. Saved time.

9515: I think either was fine, although taking time out to go see classmates or the instructor is less efficient.

9576: Since this was only a once-a-week class, being able to communicate through the net was of great use.

The notion of time and distance efficiency gain is precisely what Sproull and Keisler [Sproull and Keisler 91] defined as first-level effects of the network medium. They further argue that this kind of benefit is foremost in the mind of technology adopters when they implement network applications. I also discerned a second-level (social system) effect within many of these “convenience” responses, however. As I have said, I hoped the net would alter the students’ role within this class—give them an authorial role
regarding the class’s instructional materials. In interpreting the responses to this questionnaire item, however, it occurred to me that the network mechanisms also empowered the students to “author” the class’s time and space structure—they were no longer bound solely to the university dictated class times and instructor defined office hours. Making the net an extension of class time and space, actually empowered the students to decide, to a greater extent, when and where these activities occurred. While the students did not articulate this in the language I use here. I found evidence for a sense of empowerment in many responses (emphasis added):

95-22: ... there was no time restriction of having to make an appointment to talk to the instructor.

95-39: ... you can ask questions when you have them, instead of having to wait for office hours.

95-59: It was extremely beneficial as a way to attend class “on my own time.”

95-83: Communicating through the net was faster and didn’t need any appointments.

95-105: Through the net, you can talk or your own time. This is convenient.

5.4.5.5 A Substitute for Class?

A few students took these convenience and empowerment categories to their logical limit, suggesting that the network space could completely replace the institutionally defined face-to-face classroom:

95-5: This makes it possible to have a truly self-study course. I neither purchased the book, nor attended class but will still get an 'A'.

95-104: I liked the net. Put class notes on the web and I would only use the web and not come to class.

95-24: ... One benefit [of the net] was being able to keep up with the class (in terms of homework) without going.

These comments were a very small minority, overall, and about as many item 3 responses specifically emphasized the opposite: that the network should not replace direct inter-personal contact (perhaps some of these students feared this possibility):

95-25: I felt like it was easier for many to communicate through the net but [it] should not be used exclusively or over emphasized.

95-40: ... I don’t think the Web page replaces going to class, it wasn’t intended for that use.

95-44: Web can be accessed any time, but [you] need face-to-face for people who do not have easy access to Internet.

95-63: It was easier to communicate over email but it should not be a replacement for office hours.

In addition, a large number of responses (including most of those I coded No Preference in Table 5-11, page 200) saw the two media either as complementary or as a cost/benefit tradeoff.
5.4.5.6 *Expressiveness and Delay*

Among those item 3 responses that cited downsides for network-mediated communication, two major categories emerged: expressiveness and delay. Among these responses, about 20 distinguished between two levels of communication needs. This dichotomy was frequently framed as "simple" vs. "serious" problems—the former being amenable to resolution through the net, the latter requiring the more expressive face-to-face medium. For these students the net was a useful complement to traditional communication channels. For example (emphasis added):

795-31: Office hours helped more than the web. The web helped in *simple questions* about the assignments but office hours were better for *wide questions*.

795-62: Communicating through the web was useful if I had lots of time. or just need[ed] *basic help*. Anything in depth, or requiring discussion was easier face-to-face.

795-71: I prefer using the net sometimes for *simple problems*. It's quick and easy. For *more serious problems* however speaking with the instructor is best. And getting together with classmates to discuss problems is always the best way to get work done!

Likewise, many students (about 10) reported the inherent delay in receiving responses to questions as a downside for the net. Again, many of these responses viewed this as a tradeoff with the increased "convenience" the net offered (emphasis added):

795-39: The net is a lot slower, but you can ask questions when you have them instead of having to wait for office hours.

795-45: I didn't *use the net* but I wouldn't want to because of the time *lapse* between Q & A. I could lose my train of thought.

795-92: Web is great *unless* I *need help* immediately.

5.4.5.7 *Inhibition and the "Group Mind"*

In their questionnaire responses, most students contrasted the network and face-to-face media using first-level categories (this was also true of their responses concerning the three network mechanisms). In particular, convenience and delay are grounded in notions of time and space efficiency. On the other hand, expressiveness begins to transcend efficiency, becoming a concern of effectiveness—conversations about complex problems were not only less convenient, they were sometimes unsuccessful through the network (see Figure 5-13: An On-line Conversation Gone Wrong, page 192). In sum, many students saw the network as a convenient but impoverished medium—a trade-off.

These results are important for my first-level pedagogical goals. My deeper interest, however, was in the network’s social effects. Evidence for social effects did appear directly in the students’ responses. More than 20 responses to item 3 mentioned changes in inhibition—willingness to ask or answer questions—or
changes in the scope of communication—the creation of a “group mind.” First, in contrast to the expressiveness problem (the difficulty of discussing “serious problems” through the net) many students found network communication “easier,” in a social psychological sense:

\[12\] This term actually appeared in an item 1 response: (emphasis added):

f95-12: Personally I enjoyed talking on the net more than in class because I’m not a very talkative person. ...

f95-13: I liked it better because it relieves embarrassment about asking a dumb question.

f95-52: It’s easier to ask questions over the net ... cause all they know is your PID not your face.

f95-54: ... it’s much easier to post a problem on the net than to approach a stranger and ask for help.

f95-93: I think it is easier through the net—I’m not as shy—more apt to ask questions.

f95-22: ... Another benefit is that even though you don’t know your classmates, they offer help as if you knew them. Most people feel reluctant to help people they don’t know when they are face-to-face with them.

While I interpreted 11 responses like these (as saying that the network reduced inhibition), I also found 2 that actually reported increased inhibition in the on-line medium:

f95-50: I felt intimidated when I posted on the web. Like in-class discussion much more.

f95-126: ... I tend to be a little more reluctant to send questions to the whole class than to just a few people, of course.

In the second of these quotes, the student’s awareness is a greatly expanded audience seems more salient than the detachment from direct interpersonal contact that the net offered. This increased scope of audience was meaningful to many students, based on their item 3 responses. Sproull and Keisler cite this potential of the network—to facilitate many-to-many vs. one-to-one interaction—as perhaps its most important second-level effect. These researchers focused primarily on e-mail, however, citing anecdotes of workers putting questions to the collective mind of an entire organization (which is physically distributed, perhaps even globally) through mass e-mailing. The On-line Discussions offered this same power to put a question to the “group mind” but, in addition, because these conversations were persistent, public and structured they were available as a resource (instructional material) to all—even “lurkers” who never posted a question. The students were aware of this—both the lurkers themselves, and the authors of the new material (original emphasis):

f95-25: ... It’s good because many more people get exposed to your questions. ...

f95-30: I never actually posted anything myself, but I like being able to see what other people were having trouble with and what they thought about the lab.

f95-56: I like the idea of communicating through the net because everyone can see what questions people have.
5.4.5.8 Teamwork without Cheating: Learning in World 2.5

Table 5-12: Student Perception of Problems with Privacy, Fairness, or Honor

<table>
<thead>
<tr>
<th>None</th>
<th>Some</th>
<th>Ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

In item 5 of the Fall 95 questionnaire, I asked the students, “Did you see any problems with privacy, fairness, or the VA Tech Honor Code, etc.?” The response was a nearly unanimous “No” (several responses emphasized that the class was especially fair and that privacy had been well attended to, but most were without elaboration). Table 5-12 presents a quantitative summary of these responses. Among the 30 or so responses that did elaborate, some interesting categories emerged. Foremost, there was clearly a tension among these students between the benefits of working as a “team” and the risk of violating the Virginia Tech Honor Code—i.e., “cheating.”

Overall, there were very few questionnaire responses that provided evidence for the most profound second-level effect of network-mediated communication: a sense of community. The “group mind” response (see the previous section) is one instance; the following response to item 5 is another:

“I thought it made the class more like a team.

These responses (and the many to earlier items that cited benefits of persistent, many-to-many communication) reflect a step towards a different model of pedagogy: from learning as a process in which individuals apprehend knowledge to learning as the social construction of objectified knowledge—i.e., learning situated in World 3. (See the discussion of CSILE and Popper’s three world model in chapter 1, *Educational CMC: Social Knowledge Construction—Learning in World 3*)

The On-line Discussions, likewise, “socialized” the learning process within my class. But, situated within the World 2 culture of the Computer Science department and the University at large, this was confusing—even frightening—for some students. Virginia Tech has a University wide “Honor Code” (and associated court system) that emphasizes the sanctity of “original work” and “expressly forbids” both “cheating” (“...
giving or receiving ... unauthorized aid ...”) and “Plagiarism” (“... copying of the language, structure, ideas and/or thoughts of another ...”) [VA Tech 96]. The Computer Science department adds “departmental policy” to this code. Published as a “Survival Guide” for undergraduates, this policy even more explicitly stresses the value and evaluation of individual work. Using language of pedagogical utility, rather than morality, it states (emphasis added):

The main purpose for these guidelines and rules goes far beyond the principles of right and wrong. Doing your own work ...

[will] greatly ease the stress of developing much larger programs ... in the working world, where your individual performance will be crucial to your success. [VA Tech CS 96]

As Table 5-12 indicates, most of the students had neither moral nor pedagogical problems with the way the network was applied in this class. A few were concerned, however, about the two essential products of student work in any programming class: output and code. For example, in Fall 95 some students began to post their lab output in the On-line Discussions. (This occurred very soon after I made each assignment—they were probably proud of how quickly they solved the problem.) Typically, the first student would post his or her output and call for confirmation of its correctness: others would then respond (Agree, Disagree, etc.) and, sometimes, post their own output as an alternative. (I categorized these as “conversations for consensus” in Table 5-4, page 179.) In the item 5 responses, two students reported cases of colleagues falsifying their output—presumably taking it from these on-line conversations. For example:

95-31: I’ve heard that people got away with altering output on programs (i.e.: they got 100%). This is unfair as I have turned in appropriate results regardless of correctness. Mine were honest.

Likewise, many students included code (C programming languages statements) in their discussion postings. In the instructions I supplied for the On-line Discussions (themselves, on-line), I explicitly asked students, “not [to] include large sections of code that can be used directly in a solution to the assignment.” In my perception, the students were quite good at creating code fragments that expressed the relevant programming ideas without breaking this rule. Two students saw this differently, however:

95-11: No [I didn’t see any problems], every now and then, though, I thought too much code was displayed.

95-43: No [I didn’t see any problems], except some kid posted half his program once.

These two responses are ambivalent: No, they didn’t see a problem but, yes, sharing code and output is taboo (isn’t it?). The following responses reflect a deeper sense of moral confusion over this issue—Is working in World 3 cheating?:

95-40: No problems ... Examples of what could be posted w/out an honor code violation would be a good idea in the future. I think people were frightened by the possibility.

95-92: According to honor code, I exclude myself from human contact during all assignments. [But,] students should be allowed to “discuss.”

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95-132: I would have to think longer about this. Some people post their solutions (output), I don’t know if that should be allowed (but what’s wrong with it?).

On the other hand, for several students, it was the medium itself (asynchronous structured discourse) that resolved this dilemma. The public nature of the on-line conversations (the persistence of “utterances” and the explicit identification of their authors) legitimized discussion—transformed cheating into helping:

95-59: No, the [on-line] discussion seems to be a good way to promote discussion without cheating.

95-95: None at all. On the contrary I felt this medium encouraged cooperation within the limits of the honor code—it made a helping hint accessible ... I adamantly believe this idea strengthens the learning experience.

95-128: No, everyone discussed their programs without violating the VT Honor Code. No code was put on-line by people.

95-111: It’s fair that people are allowed to help out each other, and not have to cheat about it.

Another student (responding to my call for general comments in item 6) expressed my own stand perfectly—a stand which turns upside-down the CS department’s utilitarian justification for requiring individual work:

95-96: In the real world, programming is a group project, in school this is not as feasible, but sharing of info, code, problems, solutions, etc... should be encouraged. I feel all the on-line support was a very good idea.

5.4.5.9 Discourse Structure: Argument or Q/A?

Table 5-13: Student Perception of the On-line Discussion Discourse Structure

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>8</td>
<td>38</td>
</tr>
</tbody>
</table>

In item 4 of the questionnaire, I asked students how they liked the “structure” of the On-line Discussions, specifically, “the categories Question, Answer, Agree, Disagree, etc.” As shown in Figure 5-5, page 174, most of the responses were positive, saying, “The Structure was very good!” (95-10), or “They were good categories.” (95-49). Among the positive responses that offered more detail, many said that the structure added organization (16 responses) or ease of use (13). Among the neutral responses, 15 reported that they did not use the discussions; the rest were either ambivalent or responded to aspects other than structure—e.g., “The structure was fine, not really good, not really bad” (95-16) or “It gave an opportunity to express opinions” (95-22).

The speech act categories Agree and Disagree were the most frequently mentioned specifics (9 responses). Recall from the discussion of IBIS/APIS in chapter 2 that the rationale for the discourse structure in this model (on which WIT and the asynchronous structured discourse mechanisms used in this research are based) was to achieve a thorough exploration of issues through a “deliberate search for controversy”
While a few students did credit the discourse structure for promoting thorough discussion, these were inconsistent regarding the value of the Agree/Disagree categories:

f95-44: [The structure] was good—that way you could cover all aspects of a question if need be. Don't need agree or disagree.

f95-65: They [the categories in general] were useful for getting different points of view to a question problem solution.

f95-100: The structure was good. It made [it] easy... to see different people's solutions, and if they agreed with one another.

In addition, several responses either explicitly or implicitly discounted the value of these argumentative speech acts:

f95-40: Thought it was fine. However, Agree and Disagree are awfully strong words to use to "reply" to someone's comments.

f95-57: I thought the structure was fine although agree, disagree, seemed unused.

f95-99: I thought they were sufficient. Agree and disagree I didn't find all that useful.

Table 5-14: Responses to non-Question Postings by Speech Act Type

<table>
<thead>
<tr>
<th>Speech Act</th>
<th>Students</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Disagree</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Comment</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Question</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 5-14 shows that the students did use these speech acts in the Fall 95 On-line Discussions. When responding to postings other than Questions (recall that the structure did not allow Agree Disagree in response to Questions), students chose the argumentative speech acts over the two alternatives more than half the time.

Nonetheless, the discourse record indicates that some students might have been reluctant to post these "harsh" speech acts—particularly Disagree. Of the 19 responses that students tagged as Comments, 8 of them actually rejected answers posted by others—i.e., they disagreed with the answer. (A single student posted 6 of these; two individuals posted the others) As the table also indicates, I preferred positive responses to an even greater degree, posting 3 times as many Agree's as Disagree's. Furthermore, the overall low frequency of postings at this deeper level in the discussion tree (only 55 of the 201 total student postings) is disappointing.
As I discussed in the section above, many students seemed to view the "discussions" simply as Q/A, not a forum for exploring issues. The following item four responses reflect a minority attitude that I observed in all three case studies of structured asynchronous discourse (see also, Chapters 2 and 3)—that there was too much structure (emphasis added):

95-3: I think that maybe they were too structured. A simple "Reply" would be better. ...

95-29: This [the structure] could be narrowed down because I think the time it takes to see which is which is not really necessary. How about Q.A. comment.

95-62: I like it, however, a news group might have been better (easier to search, faster). I think the only really useful buttons were question and answer.

The universally available (at all points in the discussion) neutral Comment speech act provided flexibility within the discourse structure. This neutral act facilitated unanticipated speech events; e.g., several students used this type to make requests for action or post proposals and, in several instances, to correct or add to their own, prior postings. Likewise, I used the Comment type to circumvent an unanticipated restriction in the discourse structure: it did not allow me to post a Question in response to a student’s Question. Hence, in one case where I wanted to respond to a question with my own leading question (Socratic style; see Figure 5-13, page 192, my posting titled, "HINT: ..."). I had to tag my question as a Comment. In 6 instances, however, students selected the neutral Comment in preference to the more authoritative Answer speech act, when responding to Questions. The phrasing of these neutral “answers” reflected this apparent reluctance to assume authority—most were either qualified with uncertainty (“I don’t know if this will help you ...”) or as the author’s “personal” opinion.

5.5 Summary and Discussion

5.5.1 Asynchronous Structured Discourse in Education

The distinction between first and second-level effects of the network application was a primary interest in this case study, particularly, in relation to the three mechanisms: WWW pages, E-mail, and asynchronous structured discourse. The application supported my pedagogical goals at both levels: making more efficient use of time and space and, changing the social structure of my classroom. The WWW pages and E-mail contributed mostly at the first-level (efficiently distributing course materials, grades and announcements). The On-line Discussions were effective for changing the students’ roles, particularly, in promoting (legitimizing) learning through the social construction of knowledge. The discussion also cast many students in an authorial (rather than consumptive role), reduced my “heavy presence” in that role, and, simultaneously, introduced writing (for a “real audience”) as part of programming instruction. It is important to add that the application was able to add writing to the curriculum transparently: Students
engaged in this additional task voluntarily and without complaint (without notice), even though documentation (and writing in general) is typically an abhorrent task for programmers, particularly young students of this practice.

Although I purposefully designed the application to be marginal in this class (I did not want it to be an additional requirement), nearly all of the students made use of one or more components. In the On-line Discussions, nearly a third of the students participated actively (posted), although a small group accounted for most of the postings and about half the class did not use the discussions at all (neither read nor posted). The students were comfortable with CMC. Although a minority expressed a preference for the face-to-face medium in general, even these students cited specific benefits for the network in this class. While students mostly lauded CMC's first-level effects (e.g., the "convenience" of asynchrony), I also found evidence that asynchrony empowered the students to construct their own class time and space (contributing to their authorial role). Furthermore, many students valued the persistence that the application added to discourse and cited a decrease in inhibition in this medium, which increased participation. On the other hand, equally many distinguished between simple and complex discourse, saying that the network was deficient for the latter, and that delay was at times problematic. In sum, the network application was a good addition to face-to-face but very few students viewed it as a viable replacement for class time.

I originally intended the On-line Discussions to be a forum for exploring design ideas; the students rarely engaged in this conversation type, however. There were a few instances of argumentative exploration (in accordance with the WIT/IBIS model), but the most frequent use was question and answer. The explicit speech acts, reaffirmed in the system design, were not enough to produce the type of discourse I desired. In particular, the top-level Comment and Idea speech acts (which I specifically added to encourage assertion of design ideas that would be amenable to dispute) were not effective. I took action (within the network medium) to combat the students' predisposition to using the discussions merely to ask the teacher questions. For example, I purposefully held back in answering questions in order to allow students to assume this authoritative role. This was problematic because students sometimes provided incorrect answers and because requests for information were sometimes left unanswered. As the official authority (the teacher-grades-student power relationship remained) I was obliged to assert my presence in the On-line Discussions more than I wished.

Overall, the students liked the structure of the On-line Discussions. Many reported that the explicit speech act categories made the discussions more organized or easy to use. I was disappointed at the dearth of nested, argumentative discussion, however. There was evidence that some students were hesitant to use the "harsh" Disagree speech act (particularly in response to the teacher's postings). A very
few students did complain of too much structure, saying that only questions and answers were useful. The availability of the neutral Comment facilitated speech acts that were not anticipated in design. The students also used this act to soften the authority of their responses, however, at times selecting it over Answer or Disagree.

This case study demonstrated that asynchronous structured discourse applications can be a useful tool in transforming pedagogy from a process based on individual learning (World 2) to a social process of external knowledge construction (World 3). The students were aware that the "help" seeking/giving discourse preserved in the On-line Discussions was useful even beyond the immediate participants in individual conversations. I concede that they were motivated more by enlightened self-interest (they wanted to improve their own grade—helping others was a nice side effect) than true community (working for an external public good; see [Bellah, et al. 85] for a definition of community in this strong sense). Nonetheless, many students did conceptualize the discourse as a public good, which they helped produce.

and, in fewer cases, that the learning process itself had changed to "team work" and created a collective "group mind." These are surely second-level effects conducive to the World 3 ideal. Unfortunately, there was some sense of ethical confusion about this: on the one hand, World 3 was a better paradigm for learning; on the other, making "code" and "output" a shared object is traditionally taboo in the World 2 of Computer Science education. One of the most gratifying results was that some students explicitly credited the On-line Discussions for helping them walk the line between World 3 and "cheating."
Appendix 5-1: Fall 95 Questionnaire

CS 2304 Network Use — Student Response Form

Please tell me what you think about the use of e-mail, Web pages, and the On-line Discussions in this course. Say anything you want in addition to these questions (use the back, if needed).

- This survey is anonymous and optional but you will receive 5 points extra credit on the exam.
- Do not put your name on this sheet; Show me you did it when you turn in your exam.

1. Did you use the network in this class? How often and what did you use it for? If you didn’t use it, why not?

2. How did your use of e-mail, the Web pages, and the On-line Discussions compare to each other? For example, did you find one of these more useful than the others? Were they useful for different things?

3. How did you like communicating through the net vs. communicating with classmates and the instructor face-to-face (e.g., in class, the lab, office hours, etc.)? Were there problems or benefits either way?

4. What did you think of the structure of the On-line Discussion? Specifically, how did you like the categories assigned to postings: Question, Answer, Agree, Disagree, etc.?

5. Did you see any problems with privacy, fairness, the VA Tech Honor Code, etc.?

6. Other comments? [use the back, if needed]
6. CONCLUSIONS

At the outset of this research I planned to demonstrate the utility of ethnographic study for both design and research. The preceding chapters largely fulfill this goal. First, they show the utility of an ethnographic research approach; how this can produce rich understanding and description of both the design process and the use of applications. Second, these studies show how ethnographic methods can work within and enhance the collaborative design process itself. This concluding chapter integrates and generalizes the results from the case studies within the framework of the arguments I presented at the start of chapter 1. I first address my argument regarding the utility and methods of collaborative design. Next, I address my arguments about the effective use of asynchronous structured discourse (ASD) in education. Finally, I offer specific recommendations for both the design and the use of these applications. There, I also describe a generalized methodology for ethnography-based collaborative design.

6.1 Collaborative Design

In case studies 1, 2 and 3, I designed network-based applications collaboratively with practicing educators. All of these collaborative processes were successful—each produced a working application, which fulfilled the educators’ goals. In all cases, I found the system/activity distinction to be useful, in particular, including activities as first-class objects of design and using scenarios as activity representations proved effective. Furthermore, in the two public school projects, I demonstrated that a technologist and non-professional designers (public school teachers) can communicate and design effectively in direct collaboration. Nonetheless, these latter cases also demonstrated a power asymmetry between the technologist and practitioners in collaborative design.

6.1.1 Activities and Systems as the Objects of Design

In the three collaborative design case studies, I found that it was important to conceptualize the object of design as an application consisting of both an activity and a system. First, producing an effective design requires consideration of the broad activity context not just the technological system or even the more narrow activities ("tasks") directly associated with it. For example, in the Multimedia Magazine case, a difficult design problem involved coordinating the Data Gathering activity with a separate component of the educators’ curriculum—the students’ individual I Search projects. In this project, our focus on the activity of use within its specific organizational context also revealed the constraint of an entire school sharing only a few phone lines, which had direct impact on how we could use the available technology. Taking this broader approach to design, which casts the computer system as just one (albeit very significant) part of a larger design context, improves the chances that designers will attend to these
indirect but crucial factors. Likewise, activity goals (in these cases, pedagogical goals) often directly determine aspects of system design. For example, in the On-line Debates, the distinction between initial and new positions (which originated in the educator’s pedagogical categories of analysis and synthesis) emerged during our collaborative design of the activity sequence. (I later reified this distinction in the system itself as separate speech acts.)

Second, analyzing the relationship between activity and system will help designers and researchers understand and manage collaborative design processes at a broader scope. In all three case studies, design originated in pedagogical activities conceived by the educator, which were more or less well defined before my arrival. The relationship between the core network technology, system design, and these seminal activities, differed greatly, however. In the On-line Debates, design was largely a transposition of an existing face-to-face activity onto a given system design (WIT). The other two processes were much more complex. In the high school Issues On-line case, the original activity (peer-review) was significantly transformed through playful exploration of the network technology and, to a large extent, the influence of the On-line Debates application. In this case, the network technology, independent of the pedagogical activity, often became the primary focus of design conversation—our goal was developing an activity for this basic technology. In the middle school Multimedia Magazine case, on the other hand, we injected the network into a preconceived activity. Still, two significant activity changes did result from this: first, the participants’ roles changed—the students did not author the multimedia presentation; second, the medium for the final magazine became public—the Internet. In this case, technology, independent of the application, rarely became our focus (except when we had problems using it)—for these educators, technology was not “play.” At the beginning of this project, the goal was finding a place for the technology within the given activity; later, it was strictly “system” implementation, of a sort—designing and creating the WWW pages for the final magazine. The activity/system distinction gives designers a vocabulary and conceptual model that they can use to analyze the complex interplay between technological and contextual factors within the design process.

Third, the application concept integrates the educator’s world (pedagogical activities) with that of the technologist (computer systems) forming an object for collaborative design that casts both parties as design experts. This new object of design also calls for new representations and methods, however. Scenarios provide a natural activity representation that complements traditional system representations. Because they provide a concrete, inspectable, and traceable record of activity design, scenarios may help legitimize activity as a first-class design object for traditional systems-oriented designers. Moving design inquiry and representation into this broader domain, however, requires new methods of analysis by which technologists can understand the full context of activities—as I have demonstrated, the ethnographic
method of identifying member categories is useful here. Likewise, by grounding new technologies within concrete activities, scenarios provide an effective starting point for practitioners to learn about these technologies. Hence, the scenario-based collaborative design method I employed (see the schematic description on page 226, below) is a process mutual learning or mutual ethnographic inquiry: both technologists and practitioners become participant-observers in each others' worlds. Nonetheless, we must be careful not to take this activity/system model and its implied symmetry too literally (see my conclusions about design power asymmetry on page 218).

6.1.2 Scenarios as Design Representations

In all three cases, I found narrative, textual scenarios to be useful activity representations for collaborative design. Unlike some other participatory design research that employs these representations (e.g., [Muller et al. 95][Kyng 95]), my collaborators did not participate in writing the scenarios: rather, I authored all the scenarios in these projects. While ostensibly less participatory, the public school teachers I worked with would not have been eager to produce these written representations. Furthermore, we did use these in a collaborative process—as props for design conversation. I found these representations useful at several levels. First, the individual act of putting my envisionment into this concrete narrative form forced me to think through the activity sequences more carefully, often revealing gaps in my own understanding. Second, walking through these representations was an effective way to check for discrepancies between my vision and that of my collaborators. Third, the walk-throughs stimulated new design ideas (both system and activity) and revealed contextual constraints that were previously unknown or tacit. Finally, these representations were effective as an initial envisionment of technology within the context of concrete activities, which served as the beginning of a mutual learning process.

This last point bears elaboration. As I described in the Scenario Representations section of chapter 1, Kyng [Kyng 95] emphasizes that textual representations are not adequate to fully envision future technology use; rather, this requires hands-on experience with system mock-ups in the context of real practice. Elsewhere [Kyng 88], this researcher describes poor results using scenarios to convey envisioned design to end-users: they just read them and agreed. This was not my experience. In all instances within my case studies, the process of walking through a scenario produced some useful discussion and inquiry (although not always as much as I hoped). Furthermore, in these cases, much of the activity design represented in the scenarios did not involve direct interaction with a system (e.g., most of the On-line Debates Activity Scenario, Figure 2-7 (chapter 2), and the envisionment of scheduling multiple groups and classes in the Multimedia Magazine Data Gathering Scenario, Figure 4-7 (chapter 4)). Therefore, these aspects of design were not amenable to Kyng's prototype centered approach. Nonetheless, my
experience with the technology portion of the Data Gathering scenario clearly supports Kyng’s philosophy: it made the various network software components appear much easier to deal with than they were in practice; as we quickly discovered with hands-on experience. I don’t conclude from this that the scenario was misleading or useless, rather, that it was an effective beginning to an envisionment and inquiry process—a design hypothesis, not a design specification.

My informal method of using scenarios also failed to anticipate some important results in use—perhaps most importantly, the flaming in Issues On-line. Carroll and Rosson describe a more formal approach to scenario analysis based on identifying features of an artifact (system) or technique (activity) design and then envisioning the likely desirable and undesirable psychological consequences of each feature [Carroll and Rosson 92]. It would have been difficult to engage my collaborators in the type of formal analysis they describe; however, a less formal (conversational) but deliberate version, which extended consequences into the social domain and used the various features of CMC (asynchrony, plain text, etc.) as a guide, might have prompted us to better anticipate some outcomes.

6.1.2.1 Props and Referents in Design Conversation

I also found a relationship between the different types of representations I used as conversational props and the referent of these design conversations. First, scenarios provided a natural representation for most aspects of activity design: the sequencing of student actions, the scheduling of sub or competing activities, the context of pedagogical goals and student motivation, etc. On the other hand, when design conversation turned to aspects of structure or presentation, representations such as mock-ups and diagrams provided better support. Conversely, I found that the type of representation I employed as a conversational prop, influenced the referent of design conversation: scenarios kept the conversation in the activity domain (or at least focused on the application at hand), while mock-ups and prototypes led to discussion of system structure and presentation (as well as core technology, apart from any application).

These finding have implications for collaborative design in general. First, they suggest that narrative scenarios will be most effective when combined with mock-ups and drawings, as well as more abstract structural representations. Muller and his colleagues have indeed employed a similar combination of representations in participatory design, which they call “Bifocal Tools” [Muller et al. 95]. This combination consists of, on the one hand, a sequence of pictorial/textual cards and, on the other, “low-tech” representations of user interface components. While they distinguish these as macroscopic versus

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1 These are primarily system aspects, although structural concerns also appeared in the activity domain: e.g., the division of students into groups in the Multi-media Magazine project.
microscopic views on user activity, the differences between these representations also fit my activity versus structure and presentation distinction. Second, my finding that the representation type influences the referent of design conversation (in particular, activity versus technology) suggests that the designers who create the design representations will have more power over the design process. Although not fully aware of this result at the time, I exploited this phenomenon in the Issues On-line project. Here, I found Allen’s enthusiasm for exploring technological details problematic at times. In response, I intentionally based some design conversations on scenario representations (rather than a running system or mock-up) hoping to keep our focus on the activity. This result provides a useful tool for managing the collaborative design process. Nonetheless, designers (especially technologists who create the design representations alone, as I did) should be aware of this power asymmetry when they mean to engage in “collaborative” design.

6.1.3 Direct Collaboration between Educators and Technologists

I found evidence in these case studies that educators and technologists can and should work together directly in the design of network applications. This contrasts with Williams’ participatory design method that employs “translators” to “bridge the inter-occupational communication gap” between teachers and technologists [Williams 94]. Translators are special people who understand the language of both worlds (technology and education) and can make the ideas and concerns of the members of one side understandable to the members of the other. In fact, Williams presents translation as the preferable design situation, even speculating that by studying what translators do, we may learn how to manage less fortunate situations where translators are not available. My view is the inverse. While a translator may be a pragmatic necessity in some cases (e.g., if time constraints or the personalities of the individuals involved preclude educators and technologists learning each others’ world first-hand), direct communication in design is preferable to mediation through a translator.

First, through extended direct engagement in the design process, technologists and educators will achieve a much better understanding of the key categories of each others’ world. A particularly good example of this was the “Grand Vision” design session in the Issues On-line case study. Here, as Allen Browne sketched out a system design for his original network vision (partially conceived before my arrival), he also copiously articulated many aspects of his pedagogical philosophy, which remained relevant even as the application design changed. Also, by working (on design) within the educators’ environment, regularly and over a long period, I came to understand the extremely structured, scrutinized and hectic work environment of public school teachers in a way that second-hand reports could not adequately convey. Likewise, by working directly with the network technology and me, the middle school teachers in
the Multimedia Magazine project obtained a much deeper understanding of the possibilities (and frustrations) offered by network technology.

I also found support for the common claim of participatory design advocates that, through direct participation in design, practitioners acquire a greater sense of ownership for the application. In both of the public school projects, however, I found that the educators' ownership increased greatly once they were able to work directly with the real network materials (and, thus to shape the system implementation themselves) versus the more immediately accessible yet artificial materials of design representation. This result contrasts with the PICTIVE participatory design philosophy [Muller, et al. 95], which emphasizes the use of "low tech" design materials, specifically because these are not part of either parties' "home language" (particularly, that of the technologist [Muller 91b]). These researchers believe that "problematizing the familiar" in this way makes design issues more open to discussion. Likewise, my finding departs from design methods that recommend mock-ups constructed from materials that are already "familiar" to the practitioners (vs. implementation materials) [Kyng 88].

While I believe that low-tech design approaches are useful (and, indeed, did use many low-tech representations myself), my present experience shows that practitioner competence with realistic implementation materials also has significant benefit. Not all design circumstances allow this, however. In my case studies, the network technologies (e.g., HTML, FTP, SLIP, etc.) were high-level enough that non-professional programmers could learn to use them. This is not always the case. Furthermore, as the Multimedia Magazine project illustrates (its long learning phase and frequent frustration), even these technologies are barely usable by some educators. Better integrated and more usable tool-kits for creating WWW-based communication applications will allow educators to "own" their applications without this inordinate time and effort. (This result aligns with the viability and need for end-user tool-kits as described by [Nardi 93].)

Finally, in both the middle and high school cases, I found that public school teachers and a technologist (myself) could communicate effectively in design. These two cases differed, however. Allen (in Issues On-line) had a more extensive technical background, which made that project easier in some respects—technical problems were easier to deal with and I was freed from more mundane technical tasks, such as setting up modems, etc. On the other hand, it was often easier to stay grounded in pedagogy with Debbie and Sharon (in the Multimedia Magazine)—they were more amenable to designing at the activity level, particularly using concrete scenario representations. Although I often assumed a teaching role (recall the "HTML lessons") with these less technically experienced educators, they were still capable (as was Allen) of using and creating even quite abstract design representations.
6.1.4 Power Asymmetry in Collaborative Design

Educators are application designers by profession: they traditionally design and construct both pedagogical activities and the mediating artifacts used within them. The two public school case studies in this research further demonstrate that educators, in collaboration with a technologist, can design Internet-mediated educational applications. At the start of this research, I believed that these collaborative design processes would be symmetric in terms of expertise. I expected the educators to contribute knowledge of their teaching practice; in turn, I intended to provide knowledge of technological possibilities and constraints. This was largely the case. Nonetheless, these processes were not symmetric in terms of design power—meaning the ability to influence the form of both the design process and its product. I held greater design power than my collaborators in both regards.

The primary reason for my power advantage regarding the product of design was that I created and maintained most of the design representations. Although I presented these representations to my collaborators as design hypotheses, they were powerful in setting the trajectory of design. For example, the initial system mockup and scenario I created for the Data Gathering component of the Multimedia Magazine project (see Figures 4-5 and 4-7 of chapter 4) affected this entire application significantly. I used the WWW as a convenient prototyping medium for this mock-up and introduced several related network mechanisms in the scenario. I hoped these representations would stimulate design conversation leading us to a shared vision (possibly completely different from that in the representations) of the network applied to data gathering. Introducing this technology in this mock-up and scenario had a strong prescriptive effect, however. The educators immediately accepted these design hypotheses and quickly became engaged in learning the technologies themselves (HTML authoring, in particular). Consequently, their large investment of learning time and effort caused them to adopt this technology for the later publishing phase of the MMM application. This displaced the single-user multimedia software they had purchased for this purpose, but no longer had time or energy to learn. In turn, this new publishing technology, because of its complexity, prevented the students' from directly authoring the multimedia presentation as originally planned.

Furthermore, the representations I created directly influenced the design of pedagogical activities, as well as technological systems. Hence, my power advantage was not limited to the technology domain—my presumed area of expertise in the collaborative process. This was especially clear in the Issues On-line case. Here, I intended to use the On-line Debates system to demonstrate a technological possibility: how reviewers could post comments in a WWW-based peer-review system. Nonetheless, by injecting this representation into the process, I also significantly influenced the peer-review activity we were designing: I introduced the pedagogical idea of structured discussion, which became central in Issues On-line. The
scenarios I created for this project exaggerated this effect because I included many On-line Debates design features in these textual environments, as well.

The technologists' power over the design product comes from their power over the design process. This latter power advantage is evident in the fact that technologists both define and orchestrate the methods of collaborative. For example, in my case studies, besides creating the representations, I determined the specific kinds of representations we used, as well as how we used them (that we used representations at all, was my doing). Likewise, even in the PICTIVE/CARD participatory design methodology [Muller 91b][Muller, et al. 95], where "end-users" directly create "low-tech" design representations, technologists define the specific materials and procedures in advance. Similarly, Williams describes two participatory design case studies that use translators (see discussion at the top of the previous section) [Williams 94]. In both of these cases the translator is an ex-teacher who became a technologist. So here again, the technologist ultimately controls the process.

I do not reject the tenets of collaborative design because of these power asymmetries. On the contrary, the present research has shown how direct collaboration can both facilitate integration of diverse expertise and promote practitioners' ownership of the application. Nevertheless, this research also demonstrated that even a technologist who is self-consciously committed to symmetry in design can have difficulty achieving it. My activity/system model of applications suggests the cause of this persistent asymmetry, as well as a possible solution. As I claimed at the top of this section, educators (like most professionals) are already designers—they design learning activities. Nonetheless, when technological systems are applied within these activities, the technologists' design methods are assumed. This is symptomatic of the same bias that often casts the system as the sole object of design work. It appears that both technologists and practitioners consider technology and technological expertise more important than activities and domain expertise in design. On the other hand, acknowledging that activities are equally valuable as products of design work suggests a new approach to collaboration. Instead of immediately adopting the technologist's predefined design methods (which are not specific to the target practice domain), collaborators could first focus on integrating the practitioners' design methods into a customized application design process.

6.2 Asynchronous Structured Discourse in Education

All the applications of asynchronous structured discourse (ASD) in these case studies were successful. All the educators and most of the students in the three studies that implemented these applications viewed the experience positively. (Even Allen Browne, who felt compelled to terminate Issues On-line due to a small number of inappropriate postings, viewed it as positive overall and wanted to do something similar again.) Many students in the On-line Debates were sufficiently engaged that they offered suggestions on how to
get others to participate more and to increase the interaction—several even suggested making the activity (a school assignment, remember) last longer. The general reaction of the high school students who participated in Issues On-line was the most positive: they almost unanimously viewed the application as a beneficial experience. On the other hand, in the college classes, where participation was less strictly required (and the technology less novel) there were many students who elected not to use the application at all (20% in the On-line Debates; 50% in the On-line Discussions). In the On-line Discussions case, several students said they simply had no need for this resource: in the On-line Debates some students saw it as just another assignment, posting only what they thought was required for their grade.

The extent to which these activities engaged students in authentic social discourse is important to the second-level effects of these applications. If a student considers the act of posting within an ASD application to be just another task in an arbitrary school assignment, it is unlikely that student will conceptualize the resulting discourse record as objectified knowledge, constructed by collaborating authors. The data from my case studies indicates that for some students the activity was more than just a required task, that their role had changed, that the writing was transparent because it was for an authentic purpose, and that the recorded discourse did constitute useful external knowledge. But, individual students varied in their engagement (or simply enjoyment) within these activities. Hence, I conclude that educators should integrate ASD applications with other media and activities, both to provide alternatives and to make the ASD discourse more meaningful.

6.2.1 Transcending Classroom Social Structure

In both the On-line Debates and the On-line Discussions students acted as authors of course materials, which appeared on the WWW alongside materials created by the teacher. I found more evidence that the On-line Discussions participants conceived of themselves this way, however. I believe this is because the discourse was more authentic in this activity. These discussions were a means towards an independent goal—completing the programming assignments—and the students saw real value (for themselves and others) in the materials they created (both asking and answering questions). In contrast, a few students viewed the On-line Debates as just another artificial assignment. (This distinction is not absolute: the On-line Debates also contributed to the groups’ in-class presentations, but these were part of the same assignment.) The asynchrony of these mechanisms also allowed students to determine the time and place for some interaction that traditionally occurred within a class time and room defined by the educational institution (again, this gave them a more authorial role). This too is a double edged sword, however. While I found evidence in both college cases that many students found this to be convenient (even a
liberation from institutional constraint, in some cases), a few participants in the On-line Debates saw it as an encroachment of "class time" into their own "personal time."

In both Issues On-line and the On-line Discussions, the educator (Allen Browne and myself, respectively) hoped to use the network technology to free the students from the teacher centered structure of the traditional classroom. Allen's students did experience this, expressing it in several ways: the "luxury" to choose what to learn (where to post comments); the right to express themselves in public; and, the freedom to express themselves while "secluded" from others at their computer. Likewise, in my class, I wanted to free the students from the "heavy" authoritative presence of the teacher and many students did assume the authority role themselves: mentoring other students and evaluating my exams. Nonetheless, the external power structure and obligations of teacher authority persisted within this new medium as well. The flaming and other inappropriate behavior in Issues On-line obligated Allen to assert complete control and eliminate both the activity and its discourse record from the network. In my case, teacher authority persisted throughout the activity in more subtle ways. Although the application effectively removed the status cues (I didn't stand at the front of the class, etc.), my postings were identifiable and students treated them more authoritatively than those of other students. I also felt obligated—because I would ultimately judge correctness in programs and exams—to respond to questions that went unanswered and, in some cases, to step in and debunk incorrect student postings.

I conclude that while the ASD mechanism is effective for transferring control and authority from the teacher to the student, simply applying the mechanism is not sufficient. Rather, the activity associated with the ASD application should include off-line instruction on how much control and authority, and what kind, the students should take. Allen Browne, reached this same conclusion after the Issues On-line experience (the flaming, in particular). When I suggested designing additional mechanism to increase his on-line control, he emphasizing teaching the students, off-line, how to control themselves, instead. Likewise, in my On-line Discussions, students might have taken more authorial control (as I wished) if I had defined the activity more explicitly and had integrated it more closely with my classroom instruction.

6.2.2 A Complementary Medium for Communication

ASD applications offer new possibilities and produce different effects than the traditional face-to-face classroom. The changes in social structure, described above, are an important example of this. But, as I argued there, the system itself did not completely change the traditional social relationships and educators should accompany these applications with a shift in their classroom teaching practice. Similarly, several students in the On-line Debates called for more live classroom instruction on the technique of debate that would complement the on-line activity. In addition, I found that other effects of the ASD mechanism,
which present other useful possibilities for educational activities, are best viewed as a tradeoff with other media and across individual students.

6.2.2.1 Asynchronous Textual Communication

The CMC mechanisms in these case studies affected the communication dynamics of the classroom. In all cases, many students reported that they (or others) felt less inhibited in this medium and that it gave them more time to think and carefully craft their utterances, compared to face-to-face. As a particularly striking anecdote, the most prolific writer in the Fall 94 On-line Debates was a non-native English speaker who, reportedly, never spoke in class. Furthermore, Allen Browne, the educator in Issues On-line, reported that the most important lesson for his students was learning about each other. Even after years of “sitting next to each other” in classrooms, these students were surprised to find out how “smart” each other were through their on-line comments. These positive results were counterbalanced, however. In Issues On-line, the students also found out about their colleagues through “flames.” In the On-line Discussions (from my programming class), students differentiated between simple and complex problems, saying it was difficult to resolve the latter through CMC. In the On-line Debates, some students missed the “heat” and “impact” of face-to-face debate, both because it is more exciting and because it is a skill they wanted to master—it is more realistic. Likewise, some high school students in Issues On-line missed the quick feedback of live interaction.

These divergent results lead me to conclude that CMC will serve educators best as a complementary “place,” rather than a replacement, for the live classroom. Some students will do better in one than the other and, both provide their own particular benefits for all students. The CSILE system ([Scardamalia and Bereiter 93], see chapter 1, Educational CMC: Social Knowledge Construction—Learning in World 3) is used in this way. It provides a persistent structured medium for the collaborative construction of knowledge but, as an adjunct to other classroom activities. This is essentially how I used the On-line Discussions. Similarly, ENFI activities ([Bruce, et al. 93], see chapter 2, Networks for Writing Communities) often serve as a pre-writing warm-up before traditional individual writing. Early in the On-line Debates design process, we similarly envisioned the on-line activity as a warm-up for in-class debates; for the reasons cited above, this was probably a better idea than the strictly on-line format we finally implemented.

6.2.2.2 Structured Discourse

Students frequently reported that the structure made the discourse more organized and that the explicit speech acts made intentions clearer. (A strong majority of the students, in all three cases, liked the structured discourse in these WIT-like systems.) Students also reported that the explicit structure made
the applications easy to use. That, even with little or no training, few students reported problems using
the system, supports this. Likewise, the explicit speech acts seemed to make the activity clear with
minimal instruction. On the other hand, some students complained that it was difficult to relate deeply
nesting polarized arguments (e.g., an agreement attached to a disagreement, etc.) to the original issue; for
the most part, however, students used these without error. The Issues On-line structure was more
problematic than the other cases because, there, each top-level issue consisted of multiple pieces, with
their own polarities (i.e., Supporting and Opposing Evidence pages). This multiplicity of places to post
also made it difficult to view all the comments attached to a single project (an enhanced user interface
with combined views would address this, however). Similarly, students complained of too many referents
(multiple pro and con positions) in the On-line Debates and the lack of well-defined issues (conducive to
formulating discrete positions) in the top-level ethical scenarios.

Beyond usability issues, students also reported social (second-level) effects of the WIT-like structure.
Many said that it made the discourse “feel” more formal compared to face-to-face and other less structured
CMC mechanisms. Some students liked this, saying that it prevented discourse from degenerating into
“shouting matches” and kept the discussants on the topic. Other lamented these effects. In particular, a
small number of USENET newsgroup devotees tended to view the structure as cumbersome, preventing
the quicker, less formal, and more discursive conversations typical of USENET. Of course this very
criticism supports the premise that highly structured CMC mechanisms are appropriate for many
academic applications. Nonetheless, in the high school Issues On-line case, the system’s formal structure
was not enough to prevent some students from “flaming” and indeed reinventing the application as
informal, personal “chat.”

I conclude that a combination of CMC mechanisms, more and less structured, will be most appropriate for
many applications. For example, IRC (a synchronous Internet-based mechanism similar to Daedalus)
could support brainstorming and side conversation, preserving the asynchronous structured mechanism
for formal proposals, arguments, and results. Likewise, Allen Browne suggested that the students who
used the Issues On-line for chatting (which he viewed as a serious abuse of the system) might have
behaved better in the formal channel if they had had an alternate mechanism for informal communication.

The use of explicit discourse structure as a pedagogical mechanism varied. The On-line Debates design
purposely limited the speech acts and we easily determined what acts were needed because the application
simply reproduced the requirements of an existing face-to-face activity. In contrast, the Issues On-line
application included a *Neutral* speech act, which the students used frequently to express trade-off analyses
in their comments. It’s a matter of pedagogical purpose whether the system should enforce (or at least
encourage) students to factor such comments in to separate positive and negative postings (i.e., an explicit
dialectic). In the On-line Discussions (used in my programming class), I tried to design a discourse structure that would encourage two distinct conversation types: 1) question and answer and, 2) exploration of design ideas. Students often used the Question speech act, however, they used neither the top-level Comment nor the even more explicit Idea acts to propose design ideas as I had hoped. Here, the explicit discourse structure in the system was not enough, on its own, to move students out of their traditional role as information seekers vs. information providers (at least not in their top-level speech acts; see the discussions of knowledge construction, below). The Comment speech act was also available throughout the On-line Discussion’s discourse structure. Students frequently used this for speech acts the design did not anticipate. They also used it to soften the force or authority of utterances they could have appropriately tagged Agree, Disagree or Answer. I did not use the Comment speech act frequently, myself, but did use it for instances where the discourse structure was insufficient (e.g., posting a Socratic style leading Question in response to a student’s Question).

6.2.3 Authentic and Unobtrusive Writing

The ASD systems used within these applications did engage many students in writing for an authentic audience; but, they did so unobtrusively. In fact, even though the medium was text, for many students, the act of writing was largely transparent. In the On-line Debates, in particular, some students who complained about the volume of writing in the rest of the course wrote much more than was required within the debates. Likewise, in the On-line Discussions (in my programming class), many students were willing to write about their programming rationale even though this activity was completely independent of any course requirement. (The latter result is especially significant considering that programming students typically do not enjoy writing documentation or even recognize its value.) In both cases, I found evidence that the socially authentic environment provided by the application motivated some students: in the debates, they wrote to convince or dispute their colleagues; in the programming discussions, they wrote to seek or give help to their colleagues.

My conclusion here, like that drawn by ENFI advocates [Bruce, et al. 93], is that textual CMC is useful in any situation where writing practice is a goal: it better motivates some students, even those who are consciously averse to this practice. My findings extend this claim to the ASD mechanism, which is more like formal writing than ENFI. For example, asynchrony allows interlocutors to “write” with less time constraint, and hence, more closely resembles the individual process of traditional writing. Furthermore, the explicit discourse structure in ASD (including that in individual utterances, which consist of a subject line (title) plus a body text) is more typical of formal writing than oral conversation. (See [Ong 82] for a thorough analysis of the role of structure in the evolution from speech to print.) Students did report...
increased formality in ASD compared to other media; however, the interactive social dynamics of the ASD activities (versus the "context-free" or "autonomous" mode of traditional writing; again, see [Ong 82], page 79) made few students conceptualize these activities as writing.

6.2.4 Social Construction of Knowledge

The persistence, structure and publicity of ASD applications facilitate a change in the model of learning from an individual process of knowledge apprehension to a social process of knowledge construction. I found subtle evidence in these case studies that some students did conceptualize the ASD activities differently from traditional school work, in alignment with this distinction. For example, in the On-line Debates, while many students described their posting strategy in terms of quotas (these students were probably just fulfilling the assignment), others said they looked for places where they could contribute by adding something constructive but not redundant. Likewise, in Issues On-line, most of the high school students (even though they were members of a smaller community with a longer history than the college students) did not direct their posting towards familiar individuals, rather, they looked for interesting and controversial topics, and again, some said they looked for places were they could contribute constructively. These students were attending to the discourse itself as the important object of the activity.

While most of the On-line Debate participants did not care one way or the other about the public nature of the debates, a few suggested that discourse within this enlarged community both encouraged the students to make better contributions and allowed the outside world to benefit from their product. The high school students echoed these sentiments (although a larger proportion, half, explicitly liked the publicity), while some added that they had a right to inject their work into the public domain. Very few of the students in any of the three case studies disliked the publicity factor.

There were few "conversations" in the On-line Discussions (in my programming class) that I classified as design explorations; rather, most were question and answer (requests for help on the programming assignments). There were a few anecdotes of argumentative design exploration, however, which demonstrated the viability of the WIT/IBIS model in this educational setting. (Ironically, even these began as Questions rather than assertions of new ideas, as I had anticipated.) Furthermore, as the Are there sets in C? anecdote also demonstrated (see Figure 5-12, chapter 5), the persistent record of such conversations did indeed serve as a resource (valuable external knowledge, constructed by the students) for third parties. Many of the students were aware of this; in fact, several understood that even asking a question in this persistent medium contributed to the communal knowledge base.

In the On-line Discussions, when I asked the students about publicity, I also asked about fairness (to survey their feeling about network access disparities), privacy, and the University Honor code. Although
some students responded regarding privacy and the posted grades (almost unanimously saying it was not a problem, given password protection), by far the most salient category for these students was the distinction between individual and social learning, particularly in the context of the University's Honor Code. (They did not even mention access and fairness.) Several students indicated that the On-line Discussions promoted a communal learning environment, which they liked. Some of these students were confused, however, particularly about treating "code" and "output" as communal knowledge. The ASD medium did not completely erase this cultural predisposition of students. One of the most gratifying results of this research (for me personally), however, was the suggestion by a few students that the application itself legitimized social construction of knowledge. It redefined inter-student interaction that they had previously categorized as "cheating" as legitimate collaborative learning; furthermore, it encouraged behavior that walked the fine line between these two categories.

6.3 Recommendations for Design and Use

6.3.1 A Schema for Ethnographic Collaborative Design

I recommend an ethnographic approach in any situation where a technologist designs for the complex practice of another. An ethnographic approach means working directly, continuously, and through the long-term with practitioners and, conducting design sessions within their workplace. Only through this long-term engagement in the target environment can a designer begin to "know" the richness and subtext of another's practice. Immersion is the key. Also, note that by designing together directly, practitioners are likewise immersed in the professional designer's world—in this sense, both parties are ethnographers.

![Diagram of Ethnography-based Collaborative Design Process]

Figure 6-1: An Ethnography-based Collaborative Design Process

Figure 6-1 schematically illustrates the method of ethnography-based collaborative design that I developed and used within the case studies of this research. This method combines the technique of ethnographic coding (see chapter 1, Ethnographic Interpretation and Coding) with the use of scenarios (and other representations) as props for design conversation. I present this method, schematically, as a step by step
procedure, for the sake of clarity. This a significant oversimplification; however, the actual method was informal and not precisely defined. I will embellish and qualify this schematic description in the paragraphs that follow it.

1. **Design Conversation**: In early design sessions, the collaborators discuss the target practice (in my cases studies we discussed the educators' pedagogical goals, techniques, and work context), as well as possibilities for using the target technology within it. These early sessions include demonstrations, visits to each other's work sites (in my cases, the public schools and my computer lab), and "brainstorming" early design ideas. The technologist records these conversations in field notes and audio recordings, which he or she later transcribes (but, see the caveat about transcription time, below).

2. **Interpretation and Coding**: The technologist then analyzes and codes the data from step 1, interpreting the major ethnographic categories from the conversations and notes. These include contextual categories, such as the participants' motivations and the social dynamics and structure, as well as technological categories. In interpreting categories, the technologist should pay special attention to oppositions and conflicts (e.g., synthesis vs. analysis (case study 1), linear vs. non-linear educational computer programs (case study 2), and the MMM vs. 1 Search activity (case study 3)).

3. **Create Representations**: The technologist then develops scenarios and mock-ups that reflect his or her understanding of the collaborators' developing shared vision. The categories interpreted in step 2 guide this effort as the technologist attempts to incorporate them in the design representations (e.g., proposing resolutions to scheduling conflicts and illustrating how the application might support pedagogical goals).

4. **Continued Design Conversation**: In turn, the technologist uses these representations as conversational props for further, more focused, design discussion. Again the notes and transcripts from these conversations feed forward into continued ethnographic analysis and coding, further development of representations, and continued design conversation (repeating steps 2, 3, and 4).

5. **Completion**: The product of this process is an application design: a design for both the activity and the system used within it. This is an informal method without precise rules specifying when the design iteration should end.

Interpreting categories is the important part of this method. Full-scale ethnographic analysis—transcribing audio tapes, thorough coding of the transcripts, and rich ethnographic writing—is not be feasible as the day-to-day method in "real-world" design projects. These full-scale methods may be
practical for a few critical design meetings (e.g., early interviews and scenario sessions) or for broad
domain analysis projects (similar to this dissertation in scope) but they are extremely time consuming. In
this research, I spent from 4.5 to 8.5 hours transcribing each hour of audio tape, depending on the fidelity
(detail) of the transcription. (The interpretation and coding process itself was cost-effective, once I had
the luxury of speech on paper.) Furthermore, I found that I became more skilled, as time went on, at
interpreting categories "on the fly" and recording them directly in my written field notes. This is surely a
more practical approach for daily, real-world design work.

Ethnography integrates well with the use of conversational props—particularly scenarios—which support
direct collaboration between technologists and practitioners. As the Figure 6-1 illustrates, I used these
props within an iterative design cycle both as reflective devices (to vet my interpretation with the my
collaborators) and as projective devices (to elicit new ideas and rationale). Fetterman also recommends
projective techniques as part of ethnographic inquiry [Fetterman 89]. For example, he asks members of
the culture he is studying to respond to pictures of objects or people from their world hoping their
responses will reveal what these mean to them. Since, in my method, the technologists create the
conversational props (i.e., since they are not indigenous to the practitioners' world) there is need for
cautions. Technologists should be aware that they are introducing their own background and prejudice
through design representations and that these have a powerfully persuasive effect (see the discussion of
power asymmetry, above, page 218). The technologists should actively dispute the representations they
create in design. In particular, they should help practitioners "act out" the scenarios, using mock-ups or
the implementation technology, in order to reveal the actual effort and time scales of envisioned activities.
I do recommend using "low tech" representations that are immediately accessible to practitioners. I also
recommend engaging practitioners with the implementation technology as much as possible. Greater
competence with this technology will increase their sense of ownership for the application, as well as
their ability and confidence to question its design.

Finally, simply working directly with practitioners is not enough to ensure symmetric collaboration.
Because technologists' define both the design method and the representations used within it, they hold a
power advantage in the design process (again, see the discussion on page 218). This asymmetry is
unavoidable in many cases; often the practitioners will expect the technologist to lead the process. Hence,
technologists must adopt a sensitive and responsive attitude in collaborative design. They should
explicitly encourage the practitioners to critically evaluate the representations they create. Likewise, they
should question the origin of their design ideas and representations: do these come from a sincere
ethnographic interpretation of the practitioners' world or from predispositions that originate in their own
prior design experience.
6.3.2 Using ASD Applications in Education: Eschewing the Panopticon

Computer networks offer a range of uses in education. Increased efficiency in the transmission and reuse of course materials is important an example. New possibilities for students to explore an immensely enlarged classroom environment—the vast conglomeration of information and people that comprise the Internet—is even more exciting. Nonetheless, I urge educators to consider the second-level possibilities presented by networks. In particular, the possibilities for changing student and teacher roles in the classroom and for reconstructing learning as a social process. Of course this requires more than simply inserting an ASD system into the curriculum. Restructuring social relationships requires new activities specifically designing for this goal and, (as I claimed for technologists in collaborative design above) adopting new attitudes.

![Diagram of Panopticon](image)

**Figure 6-2: Schematic "Birds-Eye" Perspective of a Panopticon**

Spears and Lee provide a critical re-analysis [Spears and Lea 94] of the many positive research assessments of CMC (particularly the claim that CMC equalizes participation in discussion, across status differentials). In their critique (which I extend to ASD applications below) these researchers invoke the Panopticon as a metaphor for the potentially “dark side” of CMC. The Panopticon is a building design originally proposed for prisons and other institutions by Jeremy Bentham [Bentham 1843]. As analyzed by Foucault, this design provides an efficient architecture for the exercise of power [Foucault 79]. The design of the Panopticon isolates its inmates from one another. Simultaneously, it makes them conscious of the potential for constant surveillance by a watch-person (whom the inmates cannot see) located in a central observation tower, see Figure 6-2.

Used wrongly, an ASD application has features of the Panopticon. The ASD mechanism reduces communication richness; e.g., rapid feedback, gesture, and voice tone are lost. In this respect, students are more isolated from one another within the ASD medium than they are in a face-to-face setting. ASD systems also capture the students’ discourse in a central, persistent, digital record. In many cases, the
educator will have privileged access to this record, as well as other traces of student actions (e.g., log files that track read-only accesses). This positions educators in the observation tower of the Panopticon, giving them an efficient, continuous, and unobtrusive mechanism for surveillance of the students’ actions.

I recommend that educators use ASD as a complementary medium (an optional alternative) within educational activities. Otherwise, if they design activities that are limited to the ASD system or use the digital records for efficient accounting (e.g., basing grades on simple counts of accesses or postings) the Foucaultian analysis is realized: the application simply becomes a more efficient way to exercise existing power relations. Additionally, I recommend designing ASD activities so that the students collaboratively construct a knowledge structure that serves as a resource for other activities. For example, the On-line Discussions discourse record helped my students complete their programming assignments. This exploits the structure and persistence features of ASD discourse and connects the ASD activity to the real concerns of the students, making it more authentic.
7. REFERENCES


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Dr. Laughton began his professional career as a software engineer while still an undergraduate and continued working throughout his master's program. Before entering the doctoral program at Virginia Tech, he worked for seven years as a full-time engineer specializing in user interface software at Schlumberger Oilfield Services in Austin, Texas. Dr. Laughton also taught undergraduate Computer Science courses at Austin Community College from Fall 1989 through Spring 1992 and at Virginia Tech from Fall 1992 through Spring 1996.

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