Building Communities for Design Education:
Using Telecommunication Technology for Remote Collaborative Learning

by
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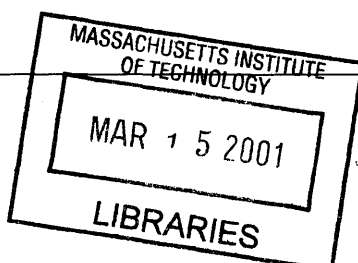
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ABSTRACT

The design studio, as both a learning environment and a social place, is one of the major components of architectural education. Traditionally, the studio has been considered a place for individual design work and one-on-one mentoring between an instructor and a student. With the integration of new information and telecommunication technologies, the nature of the design studio and the learning processes within it are being altered. This new landscape of the design studio offers opportunities for globally distributed collaborative work as well as new interpretations of design processes and studio practices. The technologies and the studio system are interwoven and their symbiotic relationships need to be understood if these technology-mediated long-distance collaborative design studios are to be common, valuable, and creative occurrences in architectural education.

In this study, the consequences of integrating telecommunication technologies into the design studio are examined through ten cases. The new studios involve multidisciplinary design participants from separate and distant physical and social environments that are electronically connected for sharing design ideas, creating a common understanding of design practices, and co-constructing design objects. With technology use, changes occur in the studio's participants and relationships, the design content and processes, and the events and organization. I argue that the changes to the studio can create an enriched environment for design learning.

The successive case studies represent a dynamic pedagogic strategy in which both students and teachers are active participants in constructing their new technology-mediated learning environment through creative experimentation. The findings of these cases provide a comprehensive description of the technical and social characteristics, conditions, and practices of remote collaborative design studios. In these new virtual design studios, there are rich opportunities for building innovative and effective communities for design education in which the traditional boundaries of time, culture, language, discipline, and institution are blurred and new configurations for design learning become possible.

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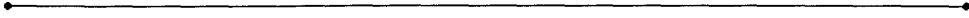
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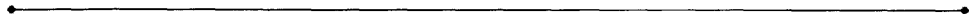**Susan Yee**

Cambridge, Massachusetts, USA
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For my parents,
Wai Kit Yee & Wing Suey Yee

Acknowledgements

Preface

In 1992, I participated in the first reported long-distance design studio conducted by Bill Mitchell and Jerzy Wojtowicz. It was christened a "virtual design studio." At a time before the development of the World Wide Web, the pioneering studio project used simple file transfer protocols and a telephone conference call to connect my classmates and me at the Graduate School of Design at Harvard University in Cambridge, Massachusetts with the students from a design class at the University of British Columbia in Vancouver, Canada. It was a collaboration of twenty-five students, faculty, and technical staff working together, but apart, from both sides of the continent on a common design problem.

Little did I know back then that I would later spend five years thinking about, designing, conducting, analyzing, and reporting on the first generation of remote collaborative design studios in architectural education. In hindsight, it now seems obvious, both in my activities in that studio and later in my efforts to integrate technologies into the design offices in which I worked, that I would come to view the appropriation of technologies into the design studio as the center of my interests.

During the course of this research, I have had the great opportunity to experience the transformations of the design studios at MIT, in both its physical space and its social space, as students and instructors slowly, and sometimes painfully, appropriated information and telecommunication technologies into their work practices. It has become clear to me that the nature of the design studio is changing and that understanding the new technology-mediated learning environment will be critical to the future of design education.

This is a study on how telecommunication technologies have changed the design studio. My central argument is that these technologies have the power to transform

the social system of the studio in ways that have potentially profound positive effects on design learning. The social system includes the design studio's members and relationships, its content and processes, and its events and organization. My purpose in doing this research is to better understand how this social system changes in a networked design studio.

Organization of this study

The dissertation is organized into five sections. The first chapter gives a conceptual context for understanding the virtual design studio as a social system and introduces the problem and argument of the research.

The second chapter reviews the origins of the design studio as inherited by the Ecole des Beaux-Arts and describes some traditional relationships, processes, and events characteristic of contemporary studio life revealing the studio's strengths and weaknesses as a learning environment.

The third chapter examines ten case studies in long-distance design education spanning a period of remarkable technological development and diffusion. The series tells a story about how telecommunication technologies may be integrated into the traditional studio and how they have affected its social system. It illustrates the nature of these new computer-mediated design environments as they have evolved over the past eight years with the expansion of the Internet and the development of the World Wide Web and its advanced capabilities.

The fourth chapter summarizes the technical and social characteristics of the new long-distance design studio. It is a description of the technologies as well as the social conditions and studio practices needed to conduct remote collaborative design work.

Finally, the concluding chapter examines the broader implications of the virtual studio on design learning and professional design practice as we use the lessons

learned from the series of case studies to build more dynamic, ambitious and effective learning environments and creative design communities.

How you might read this study

I suggest that you might read this study in a number of ways. As a researcher in design education you might test, refute, or extend my findings with similar studies. As a design practitioner or instructor, you might read this document to help you conduct virtual studios of your own and understand how they might benefit your firm or design class. As an educator, you might use it to consider alternatives to lecture-based long distance learning. As a designer of collaborative software, you might read this to understand the needs and concerns of real-life collaborative design situations. And as a design student, you might use it to help you understand the social structures within the design studio and to take advantage of a networked environment.

It is clear that the technologies will continue to improve, the members of the design studio will differ, and our interests and concerns about design education will change. In response, the design studio will continue to transform. I offer this document as a snapshot, in the year 2000, of this evolving learning environment: the virtual design studio.

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Chapter 1
INTRODUCTION
Interweaving Technology and the Social System of the Studio

Chapter 1: Introduction

Interweaving Technology and the Social System of the Studio

Technology can be a powerful change agent. It can stimulate, modify, and transform what we do, how we do it, and how we relate to each other and our environment. Ultimately, technology can profoundly influence the way we think about ourselves and about the world. When these technologies are used for interpersonal and group communication and are integrated into well-established work practices, the impact reaches into the core of a social system. This social system includes people, places, objects, events, structures, behaviors, and interactions that are guided by deeply held traditions, values, and goals. As telecommunication technologies become absorbed into our everyday lives, understanding their impact on people and their work and learning practices in professional and educational settings is vital.

Integrating telecommunications technologies into educational environments creates the conditions for global collaborative learning.[1] Separate and distant learning environments of students, instructors, and practitioners have new opportunities to join together via technologies such as email, shared databases, the World Wide Web, videoconferencing, and other Internet-based communication tools. With these advanced technological capabilities, members from remote settings may come together to share ideas, engage in critical discourse, create common understandings and joint artifacts, and ultimately form new communities for learning.[2] These

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[1] Throughout this research, I have focused primarily on the idea of studio learning, rather than teaching, from the perspective of the studio students. In this way, this study is descriptive in nature in terms of learning, rather than prescriptive in terms of proposing teaching methods. I believe that better teaching in the design studio comes first from understanding the contexts and conditions for design learning.

[2] By community, I mean a grouping to which an individual feels membership and identity because of some common goals, knowledge, artifacts, methods, places, or practices. There are many types of communities, some are place dependent and, with the Internet, an increasing number are only partially dependent or totally independent of place, as is the case for "virtual communities." Virtual communities are defined as "social aggregations that emerge from the Net when enough people carry on those public discussions long enough,

communities subsequently create their own social systems and these new social systems in turn affect, change, and develop the evolution of the technologies.

What interests me in this process, and is the subject of this thesis, is the symbiotic relationship between the social system and the technologies. That is, how can one use, influence, modify, develop, embed, and ultimately becomes the other. I explore this relationship in the educational context of the architectural design studio. My goal is to better understand this socio-technical relationship (Figure 1). How do telecommunication technologies affect the social system of the design studio? And simultaneously, how does the design studio affect the appropriation and development of these technologies?
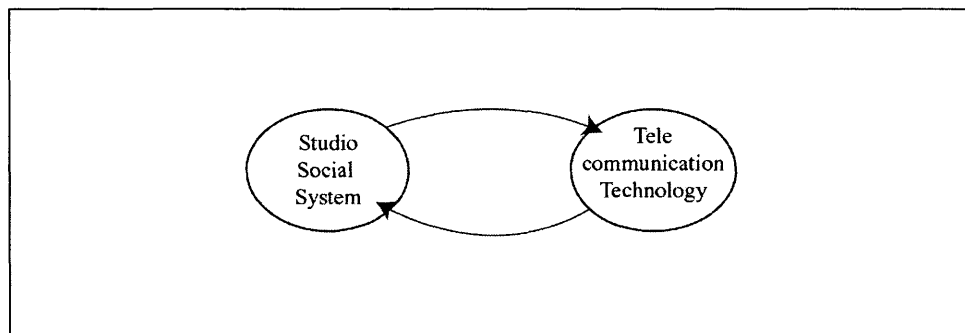
Figure 1: Socio-technical relationship in the design studio.

1.1 The Context: Technology and the Design Studio

The design studio, as both a pedagogic entity and a social place, is one of the major components of architectural education. Traditionally, the studio is a place for individual design work and one-on-one mentoring between an instructor and a student. Grounded by its origins in the Ecole des Beaux-Arts, the contemporary design studio inherited a social system that has remained relatively stable. The social

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with sufficient human feeling, to form webs of personal relationships in cyberspace," in Rheingold, Howard. 1993. *The Virtual Community: Homesteading on the Electronic Frontier.* Reading, MA: Addison-Wesley Publishing Company. p. 5. The new communities for design learning may be place-based, virtual, or any variation in between.

system describes the nature of the studio. By a studio's social system (Figure 2), I mean to include a particular set of:

- people: the studio's participants and their specific roles, interactions, and relationships with each other;

- content and processes: the content of the curriculum, the type of projects and work and learning processes developed in the studio;

- events and their organization: the reviews, deskcrits, rituals, and general behaviors found in the studio; and

- spaces: the physical environment in which the activities of the studio are performed.
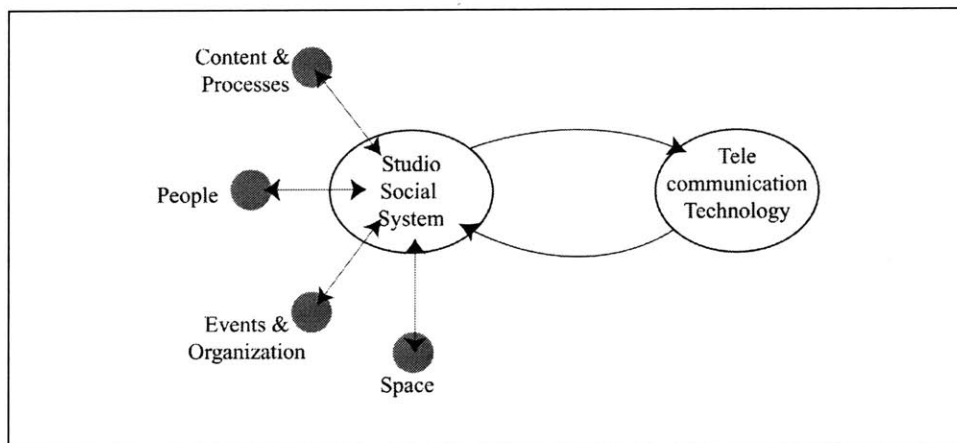
Figure 2: The studio social system is affected by the introduction of telecommunication technology.

With the introduction of new information and telecommunication technologies, the design studio is being altered. How can we understand these changes? According to Sproull and Kiesler, one meaningful way is to understand the effects of the technologies in terms of their integration into work practices. They suggest a "two-level perspective."[3] The first-level effects are about efficiency and focus on workflow processes and productivity. The second-level effects are concerned with

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[3] Sproull, Lee and Sara Kiesler. 1991. *Connections: New Ways of Working in the Networked Organization*. Cambridge, MA: MIT Press.

the social system. They define a social system as "a society, organization, group, or other social entity consisting of interdependent people, events, and behaviors."[4] They argue that communication technology can "cross hierarchical and departmental barriers, change standard operating procedures, and reshape organizational norms."[5]

We may use this tiered perspective to understand the integration of computers into design practice. First, let's look at the integration of computationally oriented design simulation and generation tools, such as computer-aided design and manufacturing (CAD/CAM) programs and expert systems. They were introduced into the design studio because we anticipated that they would make the production of design more efficient - a first-level effect. The tools would help us produce more reliable designs faster and cheaper. This first-level perspective gives us a view of the technology as "just a tool." That is, we, as users, are concerned primarily with what these tools can do. Can the computer help me visualize this complex curve? Will it perform a structural analysis on my design? Can it present me with acceptable design solutions for a given set of space constraints? Can it fabricate an accurate physical prototype of that curved surface? We are concerned with the solution or output and use the computer as a problem-solving instrument. Turkle refers to this view of the computer as "instrumental" or an "analytical engine."[6]

If we continue, as Sproull and Kiesler suggest, to look beyond the efficiency effects and towards the second-level social system effects of CAD systems, we see profound implications for designers and the "social art"[7] of design work. One

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[4] Ibid, p. 1
[5] Ibid, p. ix
[6] See Turkle, Sherry. 1984. *The Second Self: Computers and the Human Spirit.* New York: Simon & Schuster, Inc. pp. 11-25 for an interpretation of the computer as an evocative object. She makes the distinction of the instrumental computer and the subjective computer.
[7] See Cuff, Dana. 1991. *Architecture: The Story of Practice.* Cambridge, MA: MIT Press. Cuff makes the distinction between "drawing board design", or instrumental design, as it is done at the drawing table, and the "social art" of design, which puts the practice of design in the social context of the stakeholders of design.

effect is the creation of unanticipated new roles and human interdependencies. For example, in the early stages of CAD's entrance into the design office, the power of the senior designers diminished because they lacked the new skills and knowledge that the technology required. Unprepared, the new CAD operators awkwardly inherited some of this power. One frustrated principal of a busy design firm told me that he felt like he had lost all control over his office's design activities after integrating CAD technologies into his practice. Because the design work was being done on the machines, he could no longer browse through his employees' drafting tables to see the progress of the projects. The drawings, once physical and scattered on the tables, which were so critical in the social and monitoring system of the office, were now hidden inside the computers that he could not operate. In effect, he was held hostage. The hierarchical relationship between an employer, his employees, and the work was altered.

We may dismiss this as an instance of a technology in transition, but these transitional times were and continue to be important. They help us to re-evaluate what we do and how we do it, as well as the social structure underlying our activities. They help us to see the technology, in Turkle's terms, as "subjective" rather than "instrumental". Turkle describes the subjective computer as one that "enters into social life and psychological development, the computer as it affects the way that we think, especially the way we think about ourselves."[8] At first glance, the CAD technology is a mere instrument, but at second glance, it becomes, as any tool in the hands of thinking individuals, more than "just a tool." That is, it becomes integral to our activity and it affects the way we think, design, and learn. It imparts a set of values and structures about design and how we perform as designers. As Turkle suggests, this "second nature" of the technology makes us look at the computer as "an evocative object,"[9] one that affects the way we think of ourselves as thinkers, designers, and learners.

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[8] Turkle, 1984, p. 13.
[9] Ibid, p. 13

Looking at the instrumental and subjective sides of technology with first-and second-level effects helps us to understand both the context of design and the technologies themselves. Let's take the example of CAD applications again. As instrumental objects, these programs help us draw and visualize. If we look slightly harder and more subjectively, they regulate us and influence our design and design process by their inherent structure.[10] It is a structure that is programmed into the tool itself and is not always completely obvious to the user. The structure favors certain design behaviors by permitting the user to only visualize and manipulate formal objects in a certain prescribed manner. In doing so, these programs have powerful implications for the social system of design that remind us that technology is never neutral and purely instrumental. As we acknowledge and understand this other side of technology, we can influence the design and development of new computer systems to support the behaviors and interactions we would like to see in a new design studio.

1.2 The Problem: Understanding the New Design Studio

Now, let's turn to the integration of telecommunication technologies in the design studio. We looked briefly at how the design process can be affected as the designers use technologies that create and manipulate design information, such as drawings and models. But what happens to the studio when designers who are geographically distributed, not only *use* the computer to produce and capture design proposals, but also communicate them to distant partners *through* the computer? Although the technology may enable us, the problem faced by design educators is the lack of understanding computer-mediated studios and the educational implications of integrating telecommunication technology into the design studio. What really

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[10] For example, many current computer-aided design (CAD) programs, such as AutoCad, are based on the idea that design is the formal manipulation of static primitives. That is, once a form is entered into the system as a square, for example, it will always be considered a square and the designer may not spontaneously manipulate it as anything else, such as a combination of lines, unless a series of explicit intermediate steps are taken to change the structure of the square. This structure establishes values, priorities, and ways of seeing the design object and the design process. It does not take into account that the design process is often the negotiation of ambiguous and dynamic ways of seeing and manipulating form.

happens in this new breed of studio? What kinds of technologies are being deployed? How is the studio being modified? What really happens interpersonally, organizationally, and institutionally? These questions are important if we want to leverage telecommunication technologies to improve the learning processes and everyday practices in the design studio.

How do we begin to understand the nature of this new studio? I suggest that we can approach this question by examining the use and integration of telecommunication technologies in terms of instrumental and subjective objects with first- and second-level effects. Let's first consider the integration of these technologies into design studio practices. Why do we use the technologies? What assumptions or biases about design underlie their use?

One of my assumptions, carried throughout this research, is the idea that design is a social activity and that the studio is an ideal place for social learning. The strength of a studio comes from its members and their relationships with each other. The social learning involved in studio design education is about developing individual expertise not only by *learning by doing*, but also by *doing with others* and *learning from each other*. In fact, one aspect of design expertise is precisely to establish successful ways of relating and communicating with others about design. Cuff, in her anthropological study of design practice, emphasizes the importance of the social process in the design activities of the profession:

> "The most overarching observation is that the production of places is a social process. That is, a very basic task of architectural work is to collect all participants, both in the office and out, to develop a manner of working with them and to interact with them in order to create a design solution. This task, the social process, is significant to the form-giving task of architecture, for it is from this human constellation that the building's final form emerges. This simple but radical proposition is that design itself is a social process."[11]

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[11] Cuff, 1991, p. 248.

The members of an ideal design team or learning group, however, can often be geographically dispersed. In these cases, telecommunication technologies can help to assemble the most effective combination of people together in a "virtual design studio."[12]

In design education, bringing distinguished practitioners with busy schedules from distant locations into the studio process as guest critics in final design reviews is a common occurrence. The early anticipated first-level efficiency effect of using telecommunication technology in the studio process was the savings of travel cost and time of these invited critics. Furthermore, the technology could bring into the virtual studios other kinds of participants not often seen in the physical studios, such as students, instructors, consultants, and clients from varying disciplines, institutions, and cultures with the same reduction in cost and time. The virtual design studio was anticipated to be a richer and more productive environment for learning by opening up the design studio to a variety of long distance participants. These additional studio members, with their own attitudes about design and with their own methods of working, learning, and teaching, provided the foundation for the second-level social system effects of the technology.

Understanding the changes in the social system of the studio is the goal of this research. It entails understanding the *instrumental* side of the technology as well as its *subjective* side - a side that affects the way we perceive ourselves. The first step is to understand the technologies required for a virtual design studio as individual components and as instrumental objects. That is, what can each technology do? Email systems can deliver and receive text messages with attached files. Shared databases can form a repository for joint file storage and retrieval. Videoconferencing can allow real-time audio and video connections between two or

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[12] As reported in Wojtowicz, Jerzy, ed. 1995. *Virtual Design Studio*. Hong Kong: Hong Kong University Press. p. 22, the term "virtual design studio", to describe geographically distributed design studios connected by networked technologies, was first used and defined by Bill Mitchell in his talk at MIT's Media Lab in early 1993.

more computers. Understanding these technical functions, although mundane, is important, especially when the technologies are interweaved together to form the technical core of the virtual design studio. The suite of telecommunication technologies allows distributed participants to communicate synchronously and asynchronously, to have a peripheral aware of each others' activities and projects, and to store, display, and retrieve design materials for collaboration (Figure 3). Since these technologies are placed into the physical environment of the studio, the spatial location of their interfaces is also a component of their functionality.
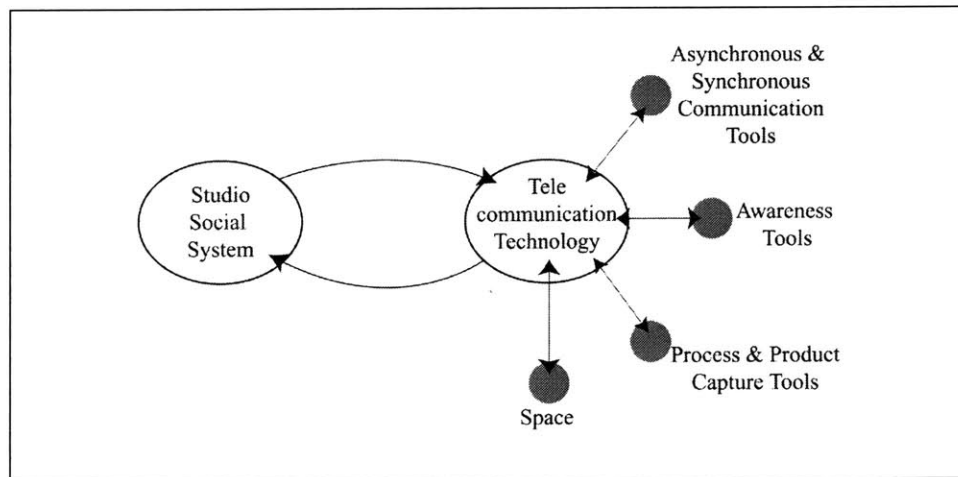
Figure 3: The suite of telecommunication technologies is affected by the requirements of the studio's social system.

The next step is to understand the suite of technologies as a subjective object as it enters into the practical and social life of the studio. How do these individual technologies and their interdependencies affect designers and design learning?

1.3 The Argument: Telecommunication Technology Reshapes the Social System of the Design Studio for Enriched Design Learning

The central argument in this research is that the integration of telecommunications technology into the well-established design practices of the design studio has the power to reshape its social system – a system that defines its members, its work, and

its culture. In the best cases, the changes to this system can improve design learning. The new design studio can also have an active role in the development of future technologies for remote collaborative design learning.

What kind of changes to the social system result from the integration of telecommunication technology into the studio process? The changes may be considered in terms of:

- people: the technologies include new participants who create new relationships, modify the roles of existing members, and shift the power hierarchy of the studio;

- content and processes: new studio participants provide new topics of inquiry and new modes of design investigation, negotiation, collaboration, and evaluation that cross boundaries of culture, discipline, and institution;

- events and their organization: the technologies require tighter organization and coordination of the events and help to open up design studio activities to a wider audience and to accommodate different styles of learning; and

- spaces: the technologies provide complementary digital spaces for design activities that connect and alter existing physical spaces to make the virtual design studio.

I argue that these changes are advantageous because they provide new opportunities to enrich the learning processes and practices in the design studio. They may increase the opportunities for social learning and learning-by-doing already inherent in the studio. The new contexts may provide mechanisms for building strong learning relationships between the members inside and outside the physical boundaries of the studio by promoting connections between studio work and other topics and people within the departmental and institutional program and between the educational studio and professional practice. Understanding the socio-technical contexts and relationships in virtual design studios, I argue, is a way to understand design learning. This takes Lave and Wenger's viewpoint that learning is a "situated

activity;" that is, "learning is an integral and inseparable aspect of social practice"[13] as learners begin to participate in social situations that are mediated by the differing views of its co-participants:

> "Learning viewed as situated activity has as its central defining characteristic a process that we call legitimate peripheral participation. By this we mean to draw attention to the point that learners inevitably participate in communities of practitioners and that the mastery of knowledge and skill requires newcomers to move toward full participation in the socio-cultural practices of a community. "Legitimate peripheral participation" provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artifacts, and communities of knowledge and practice. It concerns the process by which newcomers become part of a community of practice."[14]

In the successive cases of virtual design studios described in this study, I show how effective conditions for enriched design learning may be developed with emerging telecommunication technologies and how innovative communities of practice may be built along the way. Based on John Dewey's fundamental notion of learning-by-doing, the series of case studies is part of a dynamic pedagogic strategy in which both students and teachers are active participants in building their new technology-mediated learning environment and community through creative experimentation.

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[13] Lave, Jean and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation, Learning in Doing: Social, Cognitive, and Computational Perspectives.* Cambridge: Cambridge University Press, p. 31.
[14] Ibid, p. 29.

Chapter 2
THE DESIGN STUDIO
Origins and Traditions

Chapter 2: The Design Studio

Origins and Traditions

The design studio has been described as "the distinctive holy-of-holies of architecture education."[1] It is often considered the primary environment for learning and teaching design, and as part of a professional curriculum, it is intended to serve as a training ground for architectural practice. It is also the place of professional socialization and enculturation, that is, the studio is where "the ethos of a profession is born."[2]

To understand the design studio's important place in architectural education and how telecommunication technologies may change it, I give, in this chapter, a brief overview of the studio's origins from the Ecole des Beaux-Arts and a description of the contemporary design studio[3] in terms of its social system components: its members, its content and processes, and its events and organization. I conclude this chapter by summarizing the strengths and weaknesses of the traditional studio system.

2.1 Origins of the Design Studio: The Ecole des Beaux-Arts

How did the design studio enter into the architectural education system in America? It has origins from the Ecole des Beaux-Arts in Paris, France and is deeply rooted in apprenticeship learning.

2.1.1 From the Royal Academy to the Ecole des Beaux-Arts: A Brief History

The Ecole des Beaux-Arts in Paris officially taught architectural design from 1819 to 1968. The Ecole grew out from the schools of the Académie Royale de Peinture et

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[1] Boyer, Ernest L. and Lee D. Mitgang. 1996. *Building Community: A New Future for Architecture Education and Practice: A Special Report.* New Jersey: The Carnegie Foundation for the Advancement of Teaching. p. xvii.

[2] Cuff, Dana. 1991. *Architecture: The Story of Practice.* Cambridge, MA: MIT Press. p. 43.

[3] By contemporary studio, I mean a traditional design studio that does not use any computer-mediated communication tools.

de Sculpture and the Académie Royale d'Architecture during the period between 1792 and 1819.[4] With its initial eight members, the Académie Royale d'Architecture was founded in 1671 under King Louis XIV, as part of the French Academy system established to counter the medieval guilds that were not under royal control. The academicians were architects named by the king who met once a week to share their expertise. They formed an elitist group that would advise the king on the designs of the royal buildings. The Académie also conducted a school to share the expertise of these academicians with young architects.

Initially, the school at the Académie held public two-hour lectures on topics from theory to mechanics to stonecutting two days a week. By 1717, these topics were covered in courses lasting two or three years given year-round.[5] The Académie was intended to elevate the architects from the construction sites and studio workshops, or *ateliers*, to a structured institutional environment. However, the customs of the medieval guilds lived on since the academicians continued to have apprentices in their *ateliers*, the places in which design was actually learned. A student attended lectures at the school, but his work was done in the *ateliers*, independent of the Académie.

Jean-Francois Blondel, who became later one of the influential academicians during the early years of the Académie, began his own design school, the Ecole des Arts, in 1740 because "there was no school in Paris where a young man might be trained and learn everything he needed" under one roof. He believed that it was "indispensable to unite the study of the relevant arts" and to learn their relationships. Blondel began his private full-time training ground for architects with several teachers of varying disciplines under his direction. It was only later in 1743

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[4] Chafee, Richard. 1977. "The Teaching of Architecture at the Ecole des Beaux-Arts" in Drexler, A., ed. 1977. *The Architecture of the Ecole des Beaux-Arts*. Cambridge, MA: MIT Press. p. 61. Chafee describes both the curricular and political context of the teaching of architecture in the Ecole des Beaux-Arts including the fundamental doctrines of the Ecole during its various leaderships.
[5] Ibid, p. 61.

that the Académie officially gave, with resistance, Blondel's school permission to teach architecture. Unlike the Académie's lectures given two mornings a week, the students lived and learned at the Ecole des Arts ten hours a day, six days a week, engaged in everything from architectural composition to quantity surveying.[6] This type of environment became the model for the educational *atelier*.[7]

The Académie Royale d'Architecture grew from twenty-eight students in 1717 and to forty-seven in 1746,[8] but during the French Revolution and with brewing volatile internal politics, the Royal Academy system was abolished in 1793.[9] However, the architectural school and its teaching style persisted from the Académie Royale d'Architecture to its interim incarnation as the Ecole Spéciale d'Architecture in 1795 and finally to the Ecole des Beaux-Arts, from 1819 to its closing in 1968 during the riots at the University of Paris.

2.1.2 The Curriculum at the Ecole des Beaux-Arts

The curriculum at the Ecole des Beaux-Arts was established by its original regulations of December 27, 1823 and the methods of Beaux-Arts teaching and learning remained essentially the same until the Ecole's closing in 1968. It was a well-organized curriculum with specific stages based on the idea that there were universal design principles that could be rationally and systematically learned. The strictness of the material and methods was balanced by the flexibility in how the students went through the program. Anyone, between the ages of fifteen and thirty could apply. There was no tuition charge and all the lectures were optional.

The method was based on a system of *concours*, or competitions, and the student progressed at his own pace through the stages of *aspirant*, *élève*, and finally *diplomé*.

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[6] Collins, Peter. 1979. "The 18th Century Origins of our System of Full-time Architectural Schooling." *Journal of Architectural Education* 33:2. pp.2-6.
[7] Egbert, Donald Drew. 1980. *The Beaux-Arts tradition in French architecture*. Princeton, N.J. : Princeton University Press. p. 38.
[8] Chafee. 1977. p. 65.
[9] See Chafee, 1977, and Egbert, 1980 for an account of the people and events involved in the demise of the Royal Academy.

The curriculum involved the following stages: [10]

1. Aspirant

The *aspirant*, or aspiring student of the Ecole, would first find a *patron* and an *atelier*. Many students chose the *atelier*, or studio, according to the reputation and design attitude of the *patron*, the studio master. Some picked the *atelier* according to the kind of working atmosphere established by the members of the *atelier*. Once with a *patron*, the prospective student would register at the Ecole des Beaux-Arts and become an *aspirant*. The *aspirant* spent his time preparing for entrance exams to the Ecole. These exams, oral and written, were in architectural design, mathematics, descriptive geometry, history, and drawing. The *aspirants* would have privileges to the resources of the Ecole, such as the library, the collections of castings for sketching, and the public lectures. Although self-paced, this stage as *aspirant* usually lasted two years.

2. 2nd class Elève

Once the *aspirant* passed the entrance exams, he became an *élève*, or student, in the second class of the Ecole. The *élève* spent his time doing *concours* in hopes of being promoted to an *élève* of the first class by acquiring *valeurs*, or points, given for the quality of his completed competitions. This usually required two to four years.

3. 1st class Elève

Once promoted to *élève* in the first class, the student spent most of his time doing more elaborate *concours*. The ultimate goal of the best students was the prestigious *Grand Prix de Rome*. The competition for this prize, lasting almost half a year and implemented in stages, was conducted not by the Ecole but by the Académie des Beaux-Arts of the Institut de France and open to any French citizen under thirty years of age. The winner of the *Grand Prix de Rome* was

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[10] See Chafee, 1977 and Carlhian, Jean Paul. 1979. "The Ecole des Beaux-Arts: Modes and Manners." *Journal of Architectural Education* 33:2. pp. 7-17 for a detailed review of the curriculum.

considered the most promising architect and he would continue his training in Rome. Upon his return, he would be responsible for a public building, be a *patron* in an *atelier,* or teach at the Ecole. This ultimate prize was only available to one person, so many students did not compete for this last prize and others competed several times before winning. The end of an *élève's* career at the Ecole would be attaining the *Grand Prix* or surpassing the age limit of thirty.

4. *Diplomé*

In 1867, the designation of *Architecte Diplomé par le Gouvernement* was established to mark the culmination of studies for students of the first class who had completed a certain number of *concours.* In 1887, the diploma became popular because the Ecole began to award it to all the living winners of the prestigious *Grand Prix de Rome.* By the mid-1890's, to be a *diplomé* was the final goal of the student at the Ecole. With the designation came an increased number of students. In 1906-1907, there were nine hundred and fifty students.[11] To accommodate all the students, the Ecole established new preparatory *ateliers* and more prizes. The *ateliers* became official within the Ecole and the *patrons* went on the payroll of the Ecole. These internal studios, or *ateliers intérieurs,* were more formal than the original *ateliers extérieurs* or *libres.*

2.1.3 Distinguishing Features of the Beaux-Arts System: *Concours* and *Ateliers*

The most significant part of the Beaux-Arts system was its method. "The features of this system at the Ecole, as summed up by Walter Cook in an article that appeared in the issue of the Architectural Record for January 1901, are:

1. The divisions in ateliers.
2. The tradition of the older pupils helping the younger.
3. The teaching of design by practicing architects.
4. The beginning of the study of design as soon as the student enters the atelier.
5. The system of the esquisse."[12]

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[11] Chafee, 1977. p. 106.
[12] Harbeson, John F. 1927. *The Study of Architectural Design.* New York: The Pencil Points Press, Inc., p. 2.

The System of Esquisse and Concours

The system of *concours*, or competitions, originated during the time of the Académie Royale d'Architecture. In 1717, the Académie began planning for annual student competitions that would award gold and silver medals. In 1720, the first of these competitions took place as the last exercise of the school year. In 1763, smaller monthly competitions, or *prix d'emulations*, began to be awarded.[13]

The concours method applied to all domains of the curriculum. Concours were given in mathematics, descriptive geometry, perspective, drawing, history, and construction, the latter being the most difficult for the *élève* of the second class. The largest number of these concours was in architectural composition. There were two types: the shorter and simpler *esquisses*, or sketches, and the longer and more detailed *projet rendus*, or rendered projects.

A student had to be enrolled for at least two concours a year to maintain his status as an *élève*. Each month, a concours was offered. The process of enrollment was as follows:

- An *élève* would select a *concours* and then go *en loge* for twelve hours in a room with others in the *concours*.

- He would produce an initial drawing sketch, or *esquisse*, and give it to the guard upon leaving if he wanted to participate in the *concours*. Some students would use the twelve hours *en loge* as training and not submit the sketch.

- He would take a tracing of the sketch back to his *atelier* where, with the criticism of his *patron* and the help of the members of the *atelier*, he would develop his idea.

- Upon submission of the project, a jury of practitioners would judge the design by comparing the sketch completed *en loge* with the final drawings, which were supposed to reflect the same idea. If not, it was out of the

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[13] Ibid, p. 64

competition, or *hors de concours*, and the student would not receive any *valeurs*. The purpose was to ensure that the student developed his own idea and that the *patron* and members of the *atelier* did not do the design. The jury process was behind closed doors.

- Although this private jury system was not an educational process, all the competition entries, each attached with the sketch made *en loge*, were later exhibited. The students, sometimes with their *patrons*, went to the exhibition to study the projects. Figure 1 illustrates these *concours* events.

a. Students *en loge*[14]

c. Closed jury[15]

b. Competition submission[16]

d. Exhibition[17]
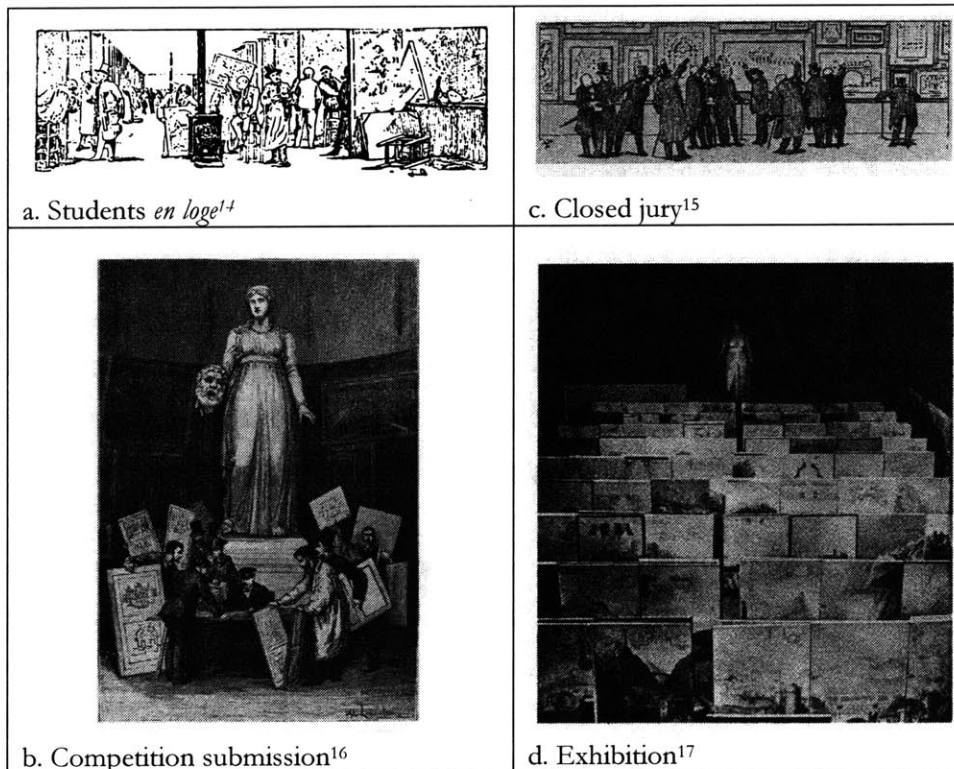
Figure 1: *Concours* events at the Ecole.

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[14] Drawing by L.-B. Bonnier, from de Penanrum, Roux, and Delaire, *Les Architectes élèves de l'Ecole des Beaux- Arts.* 1819-94, Paris, 1895 as included in Chafee, 1977, p. 84.

[15] Drawing by L.-B. Bonnier, from Delaire, *Les Architectes élèves de l'Ecole des Beaux- Arts.* 1793-1907, Paris, 1907 as included in Chafee, 1977, p. 92.

[16] Drawing from Alexis Lemaistre, *L'Ecole des Beaux-Arts dessinée et racontée par un élève*, Paris, 1889 as included in Chafee, 1977, p. 93.

[17] As illustrated in Chafee, 1977, p. 93.

The system of *concours* developed individual design skills as well as group collaboration skills. Emphasis was given to individual design work during the élève's time *en loge* as he developed his main idea, or *parti*, by himself. Here, "one of the chief objects of the Beaux-Arts method [was] to teach a man to confine his efforts to a well-defined channel."[18] Group design and coordination skills were developed in the *atelier* as the student continued his work with the help of his colleagues.

The System of Ateliers

The *atelier* was the place in which the students actually learned to design. The Ecole provided resources and programs and issued and judged competitions, but the education of the architect remained in the *ateliers*. The size of the *ateliers* varied. A *patron* could have one student or, more likely, students would ban together and a *patron* would have in 1900 from 30-80 students.[19] These *ateliers* were not offices but private design schools. An *élève* may be attracted to a particular *atelier* because of the *patron*, but also because of the *atelier*'s social atmosphere. The reputation of a *patron* was not only established by his design accomplishments, such as winning the *Grand Prix de Rome*, but it was also distinguished by his teaching abilities as shown by the number of students in his *atelier* competing and winning the *Grand Prix*.

The *patron* was the head of the *atelier*, but it was really run by the students. The *atelier* had a hierarchy of members, from the *anciens*, or veterans, to the *nouveaux*, or newcomers. There was an elected *massier*, one of the *anciens*, who managed the logistics of the *atelier* such as the rent and supplies. The social organization and traditions of the *atelier* and the learning ladder experienced by a *nouveau* were important aspects of the environment. The *nouveaux* learned quickly as a result of the *atelier's* traditional mentoring system where these *nouveaux* would help the *anciens*

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[18] Esherick, Joseph. 1977. "Architectural Education in the Thirties and Seventies: A Personal View" in Kostof, Spiro, ed. *The Architect: Chapters in the History of the Profession*. New York: Oxford University Press. p. 260.
[19] Chafee, 1977, p. 90.

with mechanical tasks in exchange for guidance and criticism on their design work. The *atelier* system not only required discipline, long hours, personal initiative, and teamwork, but group coherence and pride were also needed. This system worked because the *atelier* nurtured a spirit of cooperation and a sense of reciprocity. There was an understanding that each member had a place and a stake in the process and success of the *atelier* and that every *nouveau* would one day become an *ancien*, providing continuity and sustainability in the community.

Chafee describes the exchange of services in the *ateliers*, where the *anciens* learned to manage a production staff and the *nouveaux* were immediately thrown into the activities of design:

> "The anciens (..) gave the benefit of their experience to the nouveaux by criticizing designs, not in formal sessions but in the endless exchange of ideas about architecture that was the intellectual life of the atelier. The nouveaux assisted the anciens with presentation drawings: tracing shadows on facades, repeating patterns of ornament, and inking plans."[20]

Draper describes the experience of Americans who went to study in the French *ateliers*:

> "Whichever atelier they chose, Americans were greatly impressed by the atmosphere they found there. Tales of rowdy parties, mad charrettes, and lively traditions filled their reminiscences. The key ingredient of atelier spirit was group loyalty. The patron's little band pulled together to defend its honor against the other studios. Everyone, from the greenest nouveau to the most advance ancien, helped one another, at the same time maintaining a friendly internecine rivalry. The anciens criticized the work of the nouveaux, and the nouveaux pitched in to help the anciens render plates for a big competition. The atmosphere of cooperation and the personal guidance of the patron were as important as the more formal aspects of the program."[21]

Typically, the *patron* came into the *atelier* two or three times a week and brought some formality to it. He would conduct his critiques by going from table to table.

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[20] Ibid, p. 92.
[21] Draper, Joan. 1977. "The Ecole des Beaux-Arts and the Architectural Profession in the United States: The Case of John Galen Howard" in Kostof, Spiro, ed. 1977. *The Architect: Chapters in the History of the Profession*. New York: Oxford University Press. p. 223.

The group of students, however, was the true heart of the *atelier*, not the *patron*. A student rarely changed *ateliers* but the *atelier* would change *patrons*.[22] Chafee reveals some impressions of the *patrons*:

> "Of Léon Jaussely in 1919: When he had arrived... he had been greeted with profound ceremonial respect. He had moved from table to table, with the élèves grouped behind him with bated breath – not one word or other sound disturbing his criticism. Every word was treasured (the older men would interpret his critique later, for the benefit of all)... When he came to my esquisse... he vigorously illustrated his commentary on proportions with a diagrammatic sketch no larger than a small postage stamp. I got the point."[23]

> "Of Victor Laloux at the turn of the century: Followed by his pupils, he went from table to table, giving his criticism to each student in turn; having made the rounds, he would bow, put on his silk hat and quietly leave the room, but no sooner was the door shut than pandemonium would break loose and a noisy discussion on what he has said follow."[24]

The *atelier* spaces were simple and often located near the Ecole. They were open spaces with drafting tables and places to pin up drawings, some as long as twenty-six feet.[25] Chafee offers a description of an *atelier* by a student in 1903 to give a sense of its spirit:

> "The ateliers... occupy quarters in old buildings where cheapness and dirt keep company. A crowd of students is not a desirable neighbor: they sing much, often through the night. The walls of the rooms are decorated with caricatures and pictures until a dark somber tome is attained the accords well with the dirt, dishevelment, and confusion of the place. The lighting is by candle, and each man furnishing his one or two candles that are stuck to the board on which he is working. The air of the room is close, for there is no ventilation. Silence never prevails. Jokes fly back and forth, snatches of

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[22] Chafee, 1977, p. 95 describes cases when students chose their own *patrons*. For example, after the death of the *patron* Blouet in 1853, his students chose the successor to their *atelier*. Another case was when the students of the *atelier officiel* of the late *patron* André walked out and rented their own *atelier* with their chosen successor, Laloux when the Ecole refused their choice of *patron*. In the 1930's students did begin to change *ateliers* and this weakened the *atelier* spirit. The cohesiveness of the *ateliers* was also weakened when they became so large that they required two shifts, each working on separate *concours*.

[23] Ibid, p.94. The excerpt was from Harry Sternfeld in the *NLAE Golden Jubilee Journal*, New York, 1964, p.53.

[24] Ibid, p. 94. This excerpt was from Williams Adams Delano, *A letter to my Grandson*, privately printed, New York, 1944, pp. 35-36.

[25] Ibid, p. 87.

songs, excerpts from operas, at times even a mass may be sung, yet amid the confusion and the babble – strange as it may seem – work proceeds."[26]

2.1.4 The Beaux-Arts Method in America

The Beaux-Arts method of architectural design education was imported into America by the men who were educated at the Ecole des Beaux-Arts and it was appropriated by a growing number of educators who wanted more uniform and higher standards for the profession and who believed that the profession could be advanced by better education.[27]

The first American to study at the Ecole des Beaux-Arts was Richard Morris Hunt in 1845.[28] After a brilliant career at the Ecole, he returned to work in New York City and eventually opened his own *atelier* in 1857.[29] A former student in Hunt's *atelier*, William Robert Ware, was asked by William Barton Rogers, the president and founder of MIT, to build the first formal school of architecture in 1865.[30] Ware developed the program around the principles of the Beaux-Arts method and the first students began study at MIT in 1868.[31]

A group of former students of the Ecole, on their return to America, created the Society of Beaux-Arts Architects in New York in 1894 "to cultivate and perpetuate the associations and principles of the Ecole des Beaux-Arts of Paris."[32] The Society of Beaux-Arts Architects was later incorporated to the Beaux-Arts Institute of

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[26] Ibid, p. 91. Chafee takes this excerpt from Blair, Walter D. "Students Life at the Ecole des Beaux-Arts," *The Brickbuilder*, vol. XVIII (March 1909), pp. 52-54.

[27] Draper. 1977. pp. 209-237.

[28] Silvergold, Barbara Kornfeld. 1974. *Richard Morris Hunt and the Importation of Beaux-Arts Architecture to the United States.* University of California, Berkeley PhD dissertation.

[29] Noffsinger, James Philip. 1955. *The Influence of the Ecole des Beaux-Arts on the Architects of the United States.* Washington: Catholic University of America Press.

[30] See Chewning, J. A. 1986. *William Robert Ware and the Beginnings of Architectural Education in the United States, 1861-1881.* MIT PhD dissertation.

[31] Letang and later Despradelle, both former students of the Ecole, taught design at MIT and continued Ware's approach to the program.

[32] Bosworth Jr., F.H and Jones, Roy Childs. 1932. *A Study of Architectural Schools.* New York: Charles Scribner's Sons, p. 37.

Design (BAID),[33] which was the American incarnation of the Ecole as the prestigious authority of architectural education. Schools from across the country obtained their competition programs from the BAID.[34] The competition entries were sent to the BAID for closed jury reviews. There was also a chance to compete for the Paris prize, which gave the winning American student the opportunity to go to the upper class in the Ecole des Beaux-Arts in Paris to finish his architectural studies and travel in Europe.

Gradually, the schools began to have their own juries for reviewing the competitions and then created their own competition programs.

In the American *ateliers*, the spirit of informal hierarchical learning was alive and well, as Harbeson suggests:

> "Criticism from those in one's own class is often of use even though much of it comes in the guise of good natured banter.
>
> Now when a student becomes a Class A man he must realize that in his turn he must give this help to his juniors –not with the idea of forestalling the criticism of the Patron, or taking its place, but to prepare for the Patron, to supplement him, for the good name of the atelier and for its *esprit de corps*.
>
> And he soon learns that this help to the younger men, while it is gratefully received and appreciated by them, is of incalculable value to himself. He finds his ideas come more freely on someone else's problems than on his own because he approaches it with a freer mind – one's thinking sometimes gets into a rut on one's own problem from thinking so long and so hard on the one thing."[35]

Joseph Esherick, a student of Harbeson's at the University of Pennsylvania in the 1930's, spoke of the studio as being the students' "home and the center of [their] academic and social life."[36]

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[33] The Beaux-Arts Institute of Design after 1956 became the National Institute for Architectural Education.

[34] See Harbeson, 1927, for a detailed account of the curriculum and examples of order problems, class B plan problems, class A problems, sketch problems, and prize problems in the Beaux-Arts Institute of Design.

[35] Harbeson, 1927. p. 182.

[36] Esherick, 1977. p. 249

2.2 The Contemporary Design Studio[37]

Today, the modern *atelier*, or design studio, still retains traditions from the Ecole des Beaux-Arts. Although changing educational, institutional, and professional interests have altered the studio throughout the years, its essential characteristic as a place for project-oriented social learning with specific roles, processes, and events persists. As much time, energy, space, and resources are devoted to the design studio, its prominence in the architectural curriculum continues. The studio, as a curricular subject and a physical place, is central to the design student's activities. [38]

2.2.1 Studio Membership, Roles, and Relationships

The primary members of the studio are the instructor and his students.[39] Depending on the instructor, other participants might be introduced in the studio. Outsiders are often invited for either a one-time visit for a review or lecture. Less often, outsiders are invited to participate throughout the studio, acting much like a

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[37] The descriptions in this section are primary based on my own personal experiences in design studios during my architectural education, my interpretive overview of studios at MIT during the last six years from conversations with numerous students at different stages of their academic careers, and my detailed observations of two design studios at MIT during the spring semester of 1997. One was an undergraduate studio with Professor Andrew Scott and the other was a graduate level studio with Professor Ann Pendleton-Jullian. I collected my observations of the studio by attending the studio meetings, videotaping and analyzing the deskcrits and reviews, and by structured interviews and informal conversations with the professors and the students. These studios were chosen because they differed in design levels, complexity of the design problem, the styles of the instructors, and the social organization of the studio.

[38] At MIT, in 2000, in a first year graduate program, the design studio class represents two fifths of the required number of units per semester. Four hours a day, three times a week, are allocated as the official studio working time. The real practice in the studio often requires the student to devote much more energy and time in the studio projects than for the other subjects in the curriculum. But the students spend much more time in the studio than the official hours, working both on design work and other subjects. The studios, where each student is allocated a desk and personal workspace to make his own, are often their homebases, academically and socially. Cuff (1991) has also reported about the dominance of the design studio where in some schools, "almost seventy percent of an architectural curriculum takes place in or is related to the studio." p. 65.

[39] Although some instructors teach studio in teams, for the most part, studios are taught by one instructor and helped by one or more teaching assistant as in the MIT cases. The role of the teaching assistant differs depending on the instructor. The assistant may be very involved in the design learning or he may be only involved in coordination and logistical issues.

co-instructor. These outsiders include critics, practitioners, consultants, or clients, but the instructor has ultimate responsibility and control of the learning process and the grading system.

The dominant relationship for learning is between an individual student and his instructor. Schön, following John Dewey, considers the role of the design instructor to be that of a coach and it is though practical work and coaching, rather than teaching, that the student learns about design and designing.[40]

The peer relationships that were so important in the Beaux-Arts method are underplayed in the contemporary studio. This is not to say that there are no instances of group coherence or peer learning in the studio. There are, but they are not ritualized into the process as at the Ecole. When and if they occur, the degree of cooperative spirit varies depending on the members of the studio. For example, I have seen a studio with members feeling so strongly as a group that they asked the administration not to separate them as they advanced to the following level in the curriculum.[41] There are also instances of students helping each other by informally giving design advice and by assisting with the production of drawings and models at the end of the semester. One student, at the end of her thesis project, had a group of friends from other studios help with her presentation work. A recent graduate even came back to assist in order to repay the help that he received from her the year before. But unlike at the Ecole, this assistance is not consistent throughout the studio; another student in the same thesis class, had no helpers at all and even believed that asking for help was not acceptable.

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[40] See Schön, Donald A. 1987. *Educating the Reflective Practitioner*. San Francisco: Jossey-Bass. He follows John Dewey's ideas about learning by doing, helped along by a coach. Dewey suggests, that the student "has to see on his own behalf and in his own way the relations between means and method employed and results achieved. Nobody else can see for him and he can't see just by being 'told', although the right kind of telling may guide his seeing and thus help him see what he needs to see".
(From Dewey, J. 1974. *John Dewey on Education: Selected Writings*. ed. R.D. Archambault. Chicago Press. p. 151.)
[41] The group even declared themselves the "Barney Studio", following the children's character that values family coherence.

The relationships between the student and the visitors to the studio also vary. They are filtered by the instructor and by the atmosphere that he creates for the studio. As I observed two studios at MIT, I found differences in the instructors' attitude about outsiders to the studio. These two studio classes, although located adjacent to each other in the large studio space, were very different in terms of content and style as established by the studio instructor. The feel of the undergraduate studio was very open both in its physical configuration and its acceptance of outsiders, such as myself, into the process. The desks were arranged in open plan with many of the student desks facing their classmates. When I asked to be an observer in this studio, I was permitted, without hesitation, but only if I would participate as a critic. That is, I could only be an observer if I participated in the studio. The graduate studio had a more intimate and insular feel. The students arranged their desks inwardly, building little work niches for themselves. When I asked to observe that studio, the instructor wanted to know more about my role and activities and needed time to think about it and to ask her students' permission. I was permitted into the studio by consensus and my role was purely as an observer. Although I felt very welcomed in the studio, I also understood well that I had no right to influence the practices of the studio. In fact, I was praised later for my unobtrusiveness in the studio process.

2.2.2 Studio Content and Processes

The studio's content and processes give rise to the design practices of its members. The type of projects and learning conditions come from the structure of the curriculum as well as the style and skills of the instructor.

The Curriculum

Design studios, like other classes in the program, fit into an overall curricular system and organizational structure. Unlike the early days of the Ecole, with its optional lecture classes and freedom in entering competitions, the curriculum at MIT, like other professional schools, is dense and well defined into a prescribed time frame. The three and a half year time period to obtain a Master in Architecture, the professional degree at the Department of Architecture and the heart of the design

program at MIT, is filled with required technical and theoretical classes and a sequence of studio classes. Figure 2 shows the structure of the curriculum.

MIT Master of Architecture Curriculum 1999-2000		
Semester	**Subjects**	**Required Units**
Year 1 Fall	Level I Studio	18
	Building Technology	9
	Contemporary Architecture	9
	Design Skills Workshop/Elective	9
Year 1 Spring	Level I Studio	18
	Structures I	9
	Architecture 1750 to Present	9
	Elective	9
Year 2 Fall	Level II Studio	18
	Structures II	9
	Geometric Modeling	12
	Elective	9
Year 2 Spring	Level II Studio	18
	Energy in Building Systems	9
	Architecture in History and Present	9
	Elective	9
Year 3 Fall	Level III Studio	18
	Integrated Building Systems	12
	Elective	9
	Elective	9
Year 3 Spring	Level III Studio	18
	Professional Practice	6
	Elective	9
	Elective	9
	Thesis Preparation	3
Year 4 Fall	Thesis	24
	Elective	9
	Elective	9
Total	**27 Subjects and Thesis**	**294 +Thesis**

Figure 2: MIT Master of Architecture curriculum at MIT.[42]

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[42] Obtained from MIT's Department of Architecture Handbook, 1999-2000, p.53. Edited by Nancy Jones and Renee Caso.

Choosing a Studio

The *aspirant* at the Ecole des Beaux-Arts chose his *atelier* by evaluating the reputation of the patron and the work he had accomplished. He also used the membership of the *atelier* as criteria since he understood that he would be engaged in the camaraderie and the traditions of collaborative learning and teaching found in an *atelier* and one day become one of the *atelier's anciens*. Once accepted into the *atelier*, the *aspirant* also accepted to be a member of that community for a number of years.

A design student at MIT selects a studio according to his interest in the teaching processes determined and demonstrated by the instructor and also according to the studio content and design problem. The upper-level studios are assigned through a lottery system in which the student chooses the studios in the order of his preference and he is assigned one of these choices. He understands that he would be a member of that studio group for the duration of the semester. It is only when everyone accepts the administrator's lottery results that the student knows the identity of his ten to fifteen other studio-mates. This system is intended to ensure an even distribution of students in the studios and to give a variety of studio experiences to the students. Unlike for the *aspirant*, the social and work environment of the studio plays no role in a student's studio selection.

Individual Work

The lottery system sets up a scenario where the student enters the studio with high expectations of his relationship with the instructor and no expectations of that with his peers. The process already begins to favor individual work over group work. It is exacerbated by an institutional grading system based on the technical competences of the individual. It is up to the instructor to foster alternative learning processes, such as group projects or group activities for segments of the design investigation, such as conducting precedent studies or preparing site information (Figure 3).

Figure 3: Interpretations of the building site by the studio as a group.

There are instances of directed group work in design studios, but individual work seems to be the focus of many studios, despite our understanding that real-life design practice is often about collaboration and negotiation.[43]

In the Ecole des Beaux-Arts, the individual work of the *élève en loge*, working on the *esquisse* in isolation, was balanced by the group development of the project in the *atelier*. This group work and the competitive spirit between one *atelier* and another gave the individual *ateliers* coherence and marked the social and educational growth of the members. In the contemporary studio, the focus on individual products has different consequences on the social life of the studio. Because all the students in the studio are working on the same design problem but on an individual basis, there is an air of competition between the students within the studio. In the best of cases, it is a competitive camaraderie. One student gave an example of this when she told me that she used the competition that was so obvious in her studio to her advantage. Whenever she saw her colleagues making leaps of progress on their designs, she immediately went to work. In that studio, the students also had the habit of playing with their colleagues' design models that they thought were

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[43] The majority of the studios I have experienced involved primarily individual work, as in the two cases observed at MIT. Some of the students I interviewed told me that they had never participated in a group studio project before, perpetuating the popular view of designers as creators working in isolation.

particularly good. They moved them to odd places in the studio and placed pennies on them. It became an honor to have your model displaced and it encouraged the students to keep their work visible. The sense of competition set the pace and the quality of the studio. But that competitive nature can also have destructive effects. A frustrated student from another studio told me that she disapproved of her studio-mates' "borrowing" of her idea to use an innovative material for her sketch model. She had "discovered" it first. The competition she felt made her become secretive about her design process.

Learning and Coaching Design[44]

Schön suggests that the design process is an "reflection-in-action."[45] It involves the designer to think as he designs and it assumes that competence is embedded in practice. In reflection-in-action, the designer engages in a conversation with the design material to see it in a different light. With this "back talk" from the design, he "makes sense of a situation he perceives to be unique [and] he *sees* it as something already present in his repertoire."[46] This "seeing-as" may lead the designer into "on-the-spot experimentation" by "doing-as" he did in his previous experience with similar material. He designs, then, by reinterpretation or reframing of the situation and tries to adapt the situation to his new frame. Schön adds that, "if they are good designers, they will reflect-in action on the situation's back talk, shifting stance as they do so from "what if?" to recognition of implications, from involvement in the unit to consideration of the total, and from exploration to commitment."[47]

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[44] See Porter, William L. and Kilbridge, Maurice. 1981. *Architecture Education Study.* Consortium of East Coast Schools of Architecture. Andrew W. Mellon Foundation, for detailed cases studies of design learning and coaching in the traditional studio.
[45] See Schön, Donald A. 1983. *The Reflective Practitioner.* New York: Basic Books; Schön, Donald A.. 1985. *The Design Studio: An Exploration of its Traditions and Potentials, Architecture and the Higher Learning.* London : Portland, OR: RIBA Publications for RIBA Building Industry Trust; Schön, Donald A. 1987. *Educating the Reflective Practitioner.* San Francisco: Jossey-Bass.
[46] Schön, 1987. p. 67.
[47] Ibid, p.65.

If this is the process of design, how do we learn it or teach it? Schön suggests that design is not taught, but it is coached and that there is a "reciprocal reflection-in-action." The studio is "reflective in two senses: it is intended to help students become proficient in a kind of reflection–in-action; and, when it works well, it involves a dialogue of coach and student that takes the form of reciprocal reflection-in-action"[48] in which both student and coach give demonstrations and self-descriptions and comparisons of process and product.[49]

He describes coaching tasks as having a structure of telling and listening and demonstrating and imitating. From this structure, he proposes incremental models of coaching that include:

- "follow me!": The student accepts the demonstrations of the coach and repeats the actions. This is especially helpful in the early stages when the student designs without knowing exactly what it is and how to do it. In Schön's terms, he is in a "willing suspension of disbelief".

- "joint experimentation: This subsumes the model above where the student and the coach expect imitations to lead to experimentation. These experiments are simultaneously exploratory, where the designers gets to know the situation better; move-testing, where the consequences of design actions are considered; and hypothesis-testing; where some overall theory in the design is tested.

- "halls of mirrors": The coach mirrors the actions of the student to help make visible the student's inner processes or frames. On the receiving end, the student experiences his past processes from the outside as a "frame reflection."[50]

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[48] Ibid, p. xii.
[49] Ibid, p.118.
[50] Ibid, pp. 252-254.

During this process, the student, with the help of the coach, enters the act of design by constructing and imposing a unique coherence and structure to an ill-defined design problem.

2.2.3 Studio Events and Organization

The learning process may occur throughout the studio by the student's own learning-by-doing activities, by his interactions with coaches and studio-mates, and by "background learning."[51] The design studio, an instance of Schön's reflective practicum, has one basic activity for coaching: the critique, or crit, where a design critic reviews a student's design work with him. Crits are performed in different contexts varying in degrees of intimacy and formality, from the deskcrit to the final public review. Learning may also occur by peripheral participation in the context or "background" of the design studio.

Intimate Deskcrits

The most intimate coaching between a student and his design instructor is during the deskcrit. Deskcrits are typically one-on-one conversations between a student and a design coach. The student interacts with the coach in the public studio space that is filled with reference materials and other students. The student typically has to make room for the instructor at his desk, which is covered with drawings and models of his work-in-progress. The instructor has either appointments to see the individual students during the official hours of the studio or he may simply walk around the studio looking over the shoulders of the students to initiate a deskcrit.

Depending on the style of the instructor, the deskcrit may be a verbal discussion around a design object or it may be a dialogue supplemented with sketching and demonstrations using models (Figure 4). The content of this dialogue may range from technical problem solving to suggestions of representational methods to conceptual description of what it is to design. During this fluid conversation, the

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[51] Ibid, p. 38.

coach gives clarifications, suggestions, evaluations, analogies, and interpretations in order to recast or reinforce the design ideas presented by the student. [52]

Figure 4: Intimacy of the deskcrit with the student and the design material.

Unlike the *patron's* visit to his *atelier* where the deskcrits were observed by all the *élèves*, modern deskcrits are viewed as private encounters in a public environment (Figure 5). At the Ecole des Beaux-Arts, the open reviews at the table provided a way for the *anciens* to help the *nouveaux* later in understanding the *patron's* reframing of the design situation. In the contemporary studio, students rarely interrupt a fellow student's deskcrit. Still more rare, would a student join in on another's

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[52] See Schön, 1987, and Porter and Kilbridge, 1981, for detailed accounts of design conversations during deskcrits.

deskcrit. Individual deskcrits, despite their privacy, may be considered beneficial to all the students of the studio, since many of the concerns covered during one deskcrit may also be applicable to another student's work. Although informally, and sometimes unconsciously, practiced, the open space of the studio allows the students to learn from their neighbor's deskcrits by eavesdropping (Figure 6).

Figure 5: Deskcrits as private encounters in a public space.

Figure 6: Learning by eavesdropping during deskcrits.

Public Reviews

At the other end of the intimacy spectrum is the juried review. These formal and public reviews are usually at the midterm and final marks of the studio. The students come prepared, and often newly coiffed, with a detailed set of presentation drawings and models. Typically, they mount the drawings on the walls and place the models of varying sizes on tables or on the floor in front of the panel of invited jurors,

often composed of distinguished practitioners. The entire review usually lasts a few hours in which each student presents his project proposal and the jury offers spontaneous critiques (Figure 7). During this event, the jurors not only speak with the student but they also demonstrate their critiques by interacting with the design material (Figure 8). Some critics even get up and walk up to the material for a closer look during the student's verbal presentation.

Figure 7: Students present design proposals and critics respond.
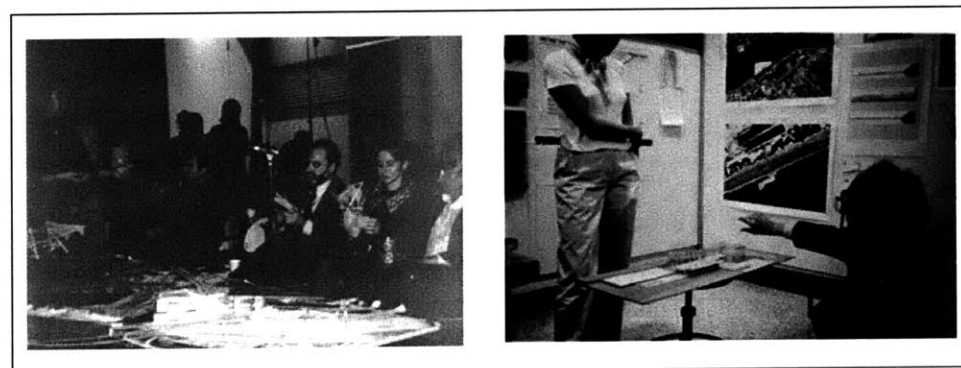
Figure 8: Using physical props for design demonstrations.

Unlike at the Ecole, where the judgment of the *concours* was held behind closed doors, contemporary design reviews are often public events located in a formal presentation room and serve educational purposes. Dinham summarizes the purposes of the juried review as an event to criticize individual students' work, to

provide general design instruction, and to initiate scholarly, seminar-like exchange.[53] It also permits multiple and simultaneous reframing of the projects by outsiders.

The jury process has been criticized because the atmosphere can sometimes be fierce and unconstructive, even morally destructive. Some even call it a "hazing ritual."[54] Although this may be true in some cases, the jury system has important educational value in the overall learning environment of the studio, especially when thoughtfully coupled with the more intimate deskcrits.

In Between: Pinups and Charrettes

In between the first deskcrit and the final review, there are typically intermediate events, such as pinups and charrettes. Their frequency and style depend on the instructors and the students. Pinups are usually a cross between deskcrits and reviews in formality and privacy. All the members of the studio are required to attend the pinup session that is usually held in the informality of the studio or an adjacent space. During the pinup, the coach reviews the progress of each student in the presence of the other students who are encouraged to critique their colleagues' work. Its educational value is similar in character to the *patron's* visits into the *atelier*.

Yet another type of design event that I encountered during my studio observations was the wallcrit, a hybrid between the deskcrit and the pinup. The instructor insisted to review each student's work pinned up on the wall rather than at the desk. Her rationale was that when the drawings grew large in size and number, it was difficult to review them in the confinement of the desk. Although true, these wallcrits also had social repercussions. Suddenly, on the walls of the corridor, what was supposed to be equivalent to a private deskcrit was now open to anyone passing by (Figure 9). Students would feel less inhibition to stop, linger, and listen to a

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[53] Dinham, Sarah M. 1986. "Architectural Education: Is Jury Criticism a Valid Teaching Technique?" *Architectural Record* 174, no. 13:51, p.53.
[54] Anthony, Kathryn H. 1991. *Design Juries on Trial : The Renaissance of the Design Studio*. New York: Van Nostrand Reinhold.

wallcrit than a deskcrit. If it was interesting, they would stay and listen, otherwise they would go back to their desks to continue their individual work.
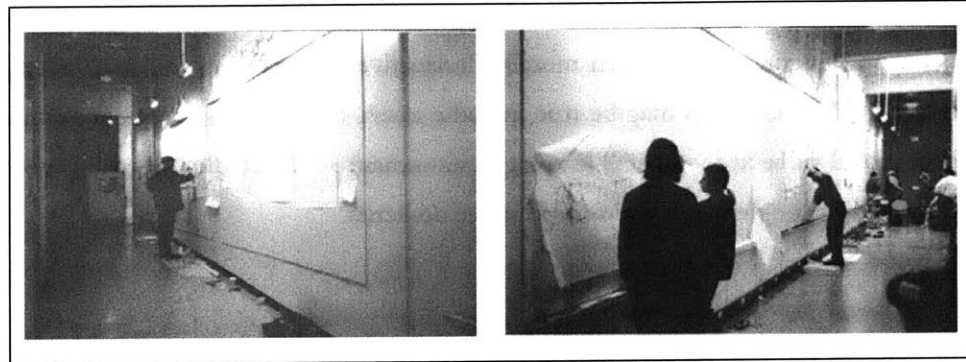
Figure 9: A wallcrit in the corridor with a pinup session in progress in the background.

The charrette is another typical event in the design studio. When the students work all night as the final push to meet a deadline, usually the midterm or final reviews, they are *"en charrette."* It has origins from the Ecole des Beaux-Arts, as Chafee explains:

> "Whenever the drawing were due [for the concours], people on the Left Bank could see the last steps in these shared efforts. Outside the ateliers, students would load their designs onto little handcarts that they would drag through the streets to the courtyard of the Ecole. This kind of cart, commonly used for all sorts of light haulage in Paris, was called a *charrette*; thus, being *en charrette* came to mean not only the rush to the Ecole, but also before that, the long hours of last-minute work in the atelier."[55]

Charrettes in the Ecole was about intense collaborative work, as the *nouveaux* helped the *anciens* with their *concours* deadlines. In today's studio, if the work is on an individual basis, the charrettes have a different feel. The students stay up all night quietly working at their desks, often with headphones streaming in their favorite tunes and keeping them in their separate worlds. There are often bursts of laughter and jokes as some stress is relieved. Many of the students have the option of

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[55] Chafee, 1977. p. 92.

working at home or elsewhere, but most work in the studio during the charrette for the social support of their colleagues, even if they are not working together on a project. One student told me that it was just nice to know that others were also staying up all night and that the social environment of the studio helped her work through the night. She also explained that she had wanted to do an "all-nighter" the day before, but when her studio-mates started to leave for home, she also left because it was just not enjoyable to stay up alone.

Depending on the instructor, the studio can also be a gathering place for more traditional learning events, like lectures and seminar-style discussions, or for site visits and quick talks regarding the studio's process and the coordination for upcoming events (Figure 10).
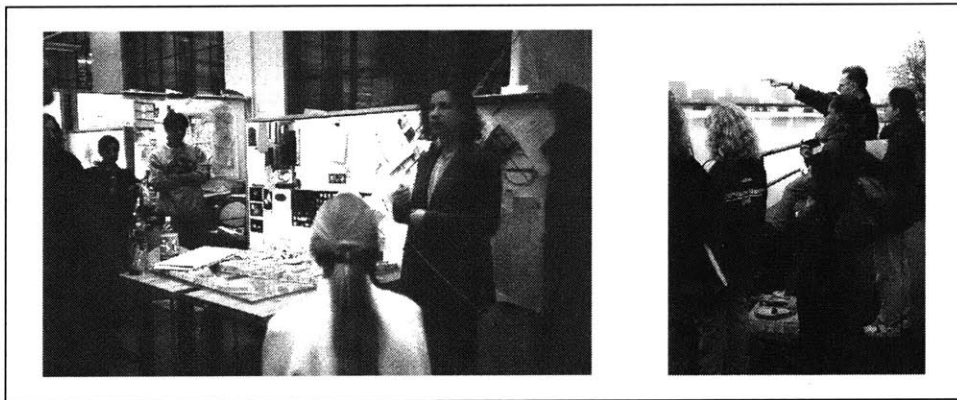
Figure 10: An instructor gathers the students for an impromptu discussion on an upcoming review. Another instructor takes his studio out for a site visit.

Eavesdropping and Voyeurism

We saw how eavesdropping on private deskcrits can be a valuable activity in the studio. Eavesdropping can be particularly effective when studios of different levels occupy a shared space (Figure 11). This exposes the student, particularly the undergraduate, to alternative studio approaches by giving him the opportunity to participate, very peripherally, in other studio groups. Although eavesdropping is usually unconscious, it can also be encouraged as one instructor did by outlawing

her students' use of headphones while she performed individual deskcrits in the studio.

Figure 11: Inter-studio eavesdropping when more than one studio shares a space.

Like eavesdropping, voyeurism is another valuable aspect of the informal learning environment of the studio. By voyeur, to complement the eavesdropper of deskcrits, I mean the student or instructor who walks around a studio casually looking at the work-in-progress left on the studio desks (Figure 12). It is a way of understanding the progress of the studio as a whole as well as an individual's work. One instructor even explicitly showed a student how to be a voyeur when, during a deskcrit with him, she guided him around the studio to other students' desks showing him alternative design approaches to a similar problem which he was facing.
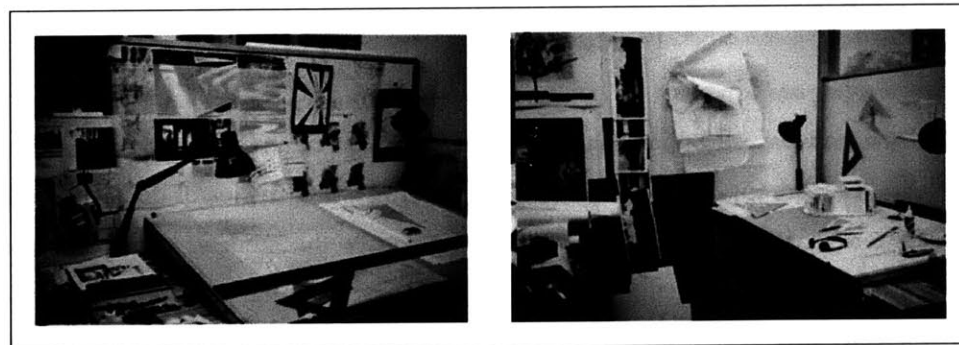
Figure 12: The voyeur's view of a student's work-in-progress.

Post-Studio Processing

At the end of the semester and after the final juried review, the design student has the final task of documenting and archiving his studio work. He does so for various reasons, the most important of which is to create his portfolio of design work. It is with this portfolio that the student will eventually search for a job. The documentation is also intended for the school's design archives, for educational use by subsequent students, and, in the case of MIT, for the overall evaluation of the student's work to determine his promotion to the next studio level.

For this archiving, student's work often is reduced to the final products of the studio, such as the presentation drawings and photographs of the finals models (Figure 13), and the important process of design derived from design explorations, decisions, experiments, conversations, and reflections is lost.
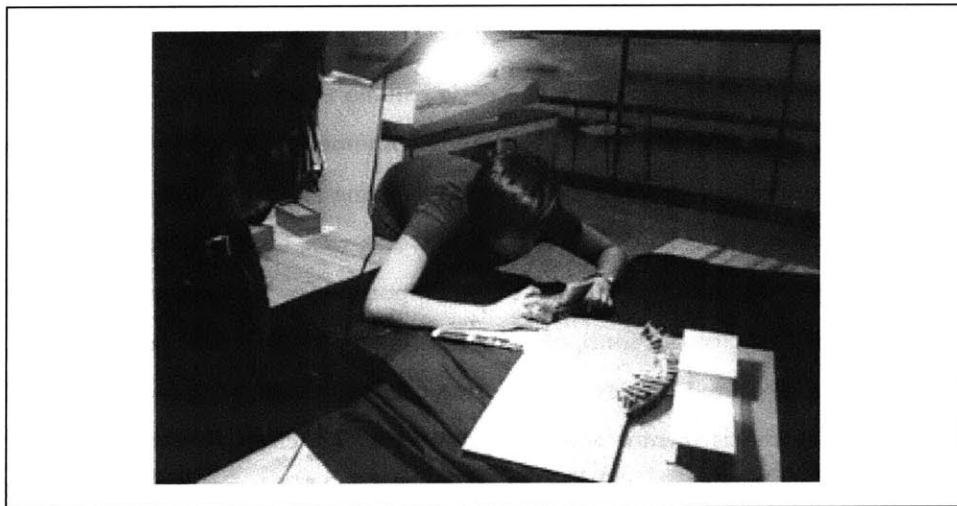
Figure 13: Student photographing the end products of her design process for her portfolio.

2.3 Strengths and Weaknesses of the Design Studio

The activities of design belong in "the indeterminate zones of practice," as Schön calls them, in which the designer is faced with situations of "uncertainty, uniqueness

and value conflict [that] escape the canons of technical rationality."[56] The design studio offers a place and a method to learn how to confront these ill-defined and complex design problems that have no singular correct answer. The learning that occurs in the studio then is not so much about acquiring and transferring particular pieces of technical knowledge, although that also does occur, but is more about exploring and internalizing multiple ways of seeing, creating, and transforming knowledge by creative construction. The most important characteristic of the studio that allows this kind of learning to occur resides then in it members and the spirit they give to the studio.

This spirit, inherited and refined by the *ateliers* of the Ecole des Beaux-Arts, is one of "freedom, competition, and variety."[57] It gives the studio its greatest strengths, but when the studio does not work well, this spirit also is the basis of its weaknesses.

2.3.1 Strengths of the Design Studio

The greatest underlying strength of the design studio is its members. Because the students and instructor are assembled into a common space joined by common interests and activities, they are poised to form some kind of community as they interact and work together. When the studio works well, this community provides various creative learning relationships and opportunities for the student. The students and instructor can form, over time, a community with a sense of purpose, belonging, and shared values. The student can develop deep and lasting relationships with his mentor and his peers as they are engaged together in their creative learning-by-doing. It is when a student feels membership in this community that he is quick to learn "the customs, methods and *working* standards

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[56] Schön, 1987. p. 6.

[57] Carlhian, 1979. p. 7. Jean Paul Carlhian characterizes the strength of his education at the Ecole des Beaux-Arts to be based on the freedom, competition, and variety of its method. In terms of freedom, he was able to choose his *patron,* pace his own learning, and enter the competitions of his choice. In terms of competition, he learned the nature of constructive competition between *ateliers* and within the group of *concours* entrants. In terms of variety, he had experienced variety in the assignments and in the cultural, economic, and political backgrounds of the people in his *atelier* and at the Ecole.

of the calling [which] constitute[s] a "tradition," and that initiation into the tradition is the mean by which the powers of learners are released and directed."[58]

The studio's spirit of freedom, competition, and variety give opportunities for a range of learning experiences in the studio. At best, a student is free to develop, with the guidance of the design coach, his personal path through the design process. He is free and sometimes encouraged to seek a variety of experts, to perform his own research, and to interpret multiple forms of knowledge in order to inform this process. This kind of freedom and variety in the student's learning-on-demand is highly motivating because it has immediate relevance to his tasks and project. Also, when the spirit of competition works well, a constructive camaraderie is developed and the peer pressure becomes motivating.

On the organizational level, the studio is free to include a wide range of events, in addition to the intimate deskcrit and the formal review, needed for the particular design problem, such as guest lectures, research seminar-type discussions, off-site visits and consultations. This project-oriented structure gives opportunities for the instructors to expose students to different people, processes, and expertise.

2.3.2 Weaknesses of the Design Studio

The benefits of the studio start with the group of people and their individual expertise. If a student is fortunate enough to be in a situation where he can build good relationships with talented individuals, then the studio may be the best place for learning design and he can take advantage of the spirit of freedom, competition, and variety. However, the limitations of the studio surface when there are few opportunities and when relationships fail. Consider the student in a design school in a remote area where few eminent practitioners might visit, let alone teach for a semester away from their busy practices. The students have few opportunities to be mentored by them or to interact with a diverse group of peers.

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[58] Dewey, 1974, p.151.

Even when there are opportunities for adding specialized expertise and collaborations, the studio system can still be very insular in cases when the student-mentor relationship fails or when the competition within the studio becomes destructive. The intimacy of the one-on-one mentoring is one of the studio's most valuable learning situations when it works well, but what happens when this relationship goes bad? The system assumes the mastery of the studio instructor, gives him unilateral control, and allows situations of "win/lose strategies of mystery and mastery"[59] in which the student thinks he cannot succeed because the design process and the coach are too mysterious.[60] In these cases, the student has little place to turn since he typically works alone and the conversations with the mentor are private and ephemeral. There is no one to interpret the guidance of the instructor as in the *ateliers* where the *anciens* helped the nouveaux understand the teachings of the *patron*.

On an organizational level, a continuous challenge for the studio is to fulfill its initial intention of being a place, like Blondel's Ecole des Arts, for integrating the theories of related disciplines, such as history and structures, with practice. The studio is often considered distinct from the other subjects in the curriculum. The insular nature of the studio maintained by a sole master may be part of the problem. A design instructor has little incentive to share his control in the studio. As a result, he does not take advantage of collaborations with experts from other disciplines that require additional efforts of coordinating joint content, curriculum, and educational visions. If the studio is also to be intended as a training ground for professional practice, then it falls short in its inclusion of design practitioners and their work environments as a social and technical resource to the studio.

Lack of community sustainability is another weakness of the contemporary studio. Learning communities take a long time to form in a studio. Surely the proximity of the participants, the intensity of project-oriented activities, and common interests

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[59] Schön, 1987, p. 135.
[60] Schön, 1987, calls this the paradox of learning to design, p. 82.

help, but it takes time and energy for a group to understand and develop it own language, social structure, and values. After this long formation period, even a thriving place-based community in the studio loses momentum when the project ends and the frequency of interaction dwindles. The studio takes no action to sustain these relationships that build the foundations of a design community.

Chapter 3
THE CASE STUDIES
Experiences with Computer-Mediated Design Studios

Chapter 3: The Case Studies

Experiences with Computer-Mediated Design Studios

Recent advances in affordable telecommunications technologies have provided new opportunities for global collaborative work. In the educational setting of the design studio, they have led to design classes that bring together geographically distributed participants through videoconferencing and Internet-based communication tools. The technology may enhance design learning by creating new settings that take advantage of opportunities to build and sustain a diverse design community – the main strength of the studio. As we reflect on the educational processes of the studio through these new mediated settings, they may also help us to overcome the studio's potential weaknesses, such as those formed by its insular nature.

In this chapter, I describe ten cases of computer-mediated collaborative design studios in which I have been involved as a student, instructor, or researcher. The cases span a period of eight years, from 1992-2000, in which amazing technological innovation and diffusion occurred - particularly the expansion of the Internet and its capabilities and the development of the World Wide Web. These long-distance design studios were conducted as part of an ongoing intellectual enterprise to diversify the studio community, to take advantage of emerging technological capabilities, to construct dynamic and effective learning environments, and to understand the new technical, social, organizational, and pedagogic landscape of the virtual design studio. I present the case studies in chronological order to narrate a story of how telecommunication technology has slowly infiltrated the traditional design studio, how studio members have appropriated the technology into their everyday practices, and how a suite of technologies and the studio system have evolved together. As a series, the successive cases represent a historical overview of the first generation of remote collaborative design studios in architectural education and illustrate how these new studios might support and enrich design learning and practice as part of a dynamic pedagogic strategy. Figure 1 lists the projects presented in this chapter.

1992 ▮	Harvard University/University of British Columbia Project	
1993		
1994		
1995 ▮	MIT/Cornell Virtual Jury	
1996 ▮	MIT Interdisciplinary Studio	
	MIT/Kumamoto/Kyoto Workshop	
1997 ▮	MIT/XeroxPARC Studio	
	MIT/Oporto/Lisbon Charrette	
1998 ▮	MIT/Ford Charrette	
	MIT/Miyagi University Workshop #1	
	MIT/F.O.Gehry & Associates Studio	
1999		
2000 ▮	MIT/Miyagi University Workshop #2	
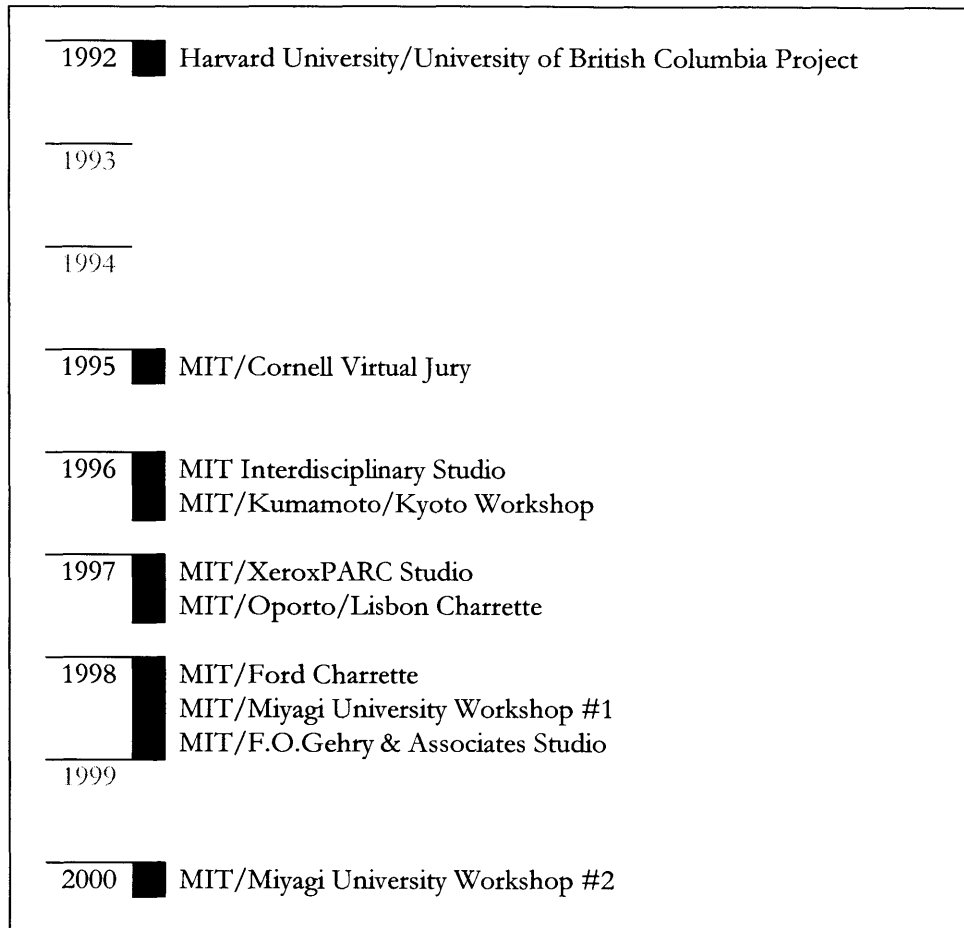
Figure 1: Projects included in this study.

The individual cases explore different aspects of the new design studio. In the first study, the Harvard University/University of British Columbia Project, we began modestly with students from separate locations exchanging digital files and preparing for a final review linked by a telephone conference call. The subsequent cases grew in technical and social complexity as new relationships were established by integrating advanced technology. As a result, studio students gained practical experience in working collaboratively with other students, instructors, critics, consultants, and clients from various locations, such as Canada, Japan, Portugal, California, Michigan, and New York. These new participants added value to the

learning environment by bringing their individual expert knowledge, cultural traditions, judgments, design values, and past experiences to bear on the content of the studio. Figure 2 summarizes the types of computer-mediated relationships that were explored in each case study.

Cases		Mediated Relationships	Student - Student	Student - Instructor	Student - Critics	Student - Consultants	Student - Clients
1	Harvard University/University of British Columbia Project		░		░		
2	MIT/Cornell Virtual Jury				░		
3	MIT Interdisciplinary Studio				█		
4	MIT/Kumamoto/Kyoto Workshop		█	░	░		░
5	MIT/XeroxPARC Studio			░	░	█	
6	MIT/Oporto/Lisbon Charrette		█	░	░		
7	MIT/Ford Charrette						█
8	MIT/Miyagi University Workshop #1			█	█		
9	MIT/F.O.Gehry & Associates Studio			█			
10	MIT/Miyagi University Workshop #2		█		░		█

Legend:

(blank)	No computer-mediated relationship
░	Little or intermittent mediated interactions
█	Primary computer-mediated relationship

Figure 2: Computer-mediated relationships in the new studio.

The first cases introduced telecommunication technology into the most formal event, the final juried review. Gradually, the technology was used during the informal pinups and deskcrits. Finally, the group working sessions, charrettes, and general activity awareness of the studio were technologically supported. Figure 3 illustrates the different studio events that were computer-mediated for each case study.

Cases		Mediated Studio Events				
		Final Review	Pinups	Deskcrits	Charrettes	Peripheral Awareness
1	Harvard University/University of British Columbia Project	▨	▨			
2	MIT/Cornell Virtual Jury	■				
3	MIT Interdisciplinary Studio	■		▨		
4	MIT/Kumamoto/Kyoto Workshop	▨			▨	
5	MIT/XeroxPARC Studio	■			▨	■
6	MIT/Oporto/Lisbon Charrette	■	▨		■	■
7	MIT/Ford Charrette	■			■	■
8	MIT/Miyagi University Workshop #1	■				■
9	MIT/F.O.Gehry & Associates Studio	■				■
10	MIT/Miyagi University Workshop #2	■				■

Legend:

	No computer-mediated interaction
▨	Little or intermittent mediated interactions
■	Sustained computer-mediated interactions

Figure 3: Computer-mediated studio events.

The research approach of this series of case studies was one of iterative exploration. Much like the design process that Schön describes, it involved exploratory experimentation, move-testing, and hypothesis-testing as the target of the studio moved with each case. Each new case study was informed by the qualitative analysis of my participant observations, video recordings of studio events and activities, and interviews accumulated from the previous case studies. Each case represented in this chapter is then part of a continuum of "thick descriptions"[1] that helps us to better understand the nuances of the new studio context.

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[1] Geertz, Clifford. 1973. *The Interpretation of Cultures*. New York: Basic Books.

3.1 HARVARD UNIVERSITY/UNIVERSITY OF BRITISH COLUMBIA PROJECT: A proof of concept

In the spring of 1992, I was a student in a design studio that involved "distanced collaboration"[2] at the Graduate School of Design (GSD) at Harvard University. The project consisted of twenty-five participants, including students, faculty, teaching assistants, and technical assistants, located in Cambridge, Massachusetts and Vancouver, British Columbia. These two groups on either side of the continent never met face-to-face but worked together on a common design problem.

The two-week project was to design a small warehouse using pre-fabricated concrete tilt-up panels on a hypothetical site. The students at both locations worked individually on the design of the pre-fabricated panels according to the same set of requirements and constraints. We also pulled from the same set of reference materials to learn about pre-fabrication technology. Figure 4 shows an example of the student designs.
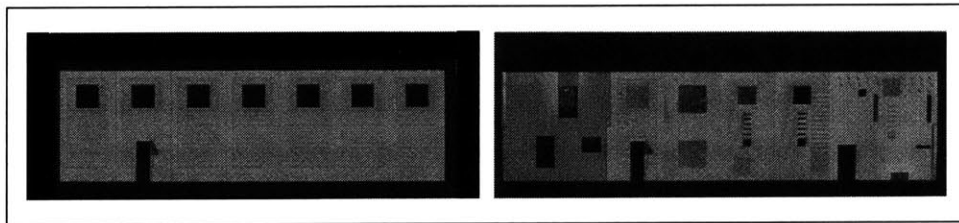
Figure 4: Students' designs of pre-fabricated panels.[3]

At a time before the World Wide Web, this brief and simple test of design students working together at a distance in a networked environment was, at that time,

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[2] "Distanced collaboration" was the term used to describe this project in the article "Digital Pinup Board – The story of the Virtual Village Project" by Jerzy Wojtowicz, James N. Davidson and Takehiko Nagakura in Wojtowicz, Jerzy, ed. 1995. *Virtual Design Studio*. Hong Kong: Hong Kong University Press. pp. 10-23. My account of the project is from this source as well as from my own recollections of events.
[3] This image is from the same article "Digital Pinup Board – The story of the Virtual Village Project" by Jerzy Wojtowicz, James N. Davidson and Takehiko Nagakura, p. 13.

pioneering. It is now considered one of the first successful experiences in computer-mediated, distributed collaborations in design education.[4] It featured a digital pinup board and the first long distance final review. This initial experience was a proof of concept – not only that virtual design studios were indeed technically and socially feasible and educationally valuable, but they could also help us to better understand the design process and the technologies to support collaborative design. It particularly showed how important it is to match the technology with the studio content and practices and how intended processes are often changed by people's actual practices in the studio.

3.1.1 Near-Anonymous Digital Pinup Board

The design problem required the design students to share design information. A file repository on each school's respective networks allowed this design exchange. It was called a "digital pinup board." [5]

The digital pinup board was used throughout the project. During the first week, we designed our individual pre-fabricated panels and submitted them in the file storage area designated as the digital pinup board. At a specific time at the end of the first week, the technical assistant transferred the set of files, consisting of three-dimensional CAD models and rendered images of our designs, from one school to the other (Figure 5). The transfer resulted in identical digital pinup boards at each location. Each student had access to the whole collection of designs.

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[4] Ibid, p.12.
[5] Ibid, pp.10-12. The authors considered the digital pinup board to be a step beyond "design correspondence" which referred to the sequential flow of "letters" in which the individual participants of a project exchanged design ideas to other individuals. Today, these letters would be emails with attachments and the digital pinup board would be postings on the World Wide Web and viewed through a web browser.
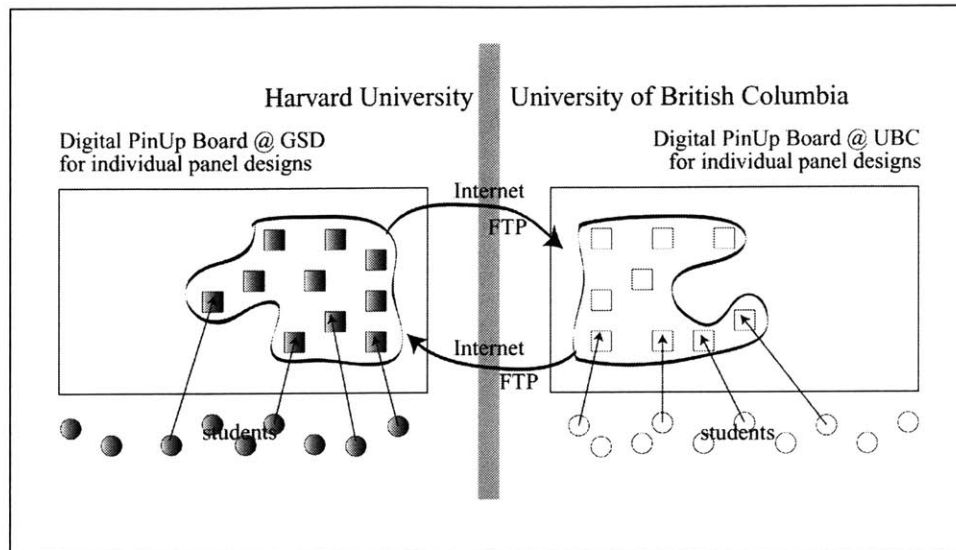
Figure 5: Use of the digital pinup board during the first week.

The organization of the pinup board was formal and very structured. There were protocols to ensure its efficient use, such as strict naming conventions for files and the timing of file transfers. Technically, this digital pinup board saved us from sending multiple copies of a file to each participant. The digital pinup board was focused on effectively moving digital information neglecting any type of long-distance interpersonal communication. The panels were submitted as models or renderings without any textual explanation that would prompt us to initiate conversation with the designers. We simply regarded the designs as objects to be accepted or rejected.

In the second week, we designed the warehouse by searching and retrieving elements from the repertoire of panels contributed from the entire group. We then submitted our final design of the warehouse to a digital pinup board designated for the final review (Figure 6). Again, at a specific time, all the files for the final review were transferred to the other site. Both sites had identical copies of the students' work ready for the final review.
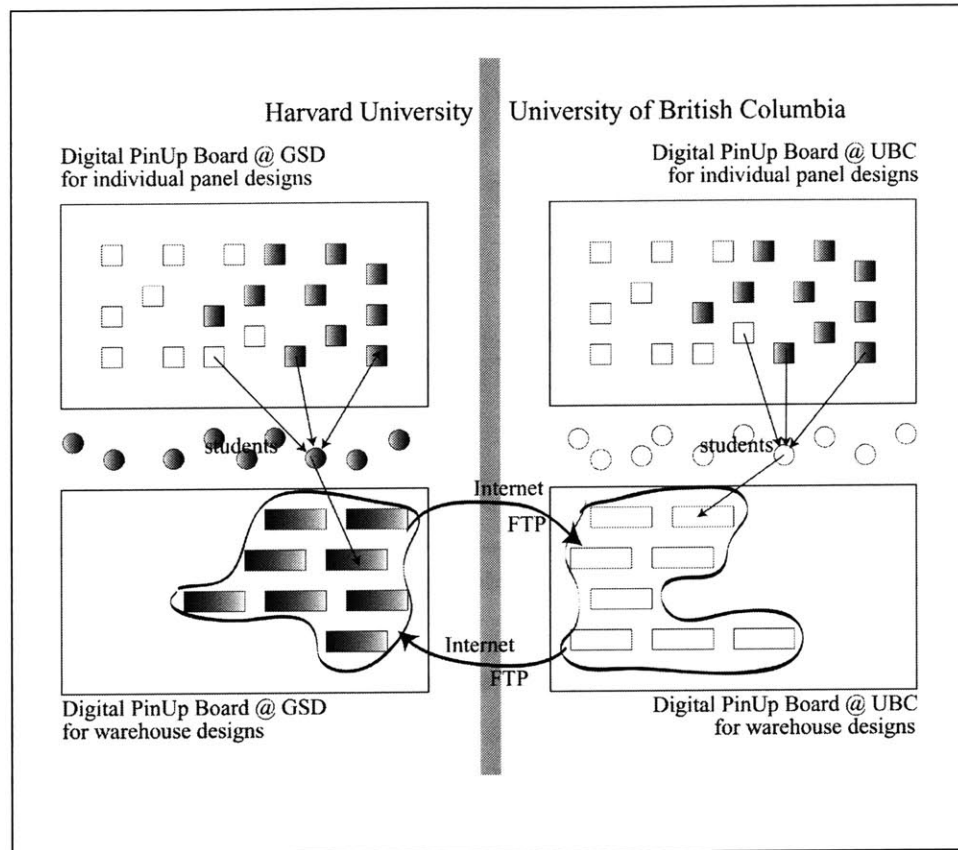
Figure 6: Students at each site retrieved and combined panels for their warehouse designs.

That is what happened technically, but what happened *to* the studio by using this digital pinup board? Did we really design the panels as suggested? What did the new process suggest about design? The use of the pinup board decreased the social interaction and informal social learning in our studio space because all our design material was required to be completely digitally generated. The material was located inside the computer and no longer visible in the studio. Although, I made sketches by hand in my notebook, I quickly switched to modeling my designs using CAD software knowing that they had to be digitally transferred later. Many of my classmates did the same, which made our studio look very bare. There were no longer traces of drawings and models lying around the studio. As a result, there were limited opportunities for voyeurism or spontaneous design discussions in the

studio among my peers. To see my collocated colleagues' design proposals, I needed to retrieve them from the file repository.

Furthermore, the designs on the pinup board gave me no indication of the author's intentions. The only mark of the author, distant or local, was embedded in the elaborate scheme for naming files. The initial designs, now forced to be born-digital, were isolated and anonymous. There was essentially no collaboration, distanced or local, and I too felt isolated and anonymous in the studio.

What did the digital pinup board suggest about design and designers? The way in which we were asked to use the pinup board suggested that design was a combinatory act. We were expected to design a warehouse by simply gathering panel pieces designed by others. The simple idea of taking these CAD models and combining some to make a building was unrealistic. In terms of digital files, it was a nice and clean idea, but the reality of design did not let me do this. What I actually did was browse through the set of panel designs and then created my own panels that would fit in my overall design, both changing the panels and the overall design simultaneously. I interpreted other students' ideas about entrance treatments, patterns of openings, and concrete textures from the panels on the digital pinup board and adapted them to my own scheme. I then broke apart my building and resubmitted my individual panels to the digital pinup board so that it would appear like a combinatory act of design. I suspect that I was not the only one who did this.

This suggests that the technologies that we integrate into a social workplace show assumptions about our work processes and when there is a mismatch, we will find ways to accommodate both the processes and the technology. In doing so, it makes us acutely aware of our own assumptions and the strengths and weaknesses of the technology.

3.1.2 First Long-Distance Final Review

The Harvard University/University of British Columbia project provided our first experience in a synchronous remote final review. At the GSD, the final review was held informally in a public cluster of computers located next to our studio desks. At a designated time, the two schools were connected by a long distance phone call over a speakerphone. Immediately prior to the session, a massive file transfer was made to ensure that both locations had the same files to review from the digital pinup board.

The review or "electronic jury"[6] was a two-hour discussion of the design work while we sat cramped around a desktop computer looking at design proposals and talking through a speakerphone (Figure 7). During my presentation, I demonstrated my design proposal by explaining a series of images. I called out each file name and our technical assistant made sure that the right image was displayed on the computer, like a slide show. I trusted that the same image was simultaneously being displayed at the other location, but we could never be certain since there was absolutely no visual awareness of the remote space. There were, however, curious instances of long silences and giggling. Were the students even looking at the screen? Did the remote critic just grimace? Could they understand my proposal at all?

The interaction was so restricted that it became clear to us that the subtleties of body language, eye contact, and gestures during design reviews were extremely important. Understanding the spatial characteristics of the remote site would have also been helpful. Was it a large formal room? Was my presentation displayed on a large screen? What kind of behavior was appropriate in this suddenly joined space?

The hesitation I felt during the review came from not understanding the remote participants and their setting that was juxtaposed onto my own space. It is precisely

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[6] Ibid, p.13.

this hybrid environment blended from the remote and local that I hope to understand through the case studies presented here.
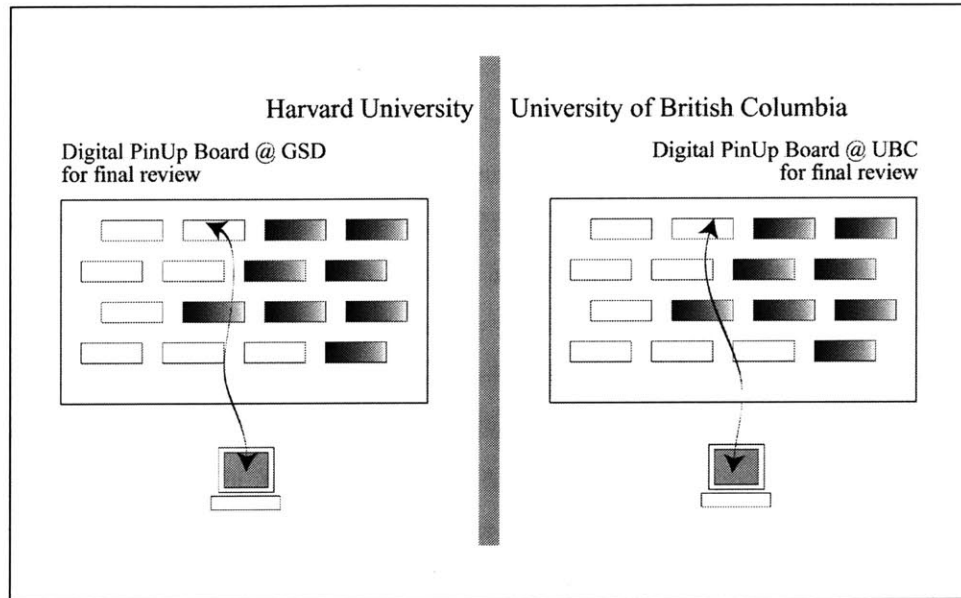
Figure 7: Presentation images displayed from the digital pinup board during the final review.

3.2 MIT/CORNELL VIRTUAL JURY

In the spring of 1995, I observed the final design review of an upper-level graduate studio at MIT that used full audio and video connections to mediate between students, faculty, and critics at MIT and a panel of design critics located at Cornell University.

The evening before the review, I participated in a charrette with one of the design students. We worked all night preparing her Web-based presentation that was required for the final review. The special features of this case study were:

- the Web-based presentations, where we found that the students took special attention in preparing them due to their linear format; and

- the technological and social environment that was created for and by the virtual jury, where we found that extra technical and coordination manpower was required for the review to operate smoothly.

3.2.1 Web-Based Presentations

The long distance review was the final event of a semester-long design project in which students at MIT worked individually to design a live-work residence in Vermont. During the course of the studio, students were encouraged to use a variety of computer-aided design tools for design visualization and analysis. As a result, much of the design materials were digital, such as CAD models, rendered still images, and computer simulations, which helped in the students' preparations for the final long-distance review. Since there would be both a remote and local jury, it was important that the design proposals were presented in a format that could be easily accessible from both sides. The Web-based presentation seemed to be the right choice, since it would be more efficient than printing out the already digital material and sending it to Cornell University. Plus, placing all the material on the Web allowed the critics to look over the design material prior to the final review if they wished, thus making the process more thoughtful and productive. It also proved to be an excellent way to archive the students' work. These were the first-level efficiency effects of using Web-based presentations during the final review.

Looking beyond these effects, there were also changes in the social relationships during the review. The most important of these changes was the student's increased control in regulating the pace and the topic of discussion during the review, thus affecting his relationship with the jury.

To understand this power shift, let's look at the nature of the Web-based presentation and the decisions we took in preparing it during the charrette.[7] Understanding that the presentation would be viewed both synchronously during the review and asynchronously before and after the event, we considered the Web presentation to be a simple linear sequence of webpages, much like a slide show (Figure 8). In putting together the website, we were concerned with this sequence and the narrative accompanying it. How would we begin the story? What kind of options would there be to skip out of the prescribed sequence? What image would conclude the presentation and left to linger on the screen as the discussion began? What would be the pace of the presentation? How long would each image be left on the screen? How much textual explanations would be needed? These new aspects of the presentation would determine the feel of the review and how the design material would be understood, all controlled by the website and the presenter.
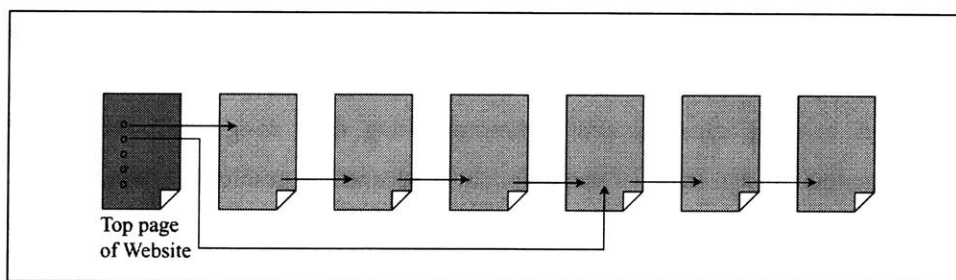
Figure 8: Linear nature of a typical Web-based presentation.

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[7] Our charrette was also computer-mediated. While I was helping the student with her Web presentation, we worked from separate locations. She was in the studio using specialized software to finish her illustrations, while I was in a public computer cluster in a different area of MIT. We communicated through an instant messaging system internal to MIT and a shared folder for exchanging files. She would give me her freshly rendering images and I would place them into the presentation and send her its location for viewing and altering.

This linear sequencing of a Web-based presentation is fundamentally different from the material presented at a traditional design review. In a traditional review, the students usually pin up their drawings on a wall and have a physical model on a nearby table. Reviewers interact with these materials differently. Some like to sit back and take in the entire presentation. Others like to get up and look at the details. Many walk around the models and pick them up for closer inspection. Regardless of what the critic prefers, the options are open. He is free to gaze at a drawing while the student demonstrates a model. The Web presentation no longer allowed this freedom. The reviewers were held captive to the particular image the student was currently showing. The student and his digital presentation could now regulate the reviewers' interactions with the material and with him.

Many reviewers felt this loss of freedom. Frustrated, they complained about the images passing by too quickly and asked to go back to view specific ones. They also noted that the linear sequence made it difficult to compare multiple images or images with models.

Acknowledging this potential control over the proceedings of the review, the students spent much time and energy on the communicative aspects of the presentation sequence. Traditionally, many students leave to the last minutes before their presentation any serious thought of the arrangement of their drawings and how they might speak about them. The Web-based presentations forced the students to think carefully about communicating their design proposals and to organize their design material and rationale in advance. It resulted in thoughtful and succinct presentations leading to equally directed criticism during the long-distance design review.

3.2.2 Long-Distance Final Review Revisited

In addition to using the Web-based presentations to illustrate the digital design material, the long-distance design review also used audio and video conferencing to connect the remote participants and to share their interactions and reactions to this

material. Since student demonstrations of physical design models and critics' feedback require both verbal and visual communication, the technical requirements included multiple video cameras to capture and transfer the participants' interactions with the models and the subtleties of body language, eye contact, and gestures during discussions. The review room at MIT was also filled with monitors to display the digital information and the remote jury. Figure 9 shows the technical configuration for the virtual final review.[8]

The virtual review, looking more like a stage-set (Figure 10), required new roles to manage the technologies and the proceedings of the event. Shelden names these new studio members as technical director and review coordinator. Together, they ensure that the review ran smoothly. The tasks of the technical director were very much like those of a film director's. He not only maintained the connection between the sites, but he orchestrated what these sites experienced. He managed the camera crew and controlled the transfer of the multiple visual and audio channels to each site. For the members of the remote jury, his role was particularly important because he essentially became their eyes and ears into the MIT review room.[9] The review coordinator at each site would ensure that the review progressed well, both in the timing and sequencing of the presentations as well as the level of satisfaction and participation of all the members. The studio instructor traditionally performed this role, but the complexity of this new event and its reliance on technology made this new role necessary. Both the director and the coordinators needed to have a good understanding of the technologies and the review process. Although these new roles were necessary, I believe that the importance of these roles will diminish with the use of increasingly sophisticated

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[8] See Shelden, Dennis, S. Bharwani, W.J. Mitchell, and J. Williams. 1995. "Requirements for Virtual Design Review," in *Architecture Research Quarterly*, EMAP Construct, Cambridge, UK, Vol. 1, No.2. pp. 80-89, for a more detailed technical description. PictureTel conferencing systems with ISDN connections were used during this review. The same equipment was used for subsequent cases of full audio and video conferencing.
[9] Ibid, p.83. Shelden had the role of the technical director at this review. There was no review coordinator at MIT.

technologies, such as remote controlled, voice-activated, and movement sensing cameras, and with increased familiarity with the social practices needed during these events.

1	Monitor displaying Web presentation
2	Monitor displaying Cornell jury
3	Monitor displaying local video source being feed to Cornell
4	Video source connected to VCR to play video design material
5	Video camera to capture local MIT student
6	Video camera to capture local MIT jury
7	Video camera to capture local MIT audience
8	Video camera to capture local Cornell jury
9	Monitor displaying MIT studio
10	Monitor displaying Web presentation

Figure 9: Technical configuration for the virtual design review.

Figure 10: Images from the final review at MIT.

How did this new high-tech environment affect the students? One student told me that she felt like she was on a television set and it made her nervous and very aware of her every move. She was very concerned with the legibility of her presentation to the remote site. During the presentation, she was distracted by her own image on the monitor and caught herself watching it. She asked me if her voice quivered, if she was clear, and if her drawings were readable. She admired one of the presenters

because he had a good camera presence and demonstrated his project well on the screen. She called the camera shots of his hands showing off his physical model as excerpts from the "The cooking with BK show." Another student told me that rehearsals with the technological setup would have been very useful since he felt lost in the technology.

In general, the students showed great enthusiasm, even in their nervousness, for the new review process. Their desire to have another chance to use their new communication skills acquired from this first experience and from watching their studio-mates, indicated that future iterations of remote reviews with improved technologies would be socially accepted. With time and practice, the students would find their own personal style of effectively communicating design through these technologies.

The virtual jury provided, instrumentally, additional critics to the design review process, thus expanding its range of expertise and making the process more productive – its first-level efficiency effect. It also had second-level effects of creating new roles, changing the relationship between the student, the reviewer, and the design material, and providing an environment for the students to subjectively reflect on their own practice and possible future practices within the important educational process of the juried review.

3.3 MIT INTERDISCIPLINARY STUDIO

In the spring of 1996, I was a teaching assistant in an interdisciplinary studio involving faculty and graduate students from three departments at MIT: Architecture, Civil Engineering, and Mechanical Engineering. It also included the architectural office of Frank O. Gehry and Associates in Santa Monica and the engineering firms of Ove Arup in New York City, and Fluor Daniel in Irvine, California. The participants at these professional offices never met the MIT students face-to-face during the fourteen-week studio, but they gave frequent design consultations via telecommunication technologies.

This studio provided a rich environment to simultaneously explore:

- an interdisciplinary design collaboration, where we found that the most challenging aspect of the collaborative process was the negotiation of the different design cultures and work ethics embedded within each discipline;

- the use and appropriation of new computer-aided design and manufacturing and telecommunication technologies in the studio, where we observed that using technologies in groups motivated the learning process;

- the first long-distance deskcrits with professional architectural and engineering firms, where we found that conducting virtual deskcrits in specialized rooms discouraged the students because they viewed the encounter as formal; and

- yet another iteration of a long distance final review, where we found that students' rehearsals and increased familiarity with the technology and techniques for distanced communication helped their performance at the review.

3.3.1 Collocated Interdisciplinary Collaboration

The design studio was a collaborative course offered jointly by the departments of Architecture, Civil Engineering, and Mechanical Engineering under different course numbers and guided by their respective faculty members and class requirements.

The eighteen graduate students[10] formed five working teams, most with participants from each of the disciplines (Figure 11).
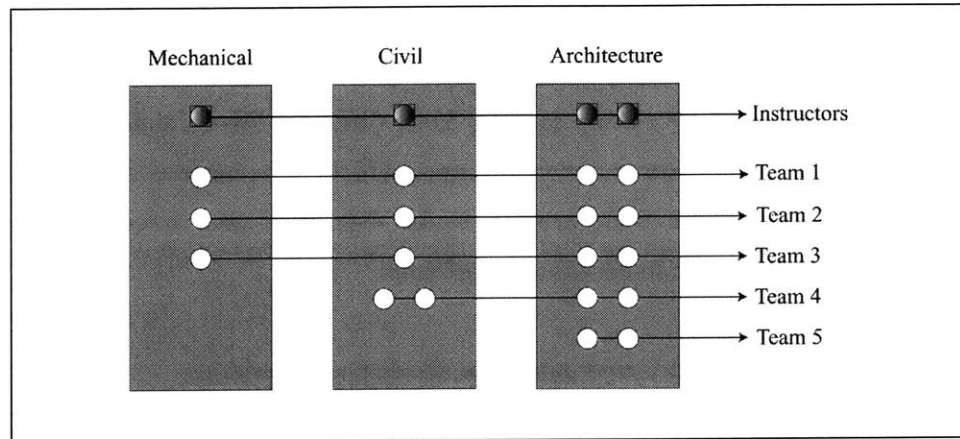
Figure 11: Collaborative interdisciplinary teams in the studio.

The teams worked on two design problems during the course of the studio. The first project was the design of a chair with a full-size prototype (Figure 12). The second longer project was the design of a sports pavilion in Washington, DC (Figure 13). Members of each team worked together to develop a single team proposal for each design problem.

The collaborative activity was the most challenging part of the studio. Technically, the studio brought members of related disciplines together in order to aggregate expertise. Subjectively, the collaborations made the students reflect on their different design cultures grounded by the traditions, methods, and values of their

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[10] The studio consisted of ten students from architecture, five students from civil engineering, and three students from mechanical engineering. The students were Jonas Coersmeier, Derek Fisher, Randall Johnson, Hee Won Lee, Kwanghyun Lee, Hyoung-June Park, Albert Presti, Kiernan Quinn, Alvise Simondetti, and Wolfgang Ungerer enrolled in the architecture studio by Dean William Mitchell and Professor Andrew Scott; Charles Dalsass, Auston M. Kilpatrick, Rochelle Nagata, Rachel Ramcharan, and Simonetta Rodriguez enrolled in the civil engineering class with Professor Jerome Connor; and Sieu Duong, Elmer Lee, and Suriyon Poolvoralaks enrolled in the mechanical engineering class with Professor Woodie Flowers.

respective disciplines. It was not so important *what* kind of technical expertise the students had, but the learning occurred in *how* they expressed and shared this expertise and how they viewed the design process through their collaborative design activity.
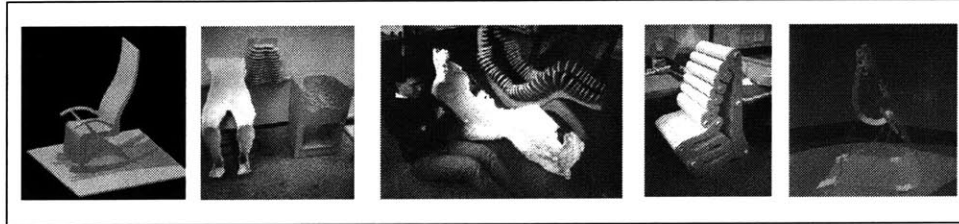
Figure 12: Chair projects
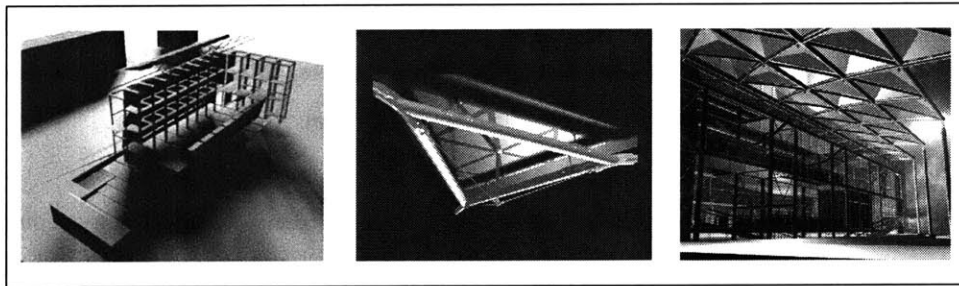
Figure 13: Sports pavilion project.

The team members took time and effort to understand, accommodate, and integrate each of these cultures for an effective collaboration. This did not come without frustration. Faced with the same design problem in the studio, the students formed culturally different interpretations of it. In Schön's terms, they created conflicting "frames" of the situation. The frustrations arose when the students tried to reconcile colliding views of design rather than any particular aspect of the design object. For example, I was called into many disputes about how to proceed to the next step in the design process of the chair project. An engineering student was discouraged because he wanted clear specifications for the chair; the user, the material, the size, and other constraints. With these clarifications, he would be able

to design the "best" chair for those given conditions. To him, design was about problem-solving and optimization, following a technical rationalist approach to design.[11] He complained that he could not advance because his teammates insisted on periodically changing the design criteria. The design that he wanted to optimize was a moving target. The architecture students' view of designing was fundamentally different than this engineering student's view because they considered the design process not as a problem-solving activity but rather as an activity that required finding structure to an ill-defined and complex problem by problem-setting.

Another difference in the design cultures was how and where the teamwork would be accomplished. The architecture students were accustomed to spending long hours in the studio, even all night during charrettes. They expected their engineering teammates to join them. To the engineers, this work ethic was not acceptable since the class was merely an elective for them.

The students had to find and negotiate compromises. Many found it by managing their own expertise, tasks, and time. The compromises, however, were biased. I noticed that by the end of the semester, the engineers were spending more and more time in the studio and even all night during the last charrette. They also showed signs of yielding to the design and the design process of the architecture students. This was surprising to me since the earlier disputes were often very heated. Thinking that the students suddenly resolved all their differences would be naïve. It was more likely that the engineering students were swayed by the dominant culture of the architecture students. It was the dominant culture because each group was composed of two architecture students compared to one engineering student from each specialty and all the meetings were held in the studio space of the department of architecture. Also, the studio was taken as a core

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[11] See Simon, Herbert. 1969. *The Sciences of the Artificial.* Cambridge, MA: MIT Press. p.134. Simon offers a design curriculum based on problem-solving and optimization of a design space through evaluations of alternatives to find the best fit.

second-level graduate design studio in the architectural curriculum, attracting motivated students who were interested in integrating technology into their design processes. But for the engineering students, also very motivated, the studio was a graduate level elective class and presented itself as a chance to collaborate with the architecture students and to integrate in the studio process.

Despite the anxiety caused by the differences in design cultures, some students felt that the cross-cultural issues were the most interesting in the studio:

> "Well, the interdisciplinary aspect of the studio was really the most fascinating part of it in the end in my opinion. Some of us took the studio for various reasons; [we] get to play with the cool equipment, get to make contacts in another field but the interplay of our various backgrounds is what turned out to be very fascinating, very complex and challenging and fun.
>
> The aspect of this class that was most different from any other studio class that I've taken at MIT was in fact the interdisciplinary working relationships that were developed in the studio. We were working not only in the class with other people, we were working in depth closely and personally with people from other fields with very different backgrounds.
>
> The studio, in my mind does model what architectural firms and engineering firms of the future are likely to become. The use of programs and products like video conferencing, lotus notes, e-mail, these communication media are now part and parcel of practicing architecture and part and parcel of practicing engineering and that they become interconnected with each other is only obvious. (...) It will happen and so the students who are part of this course are getting... I really think they are getting a bit of the future in their experience with this course."

Both student teams and the team of interdisciplinary instructors needed to collaborate to better understand the diversity in design cultures, the processes for sharing expertise during design activities, and the practices for collective presentations. The faculty found ways to share design expertise and design values. One example was a series of lectures from professionals and faculty members of each discipline, including a presentation given remotely through videoconferencing from a practitioner's office, to help share different design methods and create a unified studio atmosphere. Another initial strategy was to have students search and

present historical precedents from their own fields which would demonstrate their design attitudes and ideals for a given design problem.

One professor also thought that the cultural lessons learned were important for the future of design education:

> "The students did a fantastic job, they worked really hard, they pulled together, they made things work but on the way there we found out that the design cultures are phenomenally different among engineers and architects. If you superimpose on that (...) the difference in cultures between this country and other parts of the world, you begin to see how complex the engine is, and as we start to peel it open and discover all the crossing that we must make I think we will really start to make a real contribution by unscrambling part of that mess."

Understanding these cultural differences was critical for helping the students to appropriate new technologies and for interacting with professionals during the deskcrits as they became interpreters for their teammates of discipline-related systems and experts.

3.3.2 Technology Appropriation in Groups

Throughout the studio, we encouraged the students to explore their design proposals through different media, both physical and digital. They used computer modeling and simulation tools to visualize their designs and engineering analysis tools to evaluate them. There were also devices to help bridge the gap between the physical and the digital design worlds. These included input devices such as a three-dimensional digitizing arm used to convert physical models into digital representations for further manipulations and computer numerically controlled (CNC) output devices, such as a water-jet cutting machine (Figure 14a) and a three-axis flatbed router used to make 3D printouts of their digital models. With this specialized equipment, the students produced full-scale prototypes for the chair and components of the sports pavilion using material such as plywood, foam, and plexi-glass (Figure 14b).

With all these new complicated technologies to learn, I was amazed at the speed, enthusiasm, and mastery the students displayed in approaching them. Most of the students were interested in the technologies themselves and they needed to learn to use them for their design explorations. Enthusiastic mastery also occurred because the students were appropriating the technologies to their own project needs *as a group*. It was not only more fun and easier to learn to use software when you have a partner to share different styles of technical learning, but mastering certain technologies well also gave you a distinctive role and responsibility within the team. Sometimes, this role was prestigious.

a. Water-jet cutter   b. A team processes material
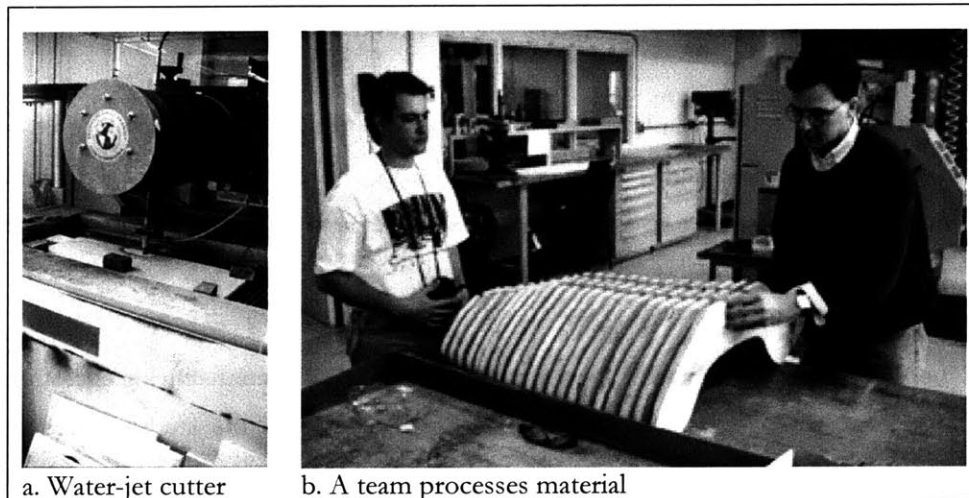
Figure 14: Water-jet cutting machine.

One student told me that he had spent most of the night learning a new software application because he wanted to show it to his teammates to convince them that it would be advantageous for their project. He claimed that he would have to be the one to teach the software to the others. Implicitly, he wanted also to show them his computational prowess. In the interdisciplinary groups, the students shared and showed their individual computational expertise by dividing tasks, such as work in imaging, simulations, analysis, or fabrication.

The students also quickly mastered a set of communication tools to help them share design ideas and the work-in-progress with each other and with remote consultants. They entered notes, questions, photos, sketches, 3-D models, and other relevant design materials into a shared team database that served as the team's communal digital space on the Web. These webpages were used for presenting their work at deskcrits and the final review with local and remote jurors.

3.3.3 First Long-Distance Deskcrits

This case involved our first attempt at virtual deskcrits. If we could make an elaborate set-up for a formal final review, why could we not use the same technology for another important educational process, the informal deskcrit?

The students' regular deskcrits with their local instructors were supplemented by deskcrits with the distanced practicing architects and engineers. We used simple videoconferencing over an ISDN digital telephone network to connect the student teams with the professional offices (Figure 15).[12]

Location was a critical factor for these deskcrits. The videoconferencing equipment was located in an isolated room at MIT rather than in the studio where the traditional deskcrits were done. This change of venue affected how the deskcrits were viewed by the students and determined whether they occurred at all. With the time zone differences and the busy schedules of the practitioners, it was difficult to coordinate deskcrits during official studio hours. Once we finally found some appropriate time slots, it was then difficult to convince the students to meet with the remote consultants. I was surprised. Why would the students not take advantage of these reputed architects and engineers? It was not everyday that you had the undivided attention of a member of Gehry's or Ove Arup's office.

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[12] We used the PictureTel Concorde 4500 system while the consultants' offices used a PictureTel desktop solution.

1	Monitor displaying consultants' office
2	Monitor displaying local MIT video source being feed to consultants
3	Scan converter to change computer signal to video signal
4	Video camera to capture MIT student
5	Document camera to capture MIT physical drawings and models
6	Video camera to capture consultants' office
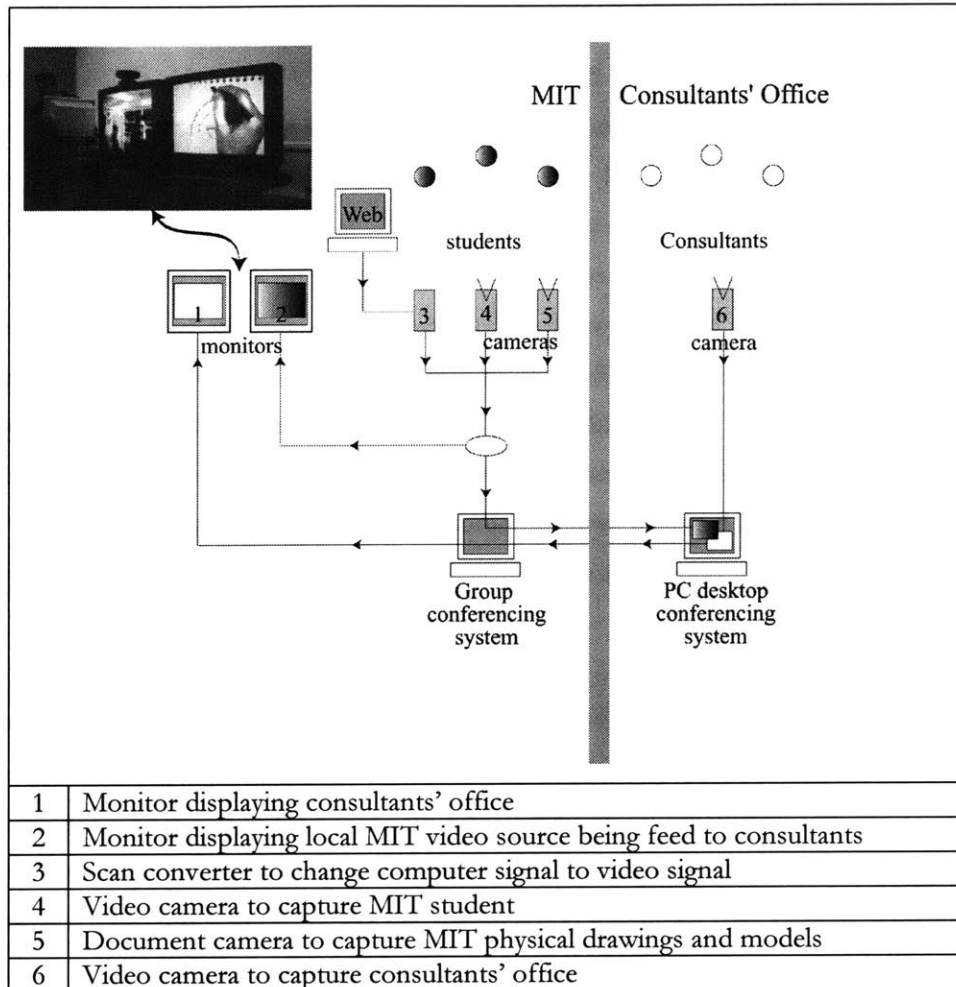
Figure 15: Long-distance deskcrits through videoconferencing.

After talking to the students, I soon realized why they were so reluctant to have these virtual deskcrits. They viewed these deskcrits as formal encounters and they did not feel that their work-in-progress was adequate. However, this same work was enough for a face-to-face deskcrit. They viewed the virtual deskcrit as formal because it was displaced out of the informal studio and into a private formal room with equipment that was associated with the more formal final reviews.

The separate location also affected how the deskcrits were conducted and what was reviewed. Instead of having the deskcrit at a students' desk with all his rough sketches, models, books, and other design and reference materials, the student had to leave the studio, where all the action was, to the isolated room with only a particular selection of his design material. Although this may have forced the student to be more organized and directed about the topic of the deskcrit consultation, it also left no room for spontaneous conversations sparked by other reference materials. It also stifled any opportunities for other studio members to eavesdrop and learn from the discussion. In taking the deskcrit out of the studio, we also took away some important parts of its social learning value. It became clear to me that it would be much more educational to reposition the virtual deskcrit into a social space. An episode during a virtual deskcrit with the offices of Ove Arup convinced me even more.

At Ove Arup, the videoconferencing equipment was placed in a public area of the office. As one student was in the middle of a discussion with an engineer, another engineer casually walking by decided to stop to see what was going on. We were lucky because that curious engineer was actually the expert in the office who would be most familiar with the design problem that was currently being discussed (Figure 16). I realized that we were not only connected to the individuals, but more importantly, we were connected to the entire workplace with the resource of its aggregated expertise, located beyond the talking heads of the screen. It would also be important to foster this kind of spontaneous encounter and serendipitous expertise sharing and learning in the studio. This episode illustrated that informal virtual deskcrits with remote practitioners could provide expert criticism, but it could also give a glimpse of a professional's way of working together in his native office setting.

Figure 16: Virtual deskcrit with unexpected encounter in remote engineering office.

3.3.4 Long-Distance Final Review Revisited Again

We attempted again a long distance final review with much the same set-up as the previous case.[13] Little was different in the technology used, but we did see some social differences. First, the review ran smoothly with the help of *both* a technical director and a review coordinator. Second, the students seemed more at ease with the technology because they had the opportunity to play with the set-up during the deskcrit sessions. Third, the teams relieved some of the technical burden placed on the technical director when one member of the team verbally presented while another team member, instead of the technical director, controlled the web presentation. And fourth, both the local jury and the remote reviewer, who had also been conducting virtual deskcrits throughout the semester, had less trouble understanding the designs because they had already had experiences in these new mediated environments (Figure 17).

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[13] For every subsequent case study conducted, another iteration of a long-distance review was performed. We believed that if we re-iterated on the design of these final reviews, we would find large and small improvements in the use of the technologies and the social practices of the participants and finally have a refined working prototype.
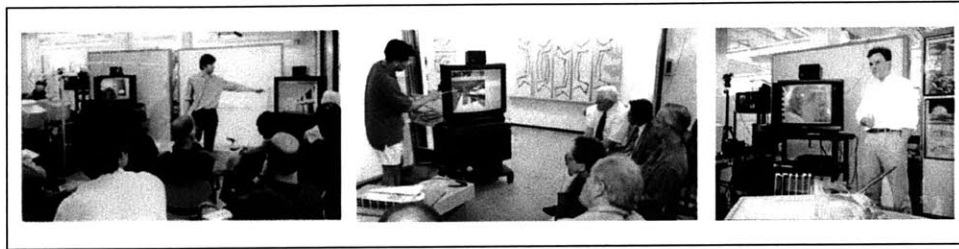
Figure 17: Final review.

3.4 MIT/KUMAMOTO/KYOTO WORKSHOP

In the summer of 1996, I was involved in a five-week project between MIT, Kumamoto University, and the Kyoto Institute of Technology.[14] It was a long-distance project joining a group of design students, faculty members, researchers, and practitioners who acted as designers, design critics, technical support, and clients. This case was the first study in this series that focused on sustained peer-to-peer collaboration.[15] It required distributed students,[16] who had never met before, to design and develop a single group solution to a design problem and to maintain a long-distance work environment. Instead of focusing on any particular design event, such as deskcrits or reviews, this case was about the day-to-day activities of distributed group work.

This project looked particularly at:

- organizing long-distance teams, where we carefully formed teams by reviewing each individual student's initial sketches presented on their personal webpages and encouraged community building by giving each student specific coordination responsibilities;

- the technologies needed to provide flexible and reliable communication between sites with a large time zone difference, where we found that asynchronous techniques were more useful;

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[14] Parts of this case have been published in a different format in Yee, Susan, William J. Mitchell, Ryusuke Naka, Mitsuo Morozumi, and Sigeyuki Yamaguchi. 1998. "The Kumamoto-Kyoto-MIT Collaborative Project: A Case Study of the Design Studio of the Future," in *Cooperative Buildings: Integrating Information, Organization, and Architecture*, Proceedings of the First International Workshop, CoBuild '98, eds. Norbert A. Streitz, Sin'ichi Komoni, and Heinz-Jürgen Burkhardt. Berlin: Springer. pp.80-93.

[15] I view the Harvard University/ University of British Columbia project to be a cooperative work, not a collaborative one that requires the students to work together to develop one group solution to a problem.

[16] The design students were Katsuhiro Iino, Masashi Matsumoto, Masayuki Takahashi from Kumamoto University with Professor Mitsuo Morozumi; Yasunobu Onishi, Ryoji Satsuma, Gaku Sasada from the Kyoto Institute of Technology with Professor Sigeyuki Yamaguchi; and Michael Fox, Scott Schiamberg, Partho Dutta from MIT with Dean Bill Mitchell, Ryusuke Naka, Professor Ann Pendleton-Jullian, and myself.

- how students adapted technologies to their own needs, where we found that a group discussion forum and tools with varying degrees of interactivity for different design situations were important; and

- how students adapted their own practices to the technologies, where we observed each team developing its own strategies and rituals for effective communication and collaboration in the virtual space.

3.4.1 Organizing Distributed Designers for Collaboration

The design problem was to develop an urban structure for the Kumamoto ArtPolis '96 International Architectural Exhibition.[17] The proposed "ArtStation" was designated for a vacant site adjacent to the Kumamoto Castle. The client for the project was Koji Yoshii, the designer originally given the commission. The project was conducted as a competition in which one of the student proposals would be actually built for the exhibition in November of 1996 (Figure 18). The MIT member of the winning team would visit Kumamoto and finally meet his Japanese colleagues.[18]
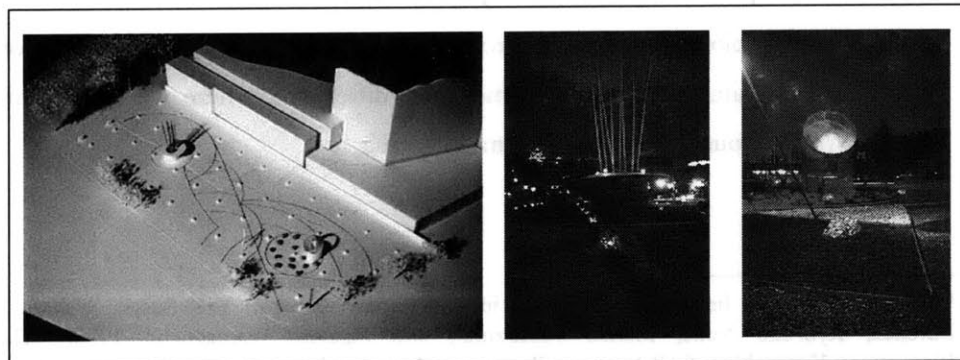
Figure 18: Final design of the "ArtStation" built in Kumamoto.

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[17] Kumamoto ArtPolis is a group that is concerned with the creation of architectural works that demonstrate and accentuate the cultural heritage of the region.
[18] One team's scheme was built but we decided at the end of the project that all the MIT students should visit the site and their teammates. One of the MIT students actually decided to stay in Japan to pursue professional design work.

Forming Teams

The students were organized into three design teams. We understood that team dynamics would be a critical factor in this long-distance collaboration, so we formed these design teams carefully. We placed one designer from each location in every team to encourage cross-fertilization of design ideas. Because the project required a deep understanding of the physical site and the regional culture, the student located in Kumamoto was a critical member for his virtual teammates. He provided images, video, and written and verbal interpretations of the site.

We wanted the students to be active in forming their own teams, so instead of assigning teams, we constructed an environment for the students to select their own teammates. This process began with a videoconferencing session prior to the start of the project for informal introductions and general inquiries about the nature of the design problem. This meeting, together with the supporting site material, such as photos, video, and CAD models assembled on a website, helped the students to get a sense of the project and their potential teammates. In the first week, the nine designers were asked to develop their individual concepts for the design problem. Comparable to the *élève* at the Ecole des Beaux-Arts who developed his *esquisses* individually *en loge*, the students placed their initial ideas on their individual webpages for a group review. The collection of webpages (Figure 19) became a kind of marketplace of design ideas forming the basis for team formation.

This initial exercise encouraged the designers to quickly jump into spatial concepts early in the project and gave the students a way to judge their compatibility with the other students in terms of design approaches, presentation styles, and technical skills. The collection also gave the students real material to discuss during the first synchronous sessions, which can often be uncomfortable when there is no object for discussion. The students used this presentation to prioritize their preferences for potential teammates and we formed the teams by best accommodating their selections.

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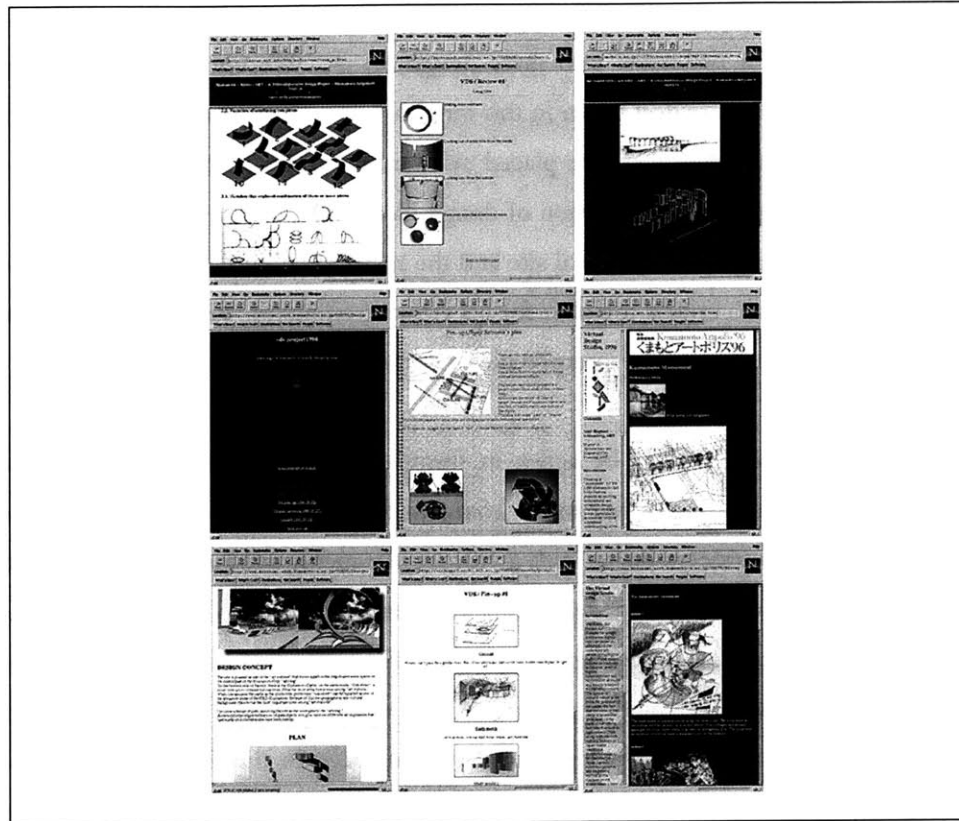
Figure 19: Collection of individual webpages for team formation.
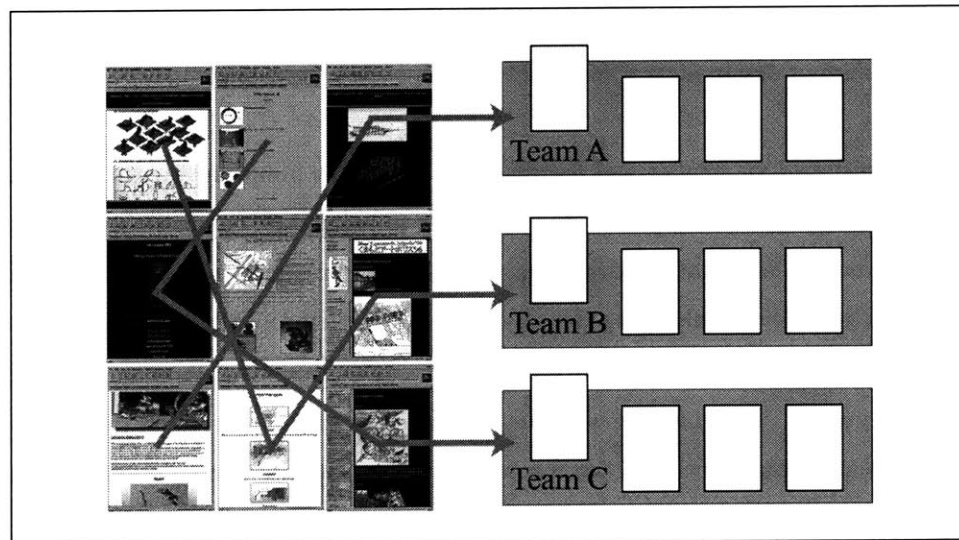
Figure 20: Forming teams by student preferences.

Making Roles

We anticipated that the distributed design process would need explicit coordination to sustain the long-distance work environment, so once the three design teams were formed, each student was asked to nominate members within his team to fulfill certain team coordination tasks in addition to design responsibilities. These roles included a team webmaster, a team minutes-taker, and a team schedule coordinator. The tasks of each role were as follows:

- the team webmaster constructed and maintained a team webpage to be used during team presentations;[19]

- the meeting minutes-taker recorded and shared the proceedings of team meetings and discussions, both synchronous and asynchronous, between team members and design critics; and

- the schedule coordinator determined the need for and coordinated the times of team meetings, ensuring effective communication between the sites.

Although these tasks were time-consuming and mundane, they were critical for establishing a common understanding of the development of the design as well as for making a coherent presentation to the design critics. All the roles had an intimate connection to the team's process of design and the designed artifact. The webmaster's page construction was designed to reflect and communicate the overall architectural idea. The minutes-taker was forced to interpret the concepts and comments of his colleagues, which helped to highlight misunderstandings and ambiguities of both natural language and graphic design language. The schedule coordinator had to understand both the collaboration process and the design progress to be effective. These roles were intended to help ease the often complex and confusing issues of collaboration within design teams.

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[19] This page served as a shared document that illustrated the development of ideas and designs produced by the collaboration. It also linked to the individual webpages, or personal digital sketchbooks, maintained by each team member.

Building Communities of Practice

The team forming and role making strategy reflected our attempt to build different kinds of groupings or communities. They included a project-centered community, consisting of the project teams; a place-centered community, involving the participants at their respective physical locations; and a task-centered (or practice-centered) community, revolving around the coordination-oriented roles distributed between team members and location. Figure 21 summarizes this organization.
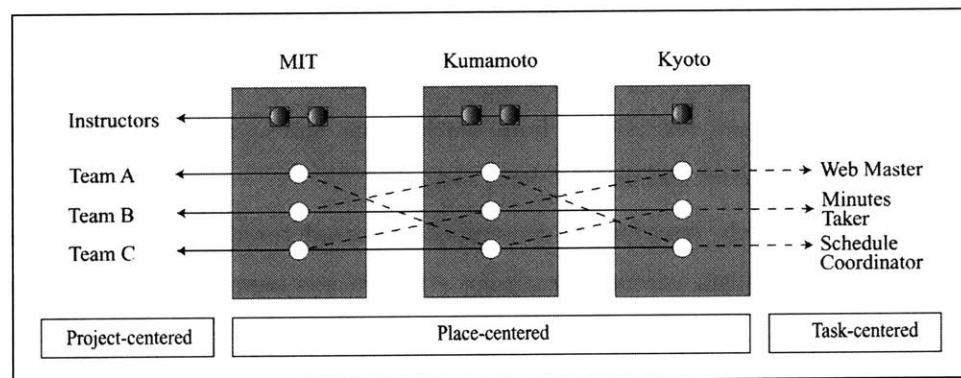
Figure 21: Community building strategy.

The project-centered community showed the strongest coherence, since the students understood well that they had to have a final product. The place-based group at MIT showed little coherence because they were actually distributed on campus and not located together in the same studio space. The webmasters of the task-centered community helped each other when they encountered technical problems. The students did not perform the other coordination roles consistently, so different students took on these tasks as needed and team leaders emerged.

3.4.2 Organizing Technologies for Collaboration

We used a mixture of synchronous and asynchronous communications technologies already familiar to us. Synchronous technologies, such as videoconferencing, were used for the reviews and asynchronous tools, such as electronic mail and the posting

of design material on the World Wide Web, were heavily used for the group work between reviews.

The Web became the central "place" of the workshop because it helped to bridge the large time difference between the sites. One student said that the asynchronous communication tools were the most important part of the collaboration because they could simply leave files to be picked up later by their teammates without concern for coordinating busy schedules.

The class website was structured to develop individual work as well as teamwork. The entry point of workshop (Figure 22) had links to:

- each students' individual webpage, where he could include personal sketches (much like a sketchbook) and his design proposals for his teammates to review and discuss; and

- a team webpage, where the team webmasters would place the designs developed and approved by the group.
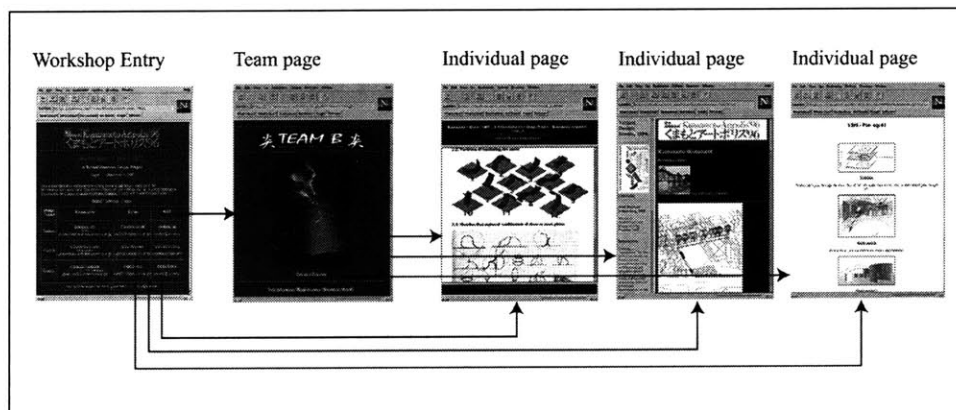
Figure 22: Workshop Website.

During the synchronous reviews (Figure 23), which were very similar to our past experiences, the team webpages were used to represent the entire group's current work. The individual pages became an archive of initial design ideas, some still very rough and others developed and moved onto the team webpage.
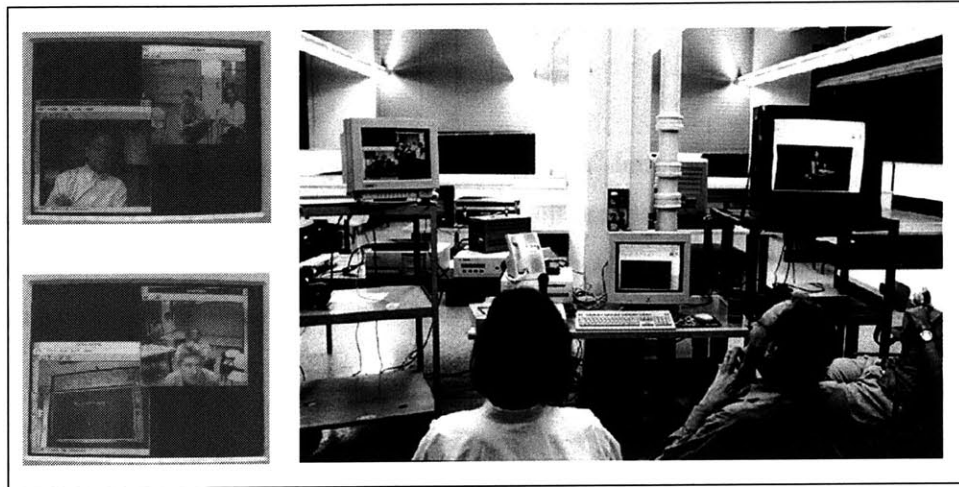
Figure 23: Videoconferencing at the final review.

3.4.3 Adapting Technologies to Studio Practice

The long-distance design partners were able to work together by adapting the technologies and adapting their own practices in the studio. Although we suggested ways to use the technologies, the students were free to develop their own communication and collaboration techniques, especially when they could not interact with their remote colleagues as they wished. Because we did not know what the students would really require for a remote collaborative project, we observed how the students carefully adapted the existing technology to their needs in unexpected ways and we listened to their requests. We were also prepared to change or add to the technologies as required or requested by the students. This experience helped reveal some tools that would be useful to long-distance collaborative designers, such as dedicated areas for asynchronous discussions and tools for varying degrees of interaction.

Discussion Webpage

The team webpages worked well in acting as a repository for design materials produced by each member of the team. They archived the products of the design, such as the sketches, images, video, CAD models, digital renderings, and explanatory text. The webpages were ideal for the *presentation* of a project, as they

were used in the virtual jury and virtual deskcrits, but the students not only wanted to view the design material, but they wanted to be able to comment on them and to manipulate them. One student said that it was "difficult to keep a record of a dialogue between each other, a record which can be reviewed at a later time." The website lacked space for this asynchronous *interaction*. If a critic or a collaborator wanted to make a comment on one of the design proposals, he would have to use another communication channel, such as sending an email, picking up the phone, or initiating a videoconference. Since email was the easiest and least expensive of these alternatives, the students and critics received and sent a large amount of email messages. These email messages were scattered in their mailboxes and the students complained about not being able to manage them. They felt overloaded. To help with managing asynchronous correspondence, we provided team discussion areas (Figure 24) on each team webpage.[20] It was a single place that kept records of the participants' interactions so that they could be understood as a coherent thread of conversation. One student called it "really the best thing. [It] became invaluable, so that we could keep a record of our dialogue and allow input from outsiders. [The system] automatically emailed each other when a new comment was added so that one was sure to check the page when there was something new added."

Typically, one team member would make a sketch, another would look at it, write some criticism about it, download it to make changes, and then upload his new sketch illustrating his criticism for his partners to further elaborate. The team website began to serve as a medium for *interacting* with the designs and with each other.

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[20] The discussion tool was implemented into our website with the help of Paul Keel. It allowed anyone to submit comments in a threaded format.
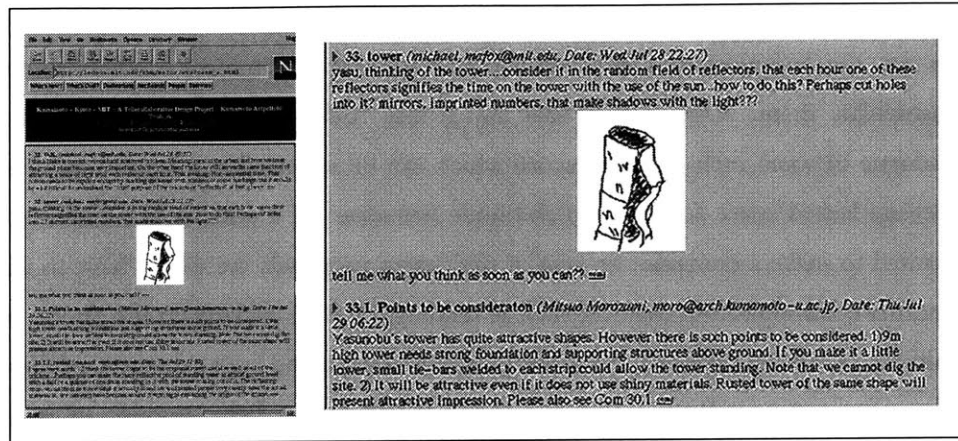
Figure 24: Discussion webpage for each team.

At the end of the project, the set of team websites transformed from a *data*-base to a *knowledge*-base for the entire workshop. It represented not only the data or *objects* of the design, but also the group *interactions* that lead to those designs. It became a collection of different impressions, interpretations, and speculations of possible design instances for the project. It was with this design knowledge-base that the final physical structure was conceived.

Email for Near Synchronous Communication

The students still used email but in an unexpected way. In certain situations, they used it as a synchronous tool, much like an instant messaging system. During the hours prior to a formal presentation, students knew, through accepted studio norms, that all the members of the team would be working at their computer stations prior to the review. They passed quick inquiries, progress reports, and words of encouragement to their partners via email instead of using more elaborate synchronous facilities, like videoconferencing or chat programs that would need more user attention.

Variable Degrees of Interactivity

As the students became more familiar with their partners and as the design process progressed from the messy concept formation phase to the refinement and production stages, the students demanded less interactive technologies.

At the beginning of the project, the degree of interactivity desired was high. The students wanted to see and speak to each other in addition to sharing a single digital workspace; that is, they wanted to emulate a face-to-face session where facial expressions, gestures, and eye contact are transmitted. Because there was a low degree of social familiarity among the participants and a high degree of complexity of design information at the initial stages of the project, they wanted highly interactive technologies. Near the end of the project, however, the students used video not for viewing their partners' facial expressions for validation, they used it for viewing physical drawings made on the fly.

Also, during the group work meeting, the students unexpectedly preferred the text chat window to using the audio channel. They preferred communicating through writing rather than speech because the quality of the audio was often poor, but also because the text could be saved and reviewed later. The text was particularly important for the Japanese students who felt more comfortable with written, rather than spoken, English. One Japanese student told me that the text interface forced him to communicate clearly and then there was the added bonus of automatically archiving the conversation for later review.[21]

3.4.4 Emerging Practices from Collaborative Technologies

With increased familiarity with the project, people, and technologies, the teams developed their own individual methods of collaborative work. The students began to have their own patterns of behavior that showed their own shared understanding and rituals.

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[21] The Japanese students asked for the transcripts so that they could "study" the design conversations and make sure that they understood all the discussions.

Communication Practices

One example of a shared practice was a team's pattern of navigation through the group's webpages at the start of each day. The team's members started each work session by first checking the discussion page for any new developments. The shared understanding of this daily ritual, however slight, by all the team members made the discussion page to be a powerful communal "place" for communication. If one student asked a question that was already clarified on the discussion page, he would be reprimanded for not checking there first, as he was expected to do.

Design Development Practices

Developing shared understanding is never easy, but when there are language barriers, as in this case, it becomes even more difficult. Because the meetings were conducted in English, subtleties of verbal language, which can be very important in communicating design knowledge, were difficult to send and receive. To overcome the language barrier, which all the participants cited as the most difficult aspect of the collaboration, the teams adopted the practice of using "monumental words" or keywords that were understood by all participants. This method served as a starting point for the design collaboration. Through these keywords, the teams developed and constructed interpretations and mutual concepts with their drawings, their common graphic language. Figure 25 shows an example of design sketches for the keyword "whirlwind."
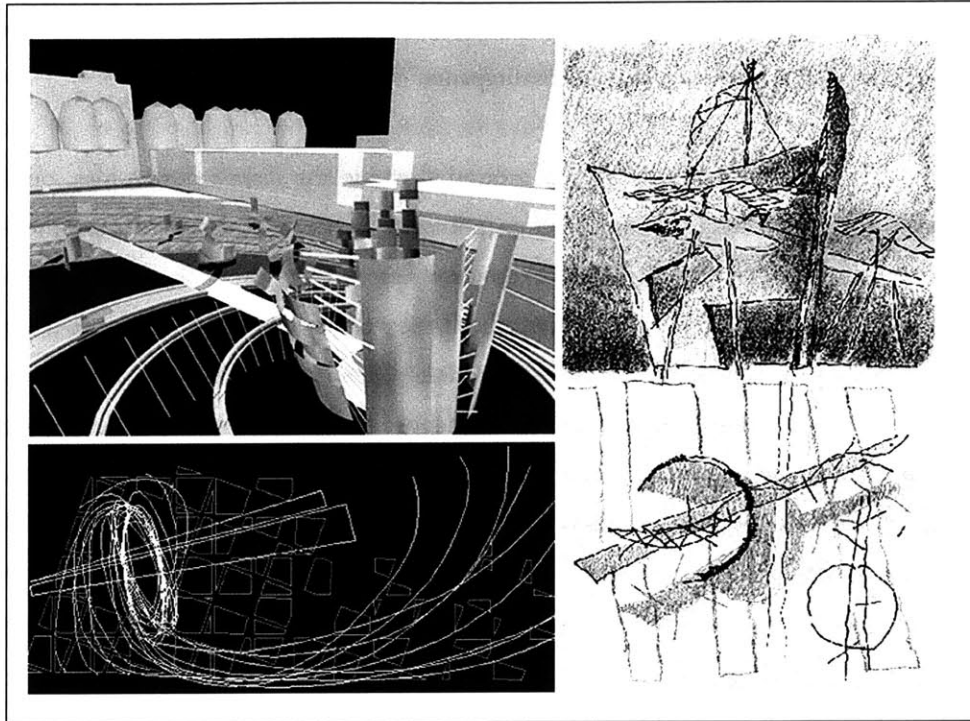
Figure 25: Graphic interpretations of the keyword "whirlwind" by individual team members.

Collaboration Practices

Although the design teams approached the collaborative aspect of the project in slightly different ways, all of the teams considered their design as a truly collaborative effort, in that they all attempted to amalgamate each team members' idea to form a single overall concept. This predominate mode of collaboration may be considered "single task collaboration", where "the resultant design is a product of a continued attempt to construct and maintain a shared conception of the design task. One student said that his team's "design was really a work of a team equally using all three of [their] ideas[...] as opposed to one person's idea [...] It was really a synthesis." In other words each of the participants had his own view over the

whole design problem and the shared conception was developed by the "superposition" of the views of all participants."[22]

Once this "shared conception" was grounded within the team's design idea, other collaboration techniques were used to stimulate innovative design development. One team divided up the design concept into parts, such as the structure, materiality, and landscaping, and delegated these parts to each member for in-depth investigation for a limited amount of time after which they would regroup and share their findings. Another team used a relay approach where the entire design was passed from one member to another for elaboration. The member possessing the design acted as the master designer for a limited time period. He would work on the proposal and then pass it on to the next designer. These collaboration techniques were only successful when there was a consensus on the overall design concept.

Lost Practices

In our attempt to encourage the use of the computer for design work and to build a solid distributed design team with telecommunication technologies and shared rituals, we unexpectedly lost, as a side-effect, much of the camaraderie found when designers working in a common physical studio environment. The designers at MIT were not designated a common physical studio space, so they worked wherever they liked and were scattered on campus. The emphasis placed on the communication tools sent out the signal that it was no longer necessary to nurture a place-based studio spirit. Since all of the design material was stored in the computer, and globally accessible via the Internet, the students did not technically need physical pin-up and personal workspaces, but I believe that a shared physical space would have nurtured traditional creative interactions within the place-based group to complement the creative activities in the virtual setting.

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[22] Maher, M.L., Simoff, S., Cicognani, A. 1996. "The Potential and Current Limitations in a Virtual Design Studio." http://www.arch.su.edu.au/~mary/VDSjournal/index.html. *Interactive Construction Online.* .

3.5 MIT/XEROXPARC STUDIO

In the fall of 1997, I was the research assistant in an upper-level design studio involving nine graduate students with two local design instructors at MIT and two technology researchers at the Xerox Palo Alto Research Center (PARC). The distributed researchers joined the MIT studio via telecommunication technologies throughout the semester and participated in all of the studio events, but never met the students face-to-face.

As the first case of sustained remote teaching in a full-fledged studio course, we examined:

- the reflective nature of the design problem, where we found advantages of using the students' own experiences and appropriation of telecommunication technology to inform the design problem;

- the relationship and persistent participation of distributed co-instructors, where we found that common goals and a strong vision of collaboration must be shared by the team of local and remote instructors;

- virtual deskcrits; where we brought the event of the remote deskcrit back to the students' workspaces with a mobile deskcrit station and found the students meeting the virtual critics in informal, spontaneous, and playful encounters in the everyday activity of the studio, allowing the critics to get closer to the students and the design work;

- process capture tools; where we tested PARC's DrawStream station that recorded video conversations of deskcrits for later review and found it useful for clarifying critiques;

- awareness tools, where we found that tools such as room webcameras helped to give a sense of place and activity to remote participants and gave opportunities for informal serendipitous encounters; and

- yet another iteration of a final distributed review, where we integrated peripheral awareness tools and used a variety of media to communicate design material to both remote and local critics effectively.

3.5.1 Self-Reflective Design Project

The studio's design problem was intimately intertwined with the research agenda of investigating the integration of collaborative tools in distributed design studio learning situations. The students' task was to design three different types of educational spaces that would explore the impact of recent advances in the information and telecommunication technologies on MIT's current physical, social, and computing infrastructure. The design problem had a sense of reality since it was founded on the recommendations made in the MIT Educational Technology Council Report that "considers the Institute's future educational activities in a world of new and emerging information technologies" and "proposes ways to support these activities." The students used this report as the starting point to investigating the symbiotic relationship between technologies, innovative architectural spaces, and new modes of social interactions.

During the course of the semester, the students used their own social and technological setting, activities, and experiences to inform their design projects. The experience of using technologies in the studio for communication and collaboration was actually very important since the innovative theme of the design project proved to be quite difficult for the participants. We encouraged the students to play with the technology as we were using them to get a sense of the physicality of the hardware and the spatial qualities that telecommunication technologies may create (Figure 26).

The students often used their own activity as a point of reference to improve their designs. One student commented on the difficulties encountered in our studio's own use and appropriation of current technology and was determined to design a better environment with new emerging technologies. The students designed these improved environments through the iterative construction of "what-if" scenarios in which they used verbal and pictorial storytelling with text, sketches, drawings, live video, physical models, full-scale prototypes, CAD models, digital renderings, and computer-generated animations (Figure 27).

Figure 26: Interacting with the physicality of the technology to understand its spatial implications.
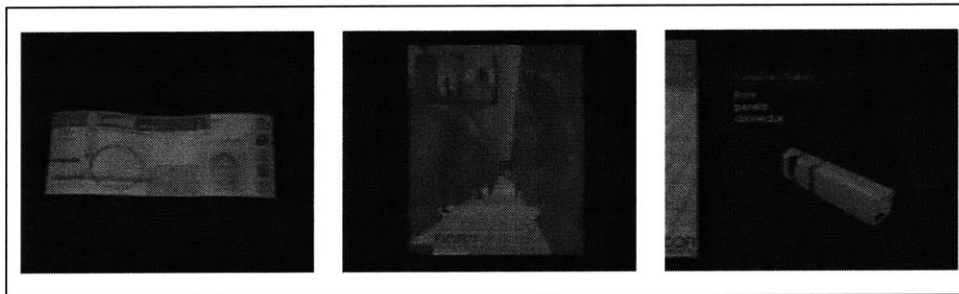
Figure 27: Examples of design solutions.

3.5.2 Distributed Co-Instructors

The PARC researchers were brought into the physical and social space of the studio by computer-mediated communication sustained throughout the fifteen-week semester. They participated in all the studio events, including the first meeting, weekly deskcrits, guest lectures, pinups, the midterm review, and the final review. This was the first case that anticipated a persistent student-remote mentor relationship in a course that was part of the regular design studio sequence and not a specialized workshop or shorter charrette-style class. The fact that this was a full-fledged studio hindered the acceptance of the remote researchers as co-instructors.

A design student typically devotes more time and energy in his studio than his other classes because it is socially considered the center of his design education. The curriculum confirms this by giving the studio class more weight in terms of credit awarded and time scheduled. Workshops and charrettes, on the other hand, may be more experimental since they are often considered to be secondary to the studio. Because of the importance of the studio, a student chooses it carefully and both the instructor and student have certain expectations of the relationships, processes, and events that unfold during the semester. The addition of the remote PARC co-instructors was an intervention that had the potential to jeopardize these expectations so their virtual participation was not initially well received.

The students formed teams to work on different parts of the design problem that were to be integrated to create a unified vision of a learning environment of the future.[23] Each student had to work within his own team as well as across teams. The students were coached by both the local and remote instructors (Figure 28).[24]
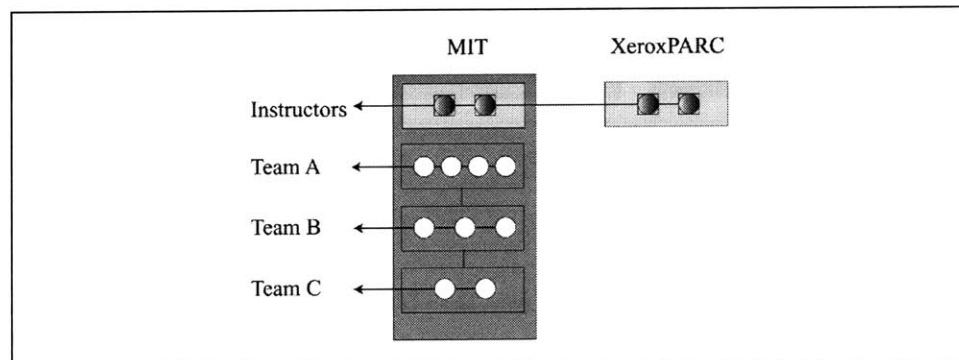
Figure 28: Studio participants included students, local instructors at MIT, and remote instructors at PARC.

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[23] One group worked on designing smaller portable devices to be incorporated into the physical environment. Another group worked on understanding transient learning opportunities in the MIT infinite corridor. The third group worked on an advanced visualization classroom. Each group had to understand the development of the other groups to make the final unified project coherent.

[24] The MIT instructors were Professors Bill Mitchell and Peter Testa. The PARC researchers were Steve Harrison and Scott Minneman. The teaching assistant at MIT was Wolfgang Ungerer. The students were Adam Balaban, Nina Chen, Michael Kilkelly, Paul Kim, Benjamin Kou, Kristin Little, Jaime Solari, Allen Tsai, and Eric Walter.

The relationship between the students and one of the local instructors was very strong. A few of the students had taken his studio class the semester before and had a very good learning experience. They felt that he cared about them and their designs. In this studio too, he nurtured a close relationship with the students, but the insular atmosphere did not welcome the frequent virtual visits of the PARC participants. Because the researchers were involved from the very beginning of the studio, took part in the pre-studio problem-setting discussions between the instructors, and anticipated a persistent role throughout the studio, they considered their roles to be that of co-instructors. The local instructor, however, considered the researchers only as technical consultants to the studio, despite their practical expertise in design. There was little collaboration between the local instructor and the researchers and this was implicitly conveyed to the students. I often felt that the PARC visits were met with resentment and was considered an intrusion into the well-guarded studio by the local instructor. For example, when there were scheduling overlaps of deskcrits between the local and remote instructors, due to the tight coordination needed for the remote participation, the local instructor asked the students if they would rather see him or "them" with a dismissive wave. Needless to say, the students chose him. The local and remote instructors never conducted deskcrits together, instead, they held parallel sessions in the common space of the studio, which increased the room's noise level since the technology sometimes required the students to speak loudly. This too disrupted the insular feel of the studio for the local instructor. Consequently, I was informed that there would no longer be virtual visits by the researchers because the students felt that the extra time needed to interact with them was impeding their design progress. The researchers, distant from the situation, did not understand this decision since the discussions with the students had been very productive. After canceling the next few virtual meetings, the students began to ask why the researchers were no longer calling and that they would like to be able to talk to them. Slowly, with the consent of the local instructor and the enthusiasm of the students, the remote participants were ushered back into the studio.

I think that this initial failure in the collaboration came from unexpected power shifts in the social environment of the studio. We did not encounter these power struggles in our previous projects because they were, in contrast to this case, merely experimental events or workshops without the full participation of remote co-instructors throughout the semester. A studio master's traditional position of control in the activities and processes of a studio is weakened by the integration of outsiders into the studio, especially when these outsiders are not filtered or chosen by him and have direct and frequent contact with the students, as in this case. Because there was a weak relationship between the local instructor and the remote participants,[25] the interventions of the remote critics could be viewed as diffusing the strong relationship between student and local instructor and disrupting the delicate social setting of the studio (Figure 29).

| a. Strong student-coach relationship | b. Additional remote relationship |
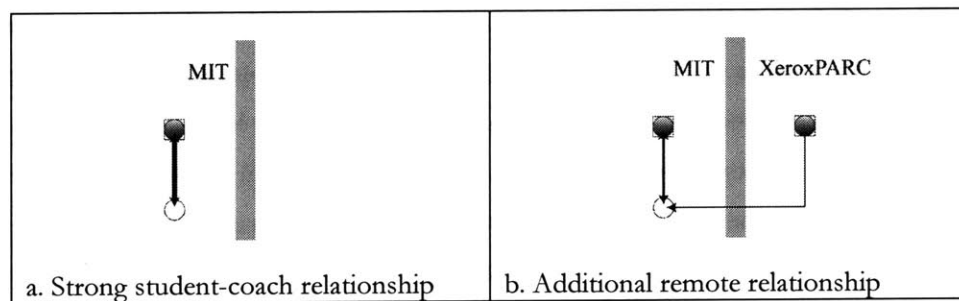
Figure 29: Direct and frequent interactions between student and remote instructors disturbed the delicate social environment of the studio.

Although subtle, this lack of cooperative spirit may be felt by the students resulting in a divisive studio. For virtual studios to succeed, the relationship between local and remote instructors needs to be strong, with signs of trust and mutual respect for

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[25] The initial collaboration began from the confluence of research interests between MIT and PARC. Although there were established personal relationships between some members of the studio and the researchers and all parties had agreed to use the studio as a research environment to investigate the practical use of communication technologies, the unanticipated interventions into the delicate social relationships weakened the initial collaborative process.

their individual competences, to help foster a studio atmosphere of reciprocal learning and collaborative spirit.

3.5.3 Long-Distance Deskcrits Revisited

The remote researchers built relationships with the students by participating, from their offices and laboratory in Palo Alto (Figure 30), in all the events of the studio, including the most intimate, the deskcrit. At MIT, the virtual deskcrits were performed in the physical space of the studio and no longer in specialized videoconferencing rooms away from the social activity of the studio.

Figure 30: Virtual deskcrits were performed from the researchers' offices and laboratory at PARC.

Progressive Technology Appropriation: From Fixed Station to Mobile Cart

We slowly integrated virtual deskcrits into the studio by progressively intervening into the physical space. At the beginning of the semester, we used a fixed deskcrit station in the corner of the space allocated for computer workstations (Figure 31).
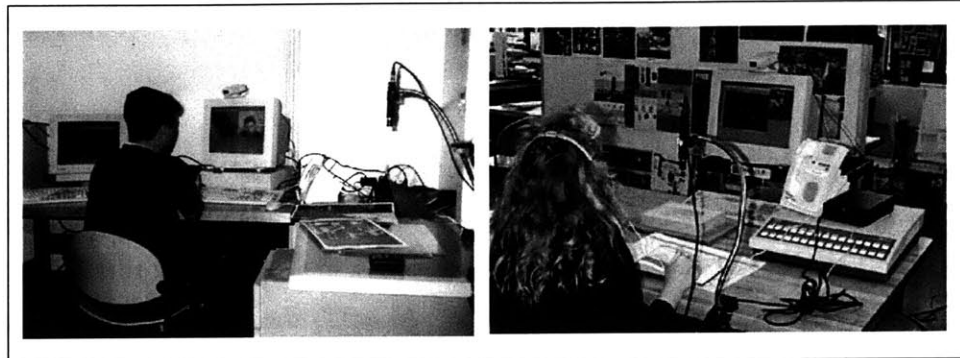
Figure 31: Fixed deskcrit station in the MIT studio.

The students communicated with the remote instructors through a desktop videoconferencing system from which they were able to see one incoming window that showed the source from PARC and one outgoing window that displayed the local material being transmitted to PARC. Since only one video stream could be transmitted at a time, the students switched their outgoing video stream from a face camera, a small camera on a gooseneck stand[26] for pointing at physical documents and models, a computer screen through a scan converter for digital material, and other video sources when needed. On the PARC side, the researchers conducted the deskcrits from their individual offices or from a common laboratory space. Their offices were wired with an infrastructure called "Media Space,"[27] that supports office-to-office audio and video connections, a connection to internal broadcasts, and connections for teleconferencing. In the offices, there were two small monitors, one to display the incoming signal from MIT and the other to view the

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[26] This was used as a portable document camera where the gooseneck stand could be clamped to a table. The students could mount this anywhere or take the camera off the stand to show the inside of models. The students needed some practice before they could keep the video image stable, but once they mastered it, they used the camera often and with enthusiasm.

[27] See Bly, S, S. Harrison and S. Irwin. 1993. "Media Spaces: Bringing people together in a video, audio, and computing environment" in *Communications of the Association of Computing Machinery* Vol. 36 No. 1. pp. 28-45, and R. Stults. 1988. *Experimental Uses of Video to Support Design Activities* Xerox PARC Technical Report SSL-89-19.

outgoing image from the local video camera or document camera.[28]   Figure 32
shows this technical set-up.

1	Computer displaying digital material
2	Scan converter to change computer signal to video signal
3	Face camera displaying MIT students
4	Document camera for physical material
5	Face camera displaying PARC researchers
6	Document camera for physical material
7	DrawStream video source (see section below)
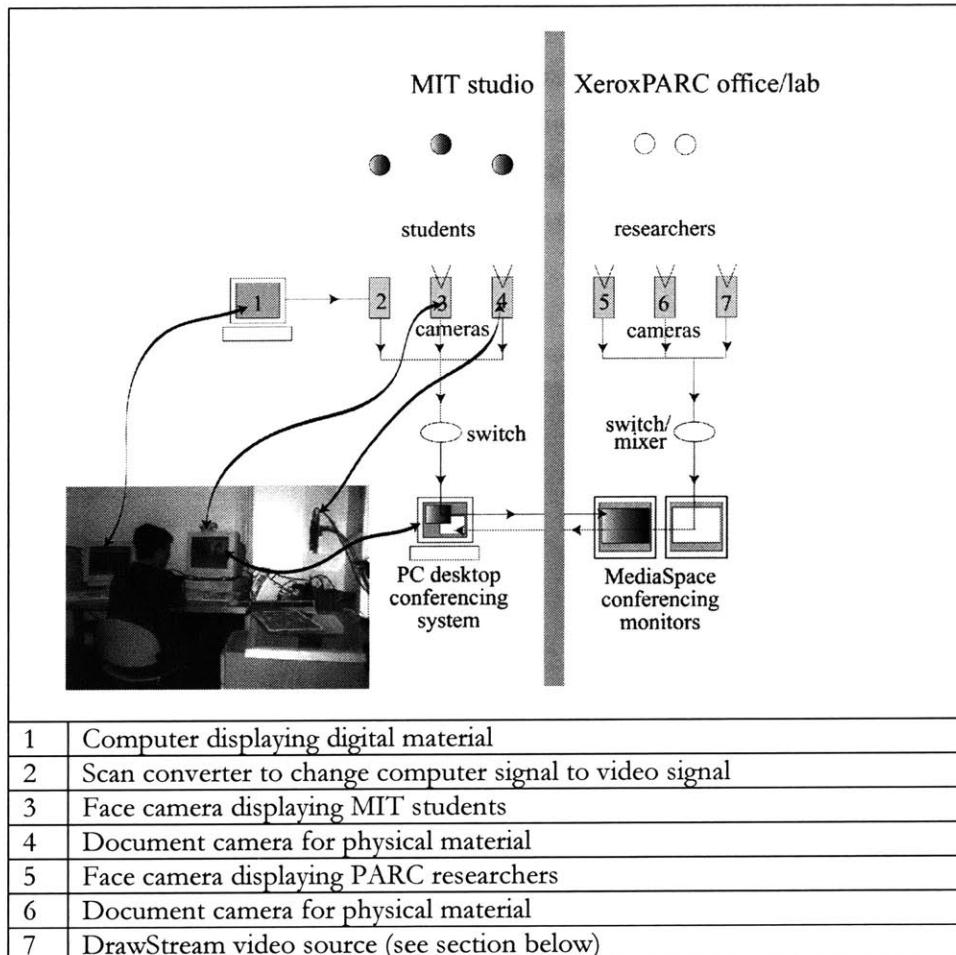
Figure 32: Technical setup for virtual deskcrits.

Later in the semester, we pulled the deskcrit station away from the other computers
and into the public meeting area of the studio to accommodate for team crits
(Figure 33). At these group meetings, the students were encouraged to take control
of the equipment by directing the camera and switching the multiple outgoing video

[28] There was also a video mixer that could send a mixture of any two video sources. For
example, it was possible to capture the image of a drawing sent by MIT and mix it with the
video source from PARC's document camera's to give an effect of overlaying images.

sources to PARC. With some students more at ease with the technologies than others, the group situation was good for distributing technical responsibilities. One student would speak while another ensured that the camera was pointing at that person or at the design material under discussion. The deskcrit station located in a communal and neutral part of the studio, rather than at a student's private desk, did not pressure any one particular student to take a dominant role. Because the students learned to use the technologies together during the group deskcrits, these events helped to make the students more comfortable and confident with the technology.
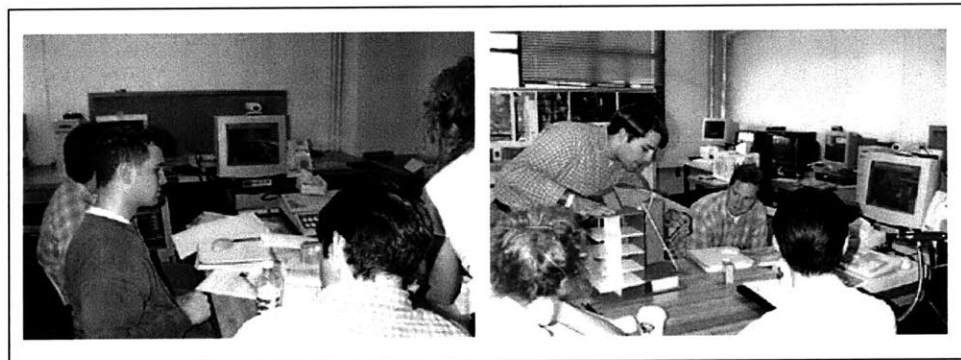
Figure 33: Group deskcrits in the public space of the studio.

Finally, midway into the semester, we brought the deskcrit activity back to its "natural" informal and cluttered surroundings of the students' personal workspaces (Figure 34). The deskcrit station, now on a rolling cart, was moved around the studio and the remote participants conducted one-on-one (Figure 35) and groups crits (Figure 36) at each student's desk with all the work-in-progress immediately available.

Figure 34: Mobile deskcrit unit at individual workspaces in the studio.

Figure 35: Individual deskcrits.

Figure 36: Team deskcrits.

The remote instructor, like the local one, was able to travel to the individual desks and the students no longer had to select and transport the relevant design material to a fixed deskcrit station. It was during these short trips from desk to desk that researchers from PARC caught glimpses of the studio spaces and its contents. Still connected, the remote critics were wheeled around to each desk (Figure 37) encountering people and things they would never had seen if the deskcrit station was fixed to one location or if each of the students' workspaces were equipped with a conferencing unit. For example, while in transit, the remote critics caught sight of a design team having a lively discussion and the critics unexpectedly and casually joined in. The serendipitous crit was enjoyable and productive (Figure 38, 39). For the remote critics, the mobility of the deskcrit cart allowed the MIT studio space and students to feel less distanced. For the MIT students, the dedicated moving computer represented the critics and they appropriated this machine playfully; dusting it off, adjusting its camera to give the critics a good view, and bringing it near a computer to look at some digital material just as they would a local critic (Figure 40). It was through these everyday casual activities that social attachments were formed between the students and the PARC researchers.
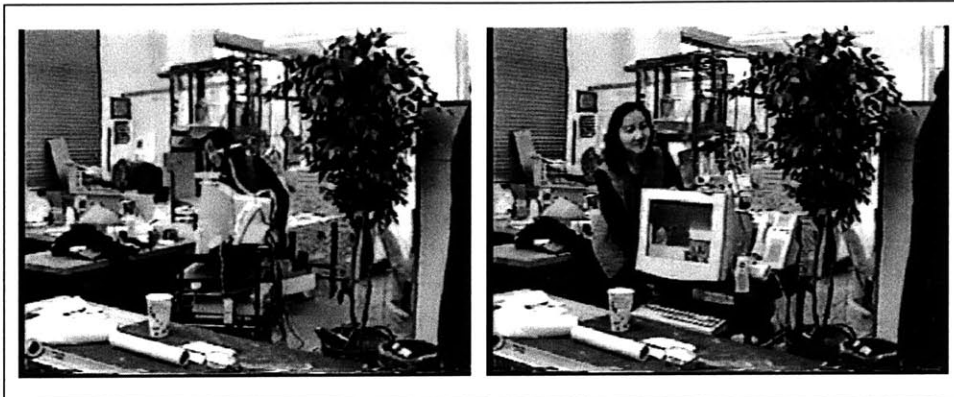
Figure 37: Mobile deskcrit station moving from desk to desk.
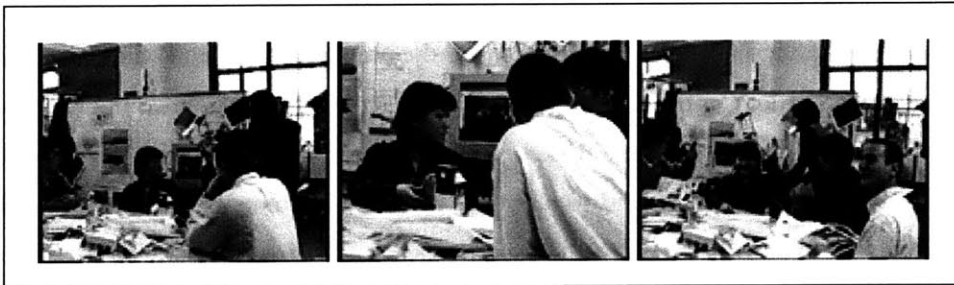
Figure 38: Serendipitous encounter with a group while critics were in transit to another deskcrit.
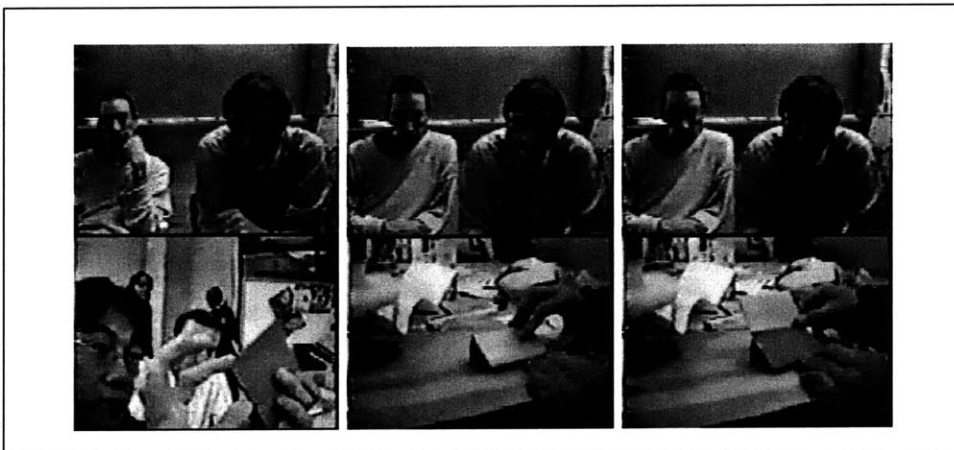
Figure 39: Computer views of interactions during the serendipitous encounter.

| a. Students showing digital design material to the local instructor | a. Students showing the same digital design material to the remote critics |
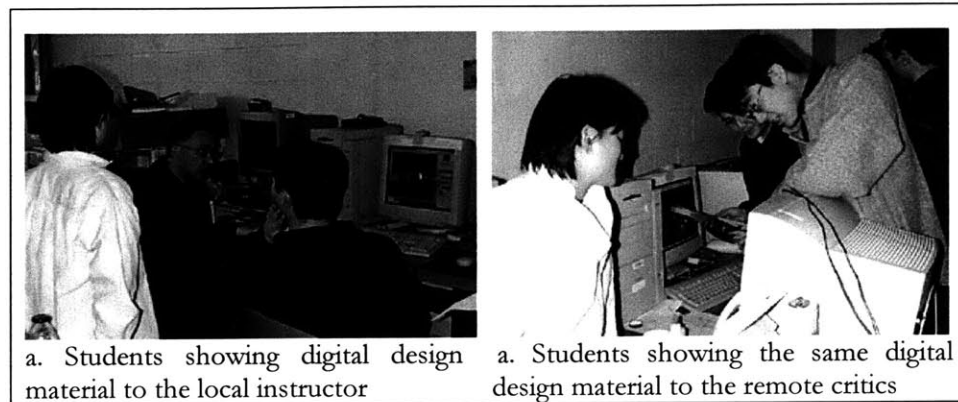
Figure 40: Students moving the remote critics to a computer to show them the design material just reviewed by the local instructor.

At each deskcrit, the student made room for the mobile unit, clamped the document camera on his desk, and arranged the cameras to show work in progress undisturbed and often still taped onto the desk. Although all the design material was close at hand and the camera captured some of the student's surroundings, the student still had ultimate control of what the remote critic saw and reviewed. Because one single stream of video was transmitted at a time, there was little possibility to view and reference many of the objects and people at the periphery of the workspace. The design material under discussion claimed its dominant position under the camera. The student's control of the camera and the quality and viewing radius of the lens built the visual boundaries of the remote interactions and often the content boundaries of the conversation. This meant that a prominent physical model in progress located at the side of a student's desk, if never deliberately presented to the remote critic, would never enter the discussion. The same goes for any other material, such as precedent studies posted on the wall, provocative preliminary sketches scattered on the desk, or the renderings currently being generated on the nearby workstation.

Overt Eavesdropping

The limited view of the student's workspace, however, had the side effect of making overt and attentive eavesdropping less inhibiting in the studio. For example, when

one student was having a virtual deskcrit, his classmate came to the periphery, noticed that the discussion was interesting, and sat down at the side of the desk making sure that the camera would not catch him. He was able to have full view of the interaction, but stayed comfortably at the periphery and listened to the long-distance discussion (Figure 41). His studio-mate's intimate deskcrit was easily accessible and he shared this learning experience anonymously.
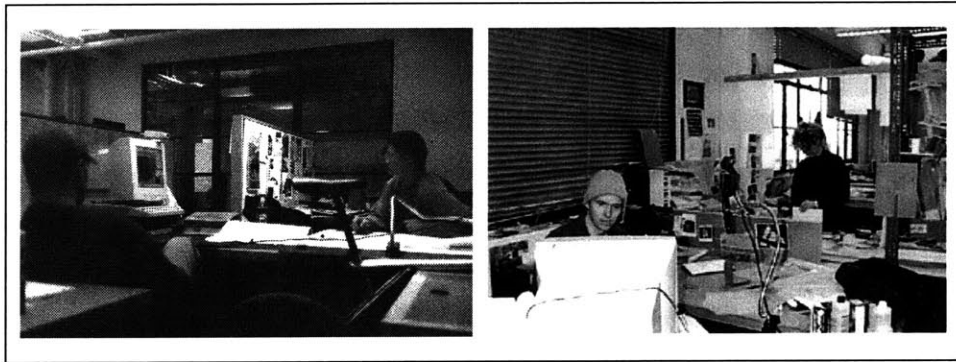
Figure 41: Eavesdropping in the studio.

With time, the students became at ease with the extra equipment at their desks and more skilled at communicating with the remote critics during deskcrits and informal pinups in the studio (Figure 42). As the students' projects developed and the role of the remote critics became understood as technology consultants, the deskcrits were more focused and these virtual meetings became socially accepted and well integrated into the daily activity of the studio.

Figure 42: Mobile deskcrit unit at pinup session.

3.5.4 Capturing Process for Asynchronous Conversations

One of the primary goals of the studio for the PARC researchers was to acquire some practical experience with a collaborative drawing tool that they were developing, the DrawStream station.[29] This tool, located in the laboratory space at PARC, allowed the researchers to make reference to and mark over the incoming images from MIT and capture their interactions with the design material for later review. The DrawStream station consisted of a downward facing camera aimed at an upward-facing monitor acting as the work surface (Figure 43). The monitor displayed the live signal from MIT, showing paper drawings, hand-drawn sketches made on the fly, physical models, digital models, webpages, and, of course, the images of the students' themselves while they discussed their work. Typically, a PARC researcher gestured at parts of the incoming image of the design proposal as he made suggestions and the MIT students were able to understand his comments by seeing both the image and his pointing hand. Simulating a traditional deskcrit action, tracing paper was also used on top of the image allowing the critic to draw over the MIT image (Figure 44).

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[29] The DrawStream station is the latest in a series of shared work surfaces for remote design collaboration that PARC has developed. For a more detailed account of the DrawStream station see Harrison, Steve, S. Minneman and J. Marinacci. 1999. "The DrawStream Station or the AVCs of Video Cocktail Napkins" in *Multimedia Computing and Systems*. IEEE International Conference on, Vol: 1 pp. 543–549. For a precursor of the DrawStream Station see Tang, J C and S.L. Minneman. 1990. "VideoDraw: A video interface for collaborative drawing" in *Proceedings of the CHI 90 Conference on Human Factors in Computing Systems*, Seattle, WA.
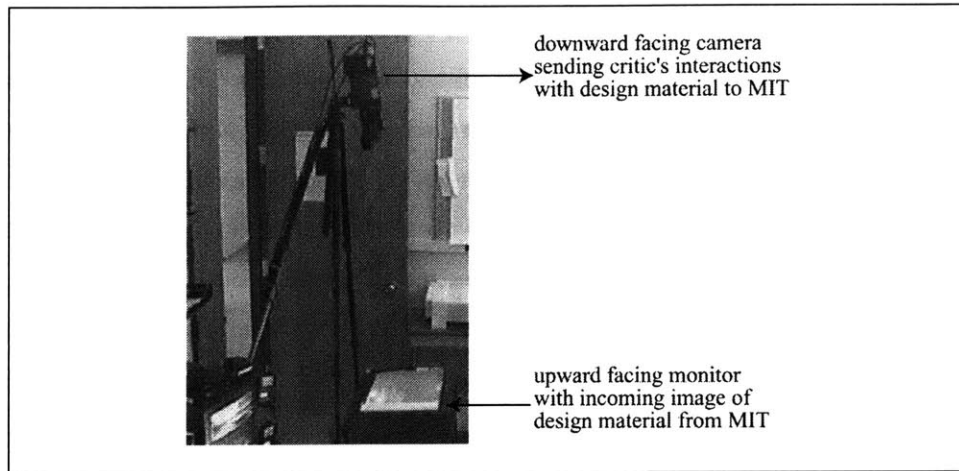
Figure 43: PARC's DrawStream station was used for the critic's physical interaction with incoming virtual design material from MIT.

Figure 44: PARC critics gesturing and drawing over MIT's design material with the DrawStream station.

The DrawStream station also had the functionality to record the mediated deskcrit sessions and to index clips for later playback. The remote critic used this tool to capture the "process ephemera"[30] of the deskcrit; that is, the DrawStream station recorded the fleeting design material and accompanying conversations usually lost once the deskcrit was over. For example, during a deskcrit with a student, the

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[30] This was the term used by Harrison et al. (1999) to describe the ephemeral "materials that come and go over the course of a project," such as sketches and rough models, product samples, or the classic cocktail napkin.

PARC researchers pulled a video clip from a previous deskcrit with that student's partner in order to review what was discussed previously. You can imagine assembling a series of these clips from every stage of the design process to illustrate the salient design discussions and decisions taken by a design team. The educational value of this tool may be in the possibility for design students to keep records of their deskcrits for reviewing later either individually, with another mentor, or with colleagues. These asynchronous reviews can be especially important when deskcrit discussions are particularly obscure and not well understood. A design instructor might also assemble and show clips of deskcrits as examples of design learning or "reflection-in-action." The use of this technology put emphasis on the design processes and practices in conjunction with design artifacts.

3.5.5 Webcameras for Studio Awareness

The researchers at PARC interacted with the students synchronously during the deskcrits, but had no sense of the activities in the studio at other times. To give the remote critics some visual awareness of the studio space, we established two webcameras; that is, two video cameras were used to feed continuous visual streams of the studio to a webpage accessible from the main website for the studio. The cameras showed the public area of the studio from two vantage points (Figure 45). As a tool for general awareness, the webcameras gave a sense of the presence and availability of studio occupants at any particular time. At first, I felt that the students would dislike this technology that permitted others to spy on them, but on the contrary, the students embraced this tool because it allowed the critics and their friends and colleagues from distant places to get a little closer to the studio.[31]

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[31] I found one student adjusting the camera mounted on the wall because the camera did not capture enough of the studio. He wanted the outsiders to be able to see more of the space and activities of the studio. Another student, not in this studio, periodically came to use the webcamera to have visual chats with her family members in Europe.

Figure 45: MIT's real-time webcameras showing two views of the studio's public space on the studio website.

Through the webcameras, the remote critics were able to be visually aware of the studio activities. For example, one day the researchers saw some students clustered around a new model during the evening hours at MIT, they spontaneously dialed into the studio videoconferencing system to chat with the students informally about their new design proposal. Both the students and the PARC critics enjoyed these drop-in calls. The remote critics also used the webcameras during synchronous deskcrit sessions allowing them to focus on one student while having peripheral awareness of the activities in the rest of the studio space.

On the PARC side, webcameras were also set up where images were posted at regular 10-minute intervals (Figure 46). These images included views into the two researchers' offices and the laboratory space. The third window of the webcamera page could either be a view to the outside of the PARC building or a display of the

incoming video source from MIT when we were connected by a videoconference. Unlike the MIT webcamera, the PARC webcameras were not often accessed.[32]
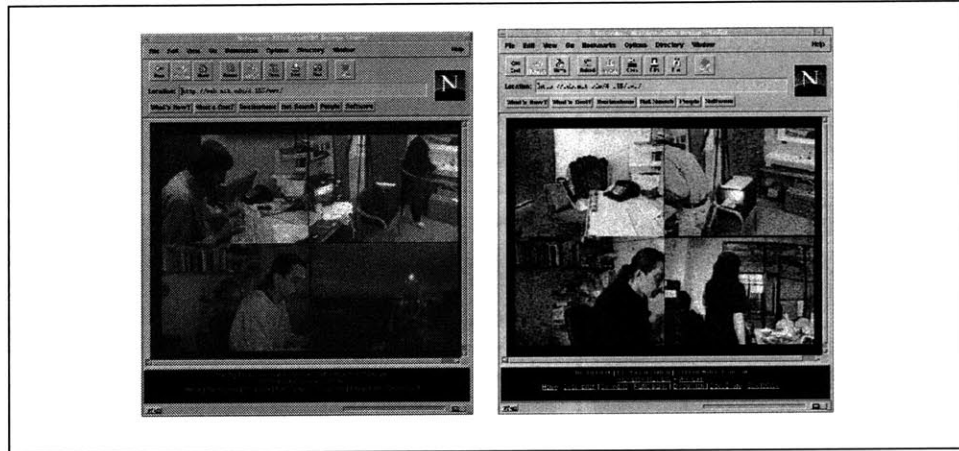
Figure 46: PARC's webcameras.

The MIT webcameras were used most extensively and enthusiastically as an inter-studio communication device. The students from other studios checked our webcamera to see who was around the studio and they wrote messages from the webpage that would be read out loud by a voice synthesizer to catch our attention (Figure 47). Many spontaneous dinners were initiated this way.

The drop-in calls and these spontaneous utterances into the studio by outsiders made the students acutely aware of the asymmetry in visual awareness of their mediated environment; that is, the remote critics and anyone else viewing the webcameras could peer into the studio whenever they pleased, but the students could not peer back at them. At this point, the students began to playfully take control of these cameras. For example, the night before the midterm review, they directed one of the webcameras toward an old and stained coffee cup etched with a

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[32] The students did not feel the need to see into the PARC spaces since they could not easily initiate a call to them. The PARC webcamera page was also deeply buried in their web hierarchy preventing easy access.

drawing of a very tired face to summarize the entire studio's exhaustion. The freedom to play with the technology and to spontaneously express themselves helped the students to appropriate the tools as an integral part of the new mediated setting of the studio.
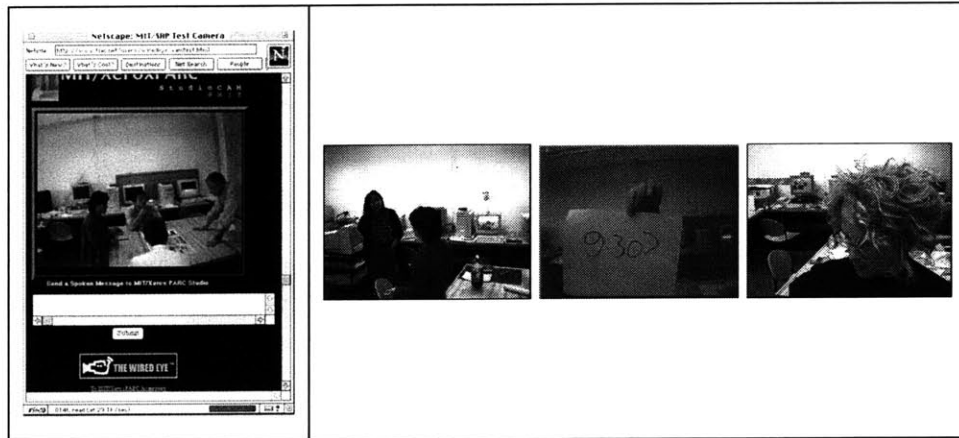
Figure 47: MIT webcamera page with area to send text to be read out in the studio.

3.5.6 Long-Distance Final Review Revisited Yet Again

The end of the studio was marked by a long-distance final review involving guest critics both at MIT and PARC. The final review was more elaborate than our previous reviews because we provided multiple video cameras to give a better feel of the proceedings to the remote participants. There were cameras to display views of the student presenters, the projection screen, and the audience reactions in addition to the usual cameras to show documents and models. This increased the responsibilities of the technical director to ensure that both audiences received a coherent and equivalent stream of information.[33] Figure 48 shows this technical set-up.

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[33] The technical director controlled the local audience view as requested by the presenters. The technical director also had ultimate control of the view of the remote critics. A functionality that would allow the remote critics to select the camera view and control the camera themselves would have given them more freedom and lessened the tasks of the technical director to anticipate their needs.

1	Computer for webcamera and design material
2	Computer for design material
3	Projection screen for local audience
4	Monitor displaying critics at XeroxPARC
5	Webcamera
6	Video camera capturing students
7	Lipstick camera capturing physical models
8	Document camera
9	Video camera capturing projection screen
10	Video camera capturing audience
11	Video camera capturing XeroxPARC critics
12	Video camera capturing XeroxPARC critics
13	Document camera
14	Computer to display webcamera view from MIT and web-based material

Figure 48: Technical set-up for final review.

We also provided a webcamera for the final review. The critics used a dedicated computer to continuously display the webcamera page to supplement the single

video channel provided by the videoconferencing system. Anyone accessing the webcamera page would also be able to view the continuously streamed video from the presentation room.[34]   Figure 49 shows some views from the webcamera.
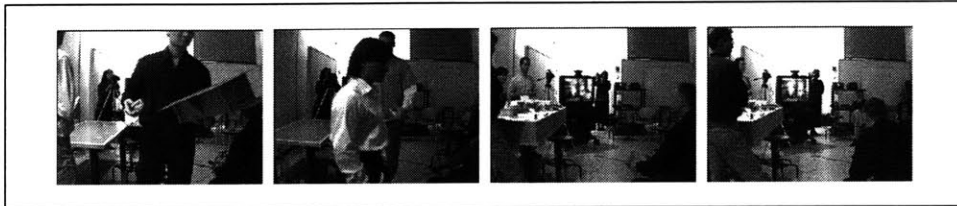
Figure 49: Views from the webcameras during the final review.

Filled with cameras, computers, and lights,[35] the presentation room was intimating but the students were, by then, very familiar with the technology and with their own way of communicating design in a mediated environment. However, they confessed after the review that it was very difficult to present to both local and remote audiences with equal emphasis. That is, what might be most useful for the local audience, such as physical models, might not be appropriate for the remote audience to understand.[36] And conversely, the best techniques to illustrate design ideas to the remote audience, such as using web-based presentations, might not be the best way to engage a local audience. The students, as a result, used a variety of media to present their design proposals, which included high-resolution computer-generated images on panels, webpages, videotaped scenarios, and physical models. Figure 50 illustrates the context of this elaborate final review.

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[34] Whenever the webcamera page was accessed, the system gave out a clicking sound that alerted us of these "lurkers" watching our presentation. We can imagine now using an audio and video livecast on the web allowing interested outsiders to follow the complete presentation and not only the visual portion.

[35] The spotlights were used by a film crew to record the proceedings of the final presentation. This added to the stage-set atmosphere of the review.

[36] One group sent a copy of their physical prototype to PARC so that the remote critics could also have a physical model to handle during the review.

Figure 50: Views of the final presentation at MIT.

3.6 MIT/OPORTO/LISBON CHARRETTE

In the fall of 1997, I was part of a five-week intensive design project involving students, faculty, and critics at three sites: the Department of Architecture at MIT, the College of Architecture at Oporto University (FAUP), and the Technical Superior Institute (IST) in Lisbon. This case investigated remote *cross-cultural* peer-to-peer team collaborations for developing a single design project.

The project focused on understanding:

- the relationship between the design problem and the distributed design process, where we found students leveraging their own experiences with remote collaborative design to inform their design proposals and reflecting and communicating their design processes;

- the relationships and incentives of collaborators, where we found that a project leader was critical in driving the collaborative process forward and that a collaborative spirit among the teaching staff was just as important as the coherence of the students;

- the assemblage of technologies, where we found that it was valuable to incorporate technologies, such as chat systems and webcameras, that allowed informal and playful communication used to interweave the other more formal studio events and to supplement the webpages;

- how students negotiated culture, where we observed students using their mutual design activity as a catalyst to share cultural ideas, explicitly and implicitly; and

- how a culture of collaboration may be built, where we found that a sustained social environment allowing frequent and purposeful interactions helped to build meaningful relationships for collaboration.

3.6.1 Relating Design Problem and Process

The design problem was the development of a housing complex for teleworkers. The location for the project was real; it was a parcel of land with an abandoned

industrial building, a chocolate factory, in Lisbon. The need for redevelopment of the site was real; there were ongoing plans by the city to renew the neighborhood surrounding the site. The premise of a residence for teleworkers was also real, since we may consider networks and current telecommunication technologies to be the driving force of this kind of information work and workers.[37]

The students had the task of designing a new building type to accommodate these new workers in the old sector of Lisbon. Because the students were collaborating through computer-mediated environments throughout the project, they were, in fact, potentially these new hypothetical workers who would inhabit their design proposals. The students were encouraged to be reflective of their personal experiences of working with remote colleagues and to leverage these experiences as a starting point to understanding the new type of housing and to giving insights on their collaborative process. In this way, the studio process became integral to the design problem.

3.6.2 Managing Collaborators

The initiation and success of any joint project comes from the enthusiasm, cooperation, and collaboration of the participants. For the large number of participants in this project with three remote sites, we found it was critical for both the teaching staff and the student design teams to build a collaborative spirit to support collectively the goals of the learning experience.

Instructor Collaborations and Complementary Incentives

The role of the traditional studio instructor changes in long-distance collaborations that involve other students and instructors because it requires sharing control and responsibilities in the studio. In the best cases, the instructor becomes a studio collaborator instead of a studio master. The traditional studio master usually has

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[37] The idea of teleworkers was initiated and pushed forward by the MIT project members. The Portuguese students were less convinced about its prevalence in Lisbon. This was in fact one of the major topics of negotiation.

freedom in the studio process. He often teaches alone. He creates the design problem, selects the site, supplies design criteria, provides design criticism, and judges and grades by himself. In the privacy of his studio, he regulates the design process and conveys his own design values, and uses his own teaching methods. There is little intervention from other instructors or students outside of the studio, except during the public reviews. In this project, however, the teaching staff from different institutions needed to communicate, coordinate, and collaborate on the content and the process of the studio.

This collaboration began with existing personal relationships between the members of the teaching staff from the different schools[38] and it flourished with a challenging design project that would provide exciting opportunities for all parties. The teaching staff of each school saw different, but complementary benefits. For the staff at MIT,[39] we believed that this project would be a good opportunity to conduct yet another long distance project and test some ideas about cross-cultural collaborative design. Cross-cultural learning was therefore an explicit part of the agenda. It was also an added bonus to be able to work with world-renowned architect and professor at Oporto, Alvaro Siza. For both the teaching staff at FAUP[40] and IST,[41] this would represent their first experience in long-distance design giving them opportunity to build relations with MIT and to understand first-hand the implications of conducting remote collaborative projects. IST was to launch its own architecture course so this project was intended to help understand a model of design learning from FAUP and MIT. FAUP, with its strong tradition in freehand

[38] The project was initiated and led by a teaching assistant, José Duarte, a Portuguese doctoral student at MIT with ties to the teaching staff at both FAUP and IST.

[39] On the MIT side, there were two instructors, three teaching assistants, and one critic. The instructors were Professors Bill Mitchell and Peter Testa. The teaching assistants were José Duarte, Pamela Campos, and myself.

[40] At FAUP, there were two instructors, a teaching assistant, and one critic. The instructors were Antonio Madureira and Fernando Lisboa. The teaching assistant was Antonio Meireles. The critic was Alvaro Siza Vieira.

[41] At IST, there were two instructors, one teaching assistant, and one critic of "territorial engineering", a kind or urban and regional planning. The instructors were João Bento and Teresa Heitor. The teaching assistant was Francisco Regateiro. The critic was José Pedro Martins Barata.

drawing, would benefit by experimenting on how to integrate computational design methods into this tradition.[42]

The joint teaching staff (Figure 51) carefully crafted the learning environment. This included initial trips to Portugal to find an appropriate site and to discuss the design program prior to the charrette. For the day-to-day activities during the charrette, it was the commitment of the teaching assistants that was critical, since they were the ones who ran the project, from coordinating the meetings, assembling the suite of technologies, ensuring compatibility and connectivity, preparing reference material, and encouraging certain collaborative design processes and work protocols, as well as critiquing the projects. A teaching assistant on the MIT side took on the role of collaboration leader and "cultural interpreter." With his personal relationships with staff members from each university, he mediated between the participants' educational and cultural differences and oversaw their collaborative efforts.
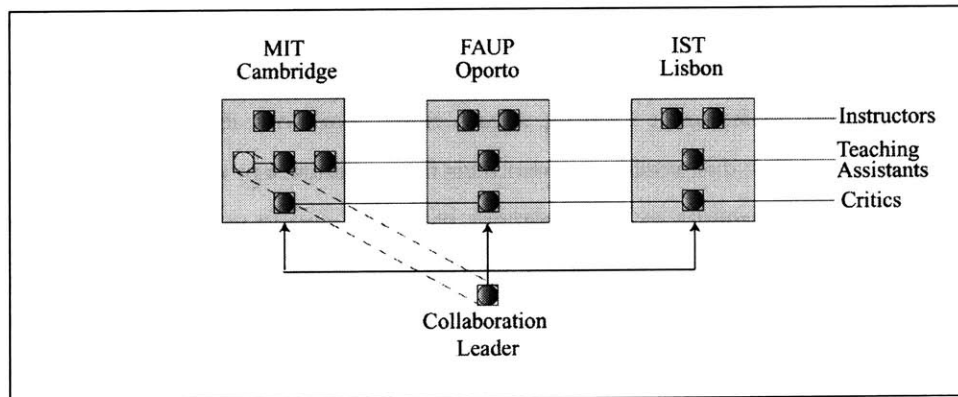
Figure 51: Collaborative teaching staff with a collaboration leader.

Student Collaborations

The enthusiasm of the design students was also extremely important. Their commitment to the project came from their interest in the design problem, the new

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[42] Duarte, José, João Bento and William J. Mitchell, eds. 1999. *The Lisbon Charrette*. Lisbon: IST Press.

working environment and its accompanying technologies, and the opportunity to work with students from another culture.

The students worked in teams that were formed during the first week of the project after a joint introductory videoconference.[43] We first asked the students to submit a statement of design intent and interest and to fill out questionnaires describing their computing skills. With this information and their personal contacts in the studio, the students first formed design teams at each location. We anticipated that these collocated teams would help maintain traditional peer-interactions at the physical sites and regain some of the studio-based camaraderie that would be lost by giving priority to remote interactions. These collocated teams chose their long-distance partners through informal and lively computer-mediated discussions about the project and their design interests and attitudes (Figure 52).
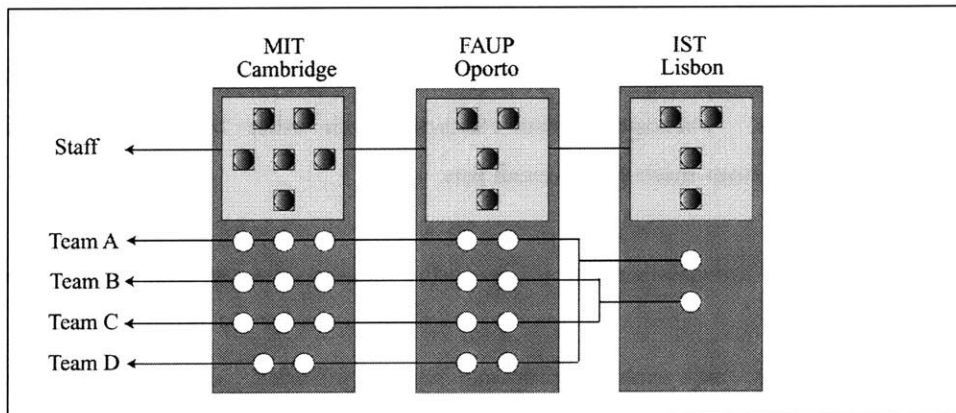
Figure 52: Cross-institutional student teams.

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[43] At MIT, the graduate students, two of which were from the Graduate School of Design (GSD) at Harvard University, formed four teams. Team A: Michelle Apigian, Sheila I. Colon, Teresa Tourvas. Team B: Heidi M. Rosenwald, Allen Tsai, Chia Ling Yin (GSD). Team C: Chris I. J. Lee, Minjung Maing, Samuel Hui (GSD). Team D: Rolando Mendoza, Hector Perez. At FAUP, the eight students were paired into four teams. Team A: Alvaro Andrade and Ricardo Pereira. Team B: Paulo Carvalho and João Dias. Team C: Sara Duarte and Raquel Paulino. Team D: Teresa Augusto and Gabriela Nascimento. At IST, each of the two students served on two teams. Pedro Matos was on Teams B and C and José Pinheiro was on Teams A and D.

3.6.3 Assembling Collaborative Technologies

This project, as in our previous cases, took the approach of gathering readily available, inexpensive, and easy to use communication tools into a suite of technologies to make a viable learning environment. The suite consisted of technologies for synchronous and asynchronous communications for verbal, textual, and graphic data exchanges during large formal meetings, such as the midterm and final reviews, as well as for small informal group meetings, such as scheduled and impromptu encounters for group work. The technologies included email, ftp sites, webcameras, chat system, websites, and ISDN video conferencing.[44] This was the first project in which we observed students interweaving individual technologies to support group design work.

Asynchronous Tools

The Web was used heavily throughout this project as a place for publishing reference material and design proposals through designated team webpages, exchanging CAD files through FTP sites, and for individual comments through discussion pages. Participants also contacted each other by individual email addresses and custom-made group email lists.

The structure of the class website (Figure 53) consisted of a top page (Figure 54a) with links to:

- webpages of each institution, which included site-specific design information supplied and maintained by each school's teaching staff (For example, the IST institutional page had all the relevant site information, their own FTP site, and links to relevant parts of their school.);

- webpages to each design team (Figure 54b), which included pinup pages for the team's design proposals (also used for synchronous design reviews) and discussion pages for comments by members inside and outside the team;

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[44] See Duarte, José Pinto. 1999. "Making the Virtual Design Studio: Tools and Protocols" in Duarte, José Pinto, João Bento and William J. Mitchell, eds. The Lisbon Charrette. Lisbon: IST Press. pp.94-109. for another overview of the technologies used in this project.

- webpages to individuals, which were personal webpages allowing participants to introduce and represent themselves to others; and

- webpages for the logistics of the charrette (Figure 54c), including places for class announcements, news events, and troubleshooting.
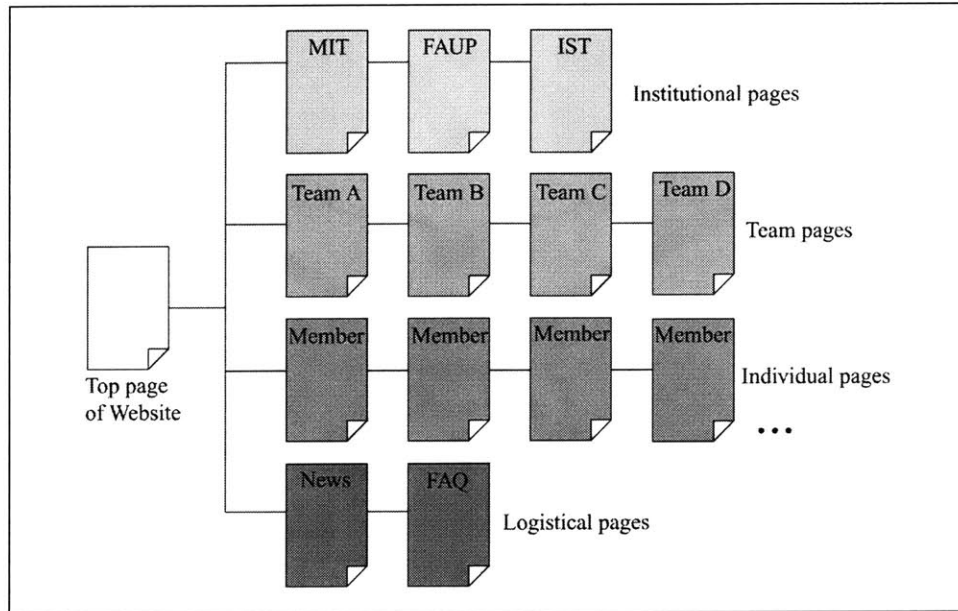
Figure 53: Structure of charrette website.

| a. Top page | b. Team page | c. News page |
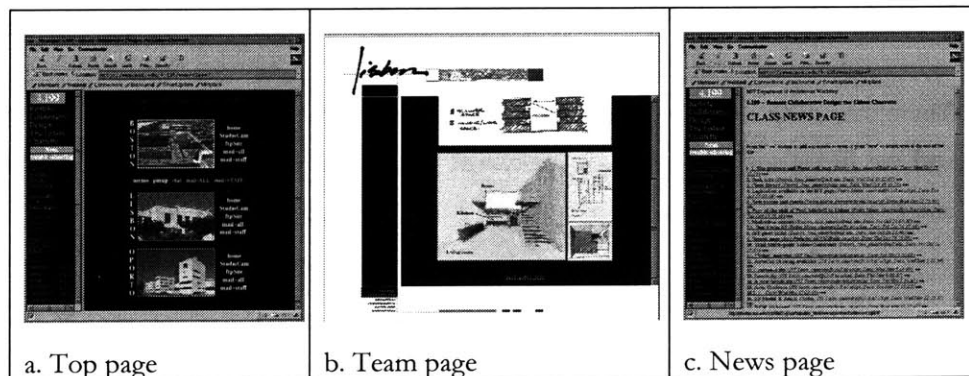
Figure 54: Examples of webpages.

Synchronous Tools

The synchronous meetings were conducted by three-way videoconferencing through a bridge service in the United Kingdom (Figure 55).
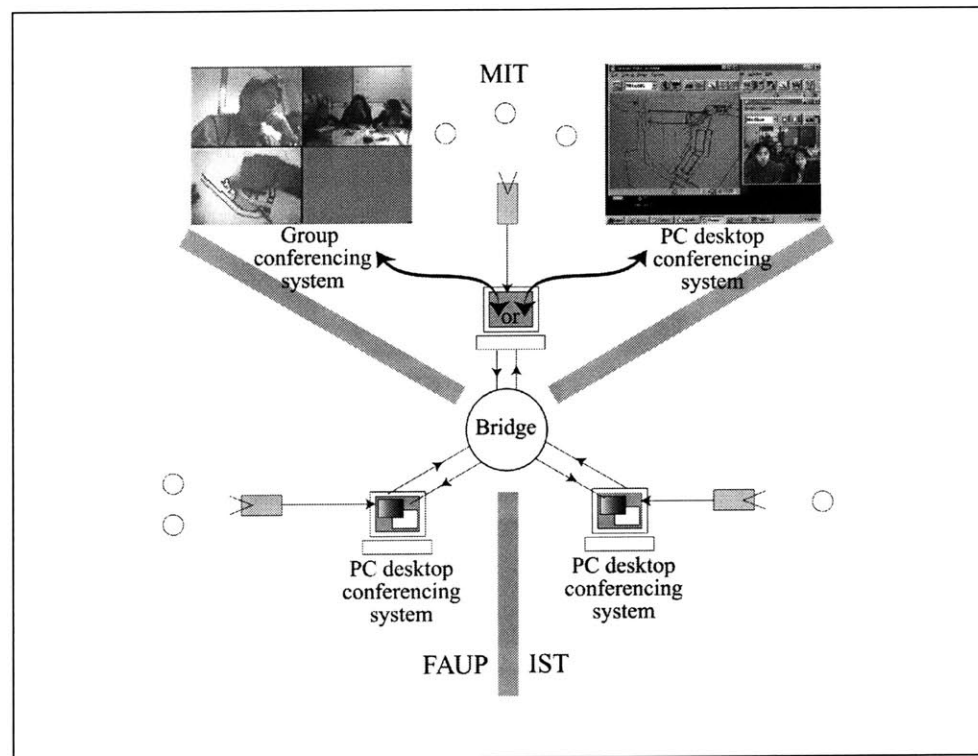
Figure 55: Three-way videoconferencing set-up.

There were large mediated meetings such as the first meeting, the midterm review and the final review. They were conducted in a formal presentation space at MIT and IST and in a computer workroom at FAUP (Figure 56).
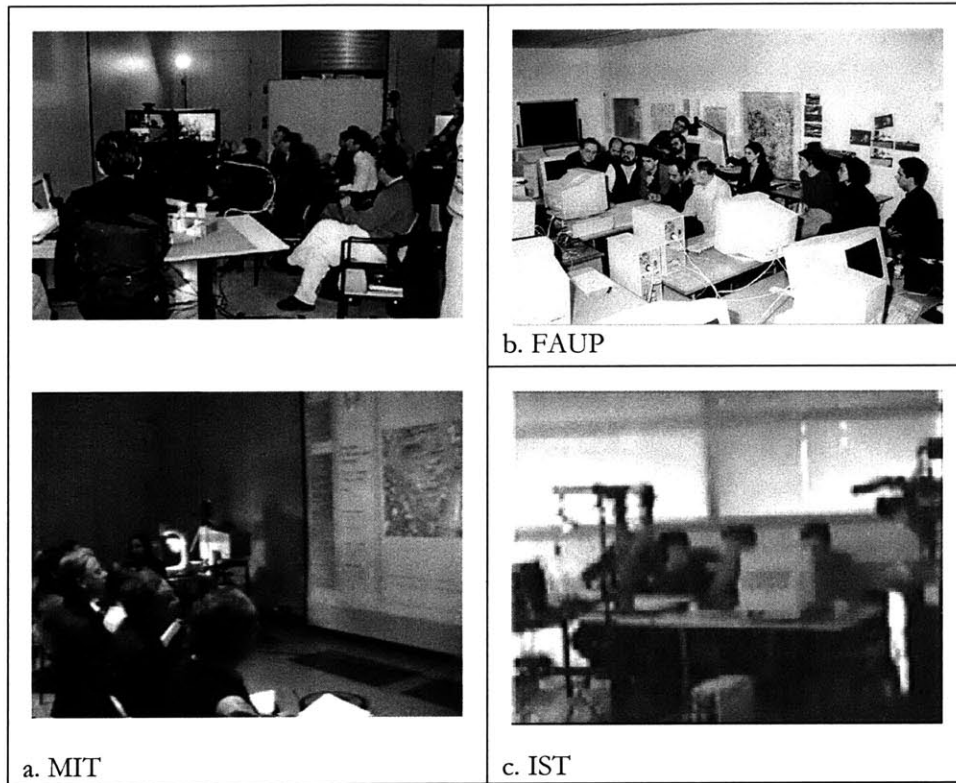
Figure 56: Final review spaces.

During these meetings, the students used their team webpages for presentation. Figure 57 shows some screen shots of the three-way videoconference.

Figure 57: Views of final review with three-way videoconferencing.

There were smaller videoconferences for the work sessions attended by the team members only.[45] At MIT, these meetings were held primarily at a reconfigured workspace in the design studio (Figure 58a,b). At FAUP and IST, they were held at a desktop machine in a computer workroom (Figure 58d). We began with a strict schedule for three-way videoconferences dedicated for group work, but as the

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[45] Only occasionally did the instructors join in these group work meetings. When they did, they often brought a sense of formality to the sessions.

charrette progressed, this schedule was relaxed and the students coordinated their own work sessions depending on their progress and needs. There were also impromptu meetings between two sites (Figure 58c).

a. Coordinator-scheduled work session by videoconference at MIT	b. Student-scheduled work session through chat and webcamera at MIT
c. Impromptu meeting with FAUP by videoconference from the MIT studio	d. Work session by videoconference at FAUP
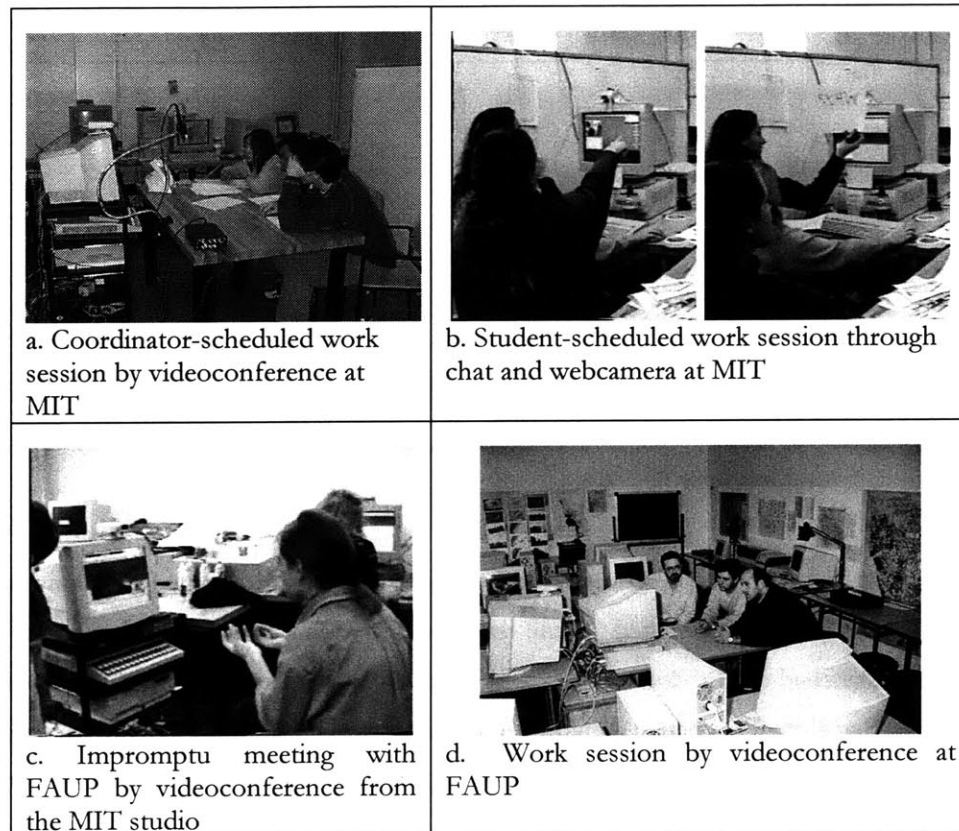
Figure 58: Group work sessions.

It was during the informal synchronous group work sessions that the students developed their design for the project as well as their team relationships. The students became increasingly engaged in the project as they slowly came to understand the others' national cultures, design sensibilities, and work practices. Because the participants never met in person, the video connection was instrumental in bringing the distinct groups into a sustained social environment in which trust and commitment, so critical in making successful working teams, may be developed through the subtleties of eye contact, body language, hand gestures,

and speech. At the beginning of the project, the students asked to see people's faces and their physical spaces, but by the end of the project the camera focused primary on their design work (Figure 59).[46] The videoconference sessions also helped to support, encourage, and validate the asynchronous interactions.
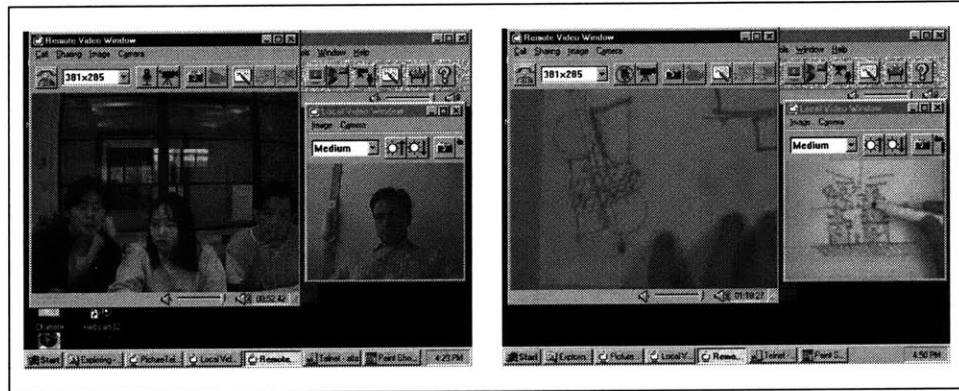
Figure 59: Desktop view during work sessions.

The style that each team developed for these work sessions determined what kind of design material was presented. Some teams preferred more verbal discussions and others sketched on the document camera and showed physical models. One group found that they were better graphically understood when they used bright colored markers and bold diagrammatic drawings (Figure 60). They were not concerned with the subtle aesthetic qualities of these drawings, but drew them to be design communication devices. As a result, this group's team webpages also had this same bold diagrammatic quality (Figure 61).

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[46] This also happened in the MIT/Kumamoto/Kyoto case where, at the start of the project, the students were eager to see the remote members, but by the end of the project, when they were more familiar with each other, they did not need to see each other to understand the subtleties in their language and their designs.
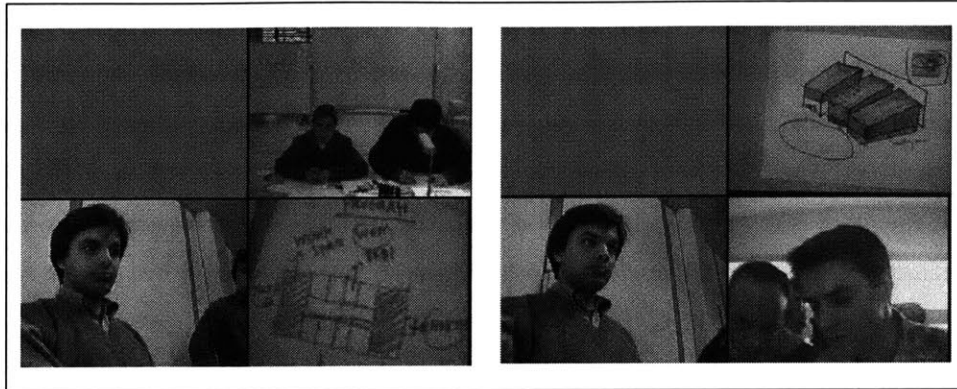
Figure 60: Desktop view of a team's use of bold diagrams for communication.
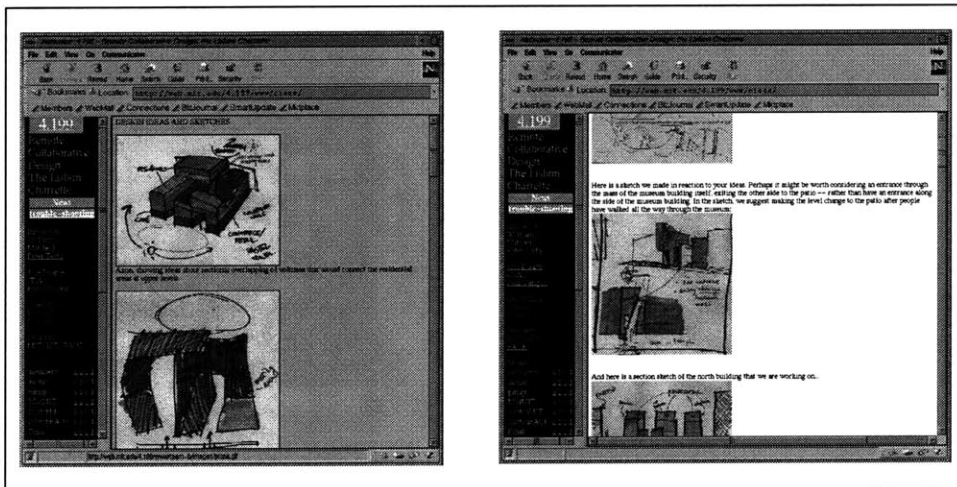
Figure 61: Bold diagrams were also used on the team's webpage.

Chats and Webcameras as Social Glue

If the three-way synchronous meetings were the central components of the charrette, then the social glue that held these important pieces together was the textual chat system and webcameras.[47] We introduced these technologies to increase the informal communication among the remote team members in the time between the synchronous group meetings.

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[47] All sites could participate in the chat system but only IST and MIT had webcameras

The webcameras were windows into the other schools' workspace for general and informal visual awareness. The real-time visual contact provided the feel of proximity. The MIT webcamera page, as part of the MIT website, provided a place where you could type in words and have those words read out by a voice synthesizer at the other end. This made it easy to catch the attention of the participants in the remote studio even when they were attending to other activities away from the computer. The students' playfulness in using the webcameras gave a sense of informality to the virtual studio (Figure 62).
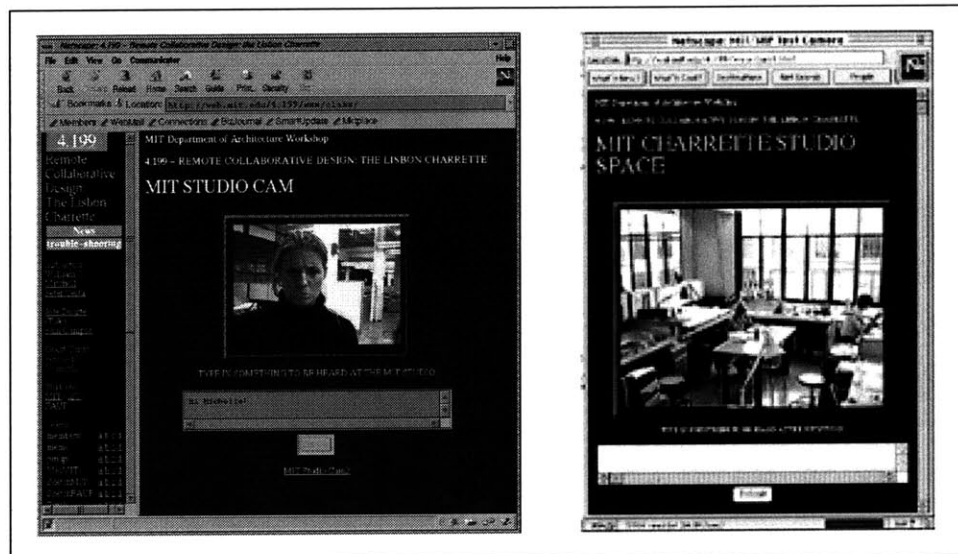
Figure 62: Playful use of informal webcameras in the studio.

The chat room gave another dimension of informality to the project. It was the informal meeting place for the students without the instructors. Often the conversations in the chat room were unlike those in person, in the videoconferences, or any other type of mediated communications. They were flirtatious, sometimes bordering on the unacceptable by face-to-face classroom standards. The students used this kind of chat to grab attention and to quickly test

the boundaries of the social environment that they were creating together.[48]
Because the students understood that they would never meet each other in person,
they were sometimes more courageous in this testing than in a face-to-face situation.
In the example below, the students discuss what should be placed in the commercial
space on the ground floor of their complex:[49]

> 20:53:20**Luis**   /toula-sofia No i'm not thinking in a Sexshop or
> something...:) But we have to think in something that bring people and
> where people feel good to go there
> 20:53:22**Helen**   /Mario Sofia says we shouldn't take it personally....
> 20:53:39**Mario**   Luis have you seen Daniel; Cesar?
> 20:53:59**Mario**   /Helen Sure, I was just kidding!
> 20:54:27**Helen**   /Mario actually, mario, I just overheard something about a
> sex shop from the Toula, Sofia, Mary group...hmm???
> 20:54:38**Luis**   /toula-sofia I saw one of the suggestions that i find
> interesting.
> 20:54:52**toula-sofia**   /Luis people WOULD feel real good there...I
> think we should seriously consider it!!!!!!!!!<:)
> 20:55:08**Helen**   /MarioI know...
> 20:55:44**toula-sofia**   /Luis ok...enough now we will be professional
> which one is interesting?
> 20:56:11**Mario**   /Helen Yes, hmm!!?? Well, Porto has a sex shop too,
> maybe they are exchanging items? Or at least their knowledge.. This is
> supposed to be an academic project...
> 20:56:14**Luis**   /toula-sofia To put commerce on the ground floor and
> residencial on upper floors is the kind of thing that happens in the block.
> 20:57:23**Helen**   /Mario I think we will get very interesting designs judging
> by the conversation!
> 20:57:41**Luis**   /toula-sofia So it would be a solution in continouity with
> the area around
> *(names have been changed)*

Although the conversations felt ephemeral and private, they were not.   The chat
room activities were recorded and anyone could retrieve these archives. In fact, the
students knew that it was public record if "you took the time to find it on the

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[48] If you were outside of this social environment, you might misunderstand this flirtatious
chat. One of the teaching assistants misunderstood the conversation and suggested that the
students stop, but all the students quickly told him that it was all in good fun.
[49] These are the original chat logs. A "/" before a name denotes that the speaker is
whispering to that party. The name "teresa-sheila" was to convey that they were sitting
together and speaking through one voice during this session. Spelling errors result from the
speed and informality of these exchanges.

website," as one student pointed out. The feel of the chat being momentary was enough to maintain the informality. Even when "real work" was being discussed, there was always a secondary underlying chat stream of friendly banter.

Also adding to the informality was the students' use of textual smiley faces and different chat room login names, such as "dr-love", "tado-ando", "jesus-christ", "big-bertha", "elvis-presley", "hot-head", or "The-Deep-Throat". During one session, one of the MIT teams logged in as "angelitas" because they felt like "Charlie's angels" that day. On a more serious note, many of the students would log in with names that clearly identified which team members were currently present, such as "heidi-allen-cyin," as they sat clustered around a single machine during these chats. It was important for the members to show ownership of their comments during these more serious work-oriented conversations.

Weaving Technologies

Together, the webcameras and the chat system helped to keep the channels of communication open among the participants during the times in between the more formal videoconferences by providing opportunities for:

- spontaneous drop-in sessions for work-related or social conversations;
- peripheral studio awareness of the studio space and activities;
- bridging between other technologies, such as videoconferencing, email, and web postings; and
- private discussion without possible instructor intervention.

There were situations in which the students interweaved all the technologies in unanticipated ways. Examples were situations in which:

- the students used the chat system as preambles to a large videoconference;
- they continued their discussion in the chat room after their allocated timeslot was exceeded in the videoconference;
- they used the chat room to discuss an email they just received;

- they checked on the webcamera to see who was working late in the evening and then called the remote teammates for a chat; or

- they used the webcamera to show improvised sketches and models during chat room discussions.

3.6.4 Negotiating Culture through Group Design Activity

This project suggested that remote collaborative design could be a promising method for exposing students to cross-cultural issues. The group design activity challenged the students' design assumptions, trained them to negotiate and integrate different design perspectives and social needs, and engaged them in critical design discourse that resulted in creative designs showing sensitivity to different cultures and design approaches. The technological, social, and educational environment that was created for the charrette gave opportunities for cultural exchange, explicitly and implicitly. These exchanges occurred in a variety of ways. Some groups had heated synchronous discussions during videoconferences, others used email in a more formalized way with bulleted arguments, and still others used the informality of the chat room. Regardless of how and when these cultural negotiations took place, the design problem and collaborative design process were the catalysts for the exchange.

Explicit Cultural Exchange

The need to understand the Portuguese culture was explicitly programmed into the design problem. Because the design site was in Lisbon, the students at that location had the task of communicating not only the physical conditions of the site, but also its social, cultural, and historical context. In this explicit cultural exchange,[50] the Lisbon students learned to make tangible and understandable their own personal tacit knowledge of place and culture. Describing the site through appropriate

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[50] See Dave, B. and J. Danahy. 1998. "Virtual Study Abroad and Exchange Studio" in *Proceedings of ACADIA '98*, Quebec City, Canada, pp. 101-115, for a description of a study focusing specifically on virtual cultural exchanges in long-distance studios. Students did not design jointly for a common site but each collocated group of students designed for a site in the city of the remote group. The central collaborative activity was the communication of site information to distant and foreign designers.

representations and interpretations became the important role of the IST students.[51] This was considered the biggest challenge for the IST participants, both technically and socially, since the remote students would not visit the site.[52] Moreover, many of the MIT students[53] had never visited Portugal. The information was posted on the charrette website, under IST's institutional page (Figure 63). This included aerial photos, terrain models, diagrams illustrating the urban context, two- and three-dimensional data about the chocolate factory, a video to describe the daily life of the neighborhood, and formal building code regulations. These documents became the starting point for group discussions in which the IST students often took the role of client, zoning board, or site guardian.

The remote aspect of the studio required the MIT students in turn to see the foreign site through the eyes of their native co-designers. This was a new and interpretative way of receiving and understanding site information. The MIT students also participated in planned extracurricular cultural events, such as Portuguese movies, concerts, and dinners, which would give the virtual teams material for informal and amusing topics of cross-cultural conversation.[54]

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[51] See Heitor, Teresa. 1999. "Formulating the Design Problem: Issues in Remote Description" in *The Lisbon Charrette*, pp. 74- 91, for a comprehensive review of the design problem. The IST students' task was divided in two parts. First, they selected the site of the chocolate factory in a part of Lisbon undergoing urban and social changes and formulated a design brief that took into considerations the rules outlined by the Lisbon Master Plan and other official zoning documents such as the General Regulations for Urban Buildings. Second, the IST students had the challenge of selecting and transferring technical, which included topographical, spatial, regulatory information, as well as historical, cultural, and social information about the site to their remote teammates.

[52] One of the comments that Alvaro Siza had about this experience, despite its innovations, was that the final projects showed that a visit to the site was very necessary: "I believe, nevertheless, that a visit to the site is necessary. This might be a dreary thing to say, but I have the feeling that to experience the atmosphere of the streets would be a complement that could enrich the approach. I also have noticed that topography might not be well expressed in the final proposals. This site is very complex and the design proposals, in general, do not express such complexity."

[53] The MIT group was diverse, representing seven nationalities, and eager to share cultural differences. During one of the chat room session, the students expressed how wonderful it was that so many nations were represented in the charrette. They began to teach each other words in different languages and used them amusingly throughout the charrette.

[54] These events were initiated and guided by José Duarte.
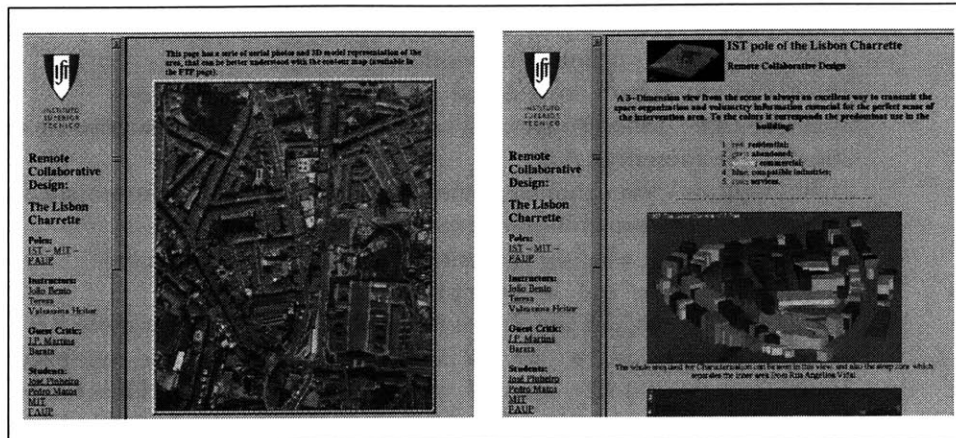
Figure 63: Site information on the IST website.

Implicit Cultural Exchange

The sustained social environment built by the students allowed implicit cultural exchanges. With every new interactive session, value systems were discussed, challenged, debated, and possibly reconfigured. These values were not only concerned with national culture, but also with different values found in the individual design groups and institutions.

Particular cultural values and attitudes were embedded in the design concepts and proposals. Because the cross-cultural teams had to collaboratively design one single coherent proposal, they argued, sometimes fiercely, for their own cultural values about design as demonstrated in their particular design solutions. In their act of consensus forming, there were clear differences in the students' attitudes about various design issues, including the idea of telework, the relationship between public and private spaces, and the need of historical preservation.

The students debated the initial premise of telework in the Portuguese context. The MIT students were convinced about the idea while their remote partners were skeptical:

> 21:08:24**daniel** anyone knows if the project program refers to tele-workers -or- students?

21:08:25**helen**   does Miguel cross-dress?

21:09:16**helen**   it's definitely teleworkers

21:09:19**Mario**   what's cross-dress?

21:09:56**helen**   lisbon+oporto: 1) cross-dressing is when a man dresses as a woman. and american thing.

21:10:15**Mario**   Not definitely, Helen, The housing for students possibility is an option. It all depends on our analysis...

21:10:41**helen**   2) what are your interests, in terms of being more theoretical or more "real" in the approach of the project?

21:10:46**sofia**   miguel: although it is for teleworkers it doesnt mean it is SUPER technological....we are still investigating real people and real spaces!

21:12:11**helen**   Actually, for MIT students, we have been told that this is definately for tele-workers - still real spaces and real people but with the added layer of "virtual/computational "issues

21:12:18**Mario**   I prefer the term imaginative rather than theoretical... It wouldn't make much sense to plan something we know won't be possible.

21:12:57**Luis**   Mit, i read your texts at pinup, and i find your interests in the project (public spaces inside the block and telework) very important, but they really too much specific for the beggining of the project. I would like to here from you ideas and interrogations for the zone, the way of working the old facade and the new building, the relation between the intervention and the urban fabric around.

21:13:51**sofia**   Mario I think that is a good point and is good to know tha exist other posibilities other than tele-work.

21:14:11**helen**   theoretical does not mean "impossible"; theory shoulk bring up the underlying issues that may not brought up in more "real" or less exaggerated approach...

21:14:52**Mario**   Helen: Yes, i imagine the pressure on the MIT teams is for you to think a "City for Bits"... :-)

21:14:58**Luis**   I also think that, all together or in the groups should discuss the program in a detailed way

21:15:08**helen**   Lisbon+oporto - at MIT, we have now moved into our two groups so that it will be easier to discuss ideas for thproject in our respective groups

21:17:19**helen**   Mario:Actually, we are not "city of Bits" advocates - we are not thinking of theoritical as equal to virtual reality, but as a way of asking questions about what telecommuting can be (i.e fundamental spatial qualities that are altered because of this new

21:17:30**Luis**   In the IST pages i don't really find much weight in telework, but i th. it's an interesting theme

(names have been changed)

Another group spent a great deal of time and effort negotiating the decision to preserve the façade of the old chocolate factory. During each session, the students

reframed the question of historical preservation and the need for interlacing old and new aspects of the city:

> 17:46:22**Alex-Helen-Cindy**   Also, I (Alex) doubt the honesty of the gesture of making an artificial ruin of the facade... since we gut the entire building behind it, how true to the fabric are we being? If what we will do is a new intervention, why should we hide it behind the empty...
>
> 17:46:54**Mario**   You've seen the photos of the surrounding facades. What do you suggest instead of the factory's facade?
>
> 17:47:17**Alex-Helen-Cindy**   ...behind the empty shell of what was once there.
>
> 17:47:55**Alex-Helen-Cindy**   Actually, we were hoping that Oporto would have done some work on that this weekend. We haven't seen any sketches yet.
>
> 17:48:00**Cesar**   hello Cindy, Alex, Helen and Mario. Miguel is with me
>
> 17:50:04**Alex-Helen-Cindy**   I (Helen) think somewhat differently...I can imagine that the existing facade would add an interesting layer to the new building. On the other hand, it is merely an empty shell that we are trying to enhance with this new architecture?
>
> 17:50:22**Alex-Helen-Cindy**   Hello Cesar and Miguel!!
>
> 17:51:45**Mario**   Hi Cesar and Miguel. (continuing) Because the spirit is not take it all or nothing. We (team) concluded that the interior was lousy and the facade was a strenght element. That is the reason why i think we should demolish the interior and use the facade. Simple as that. I general terms I do agree with you that the building is a whole but, in this case, only the facade matters.
>
> 17:52:24**Mario**   Empty shells are pretty too...
>
> 17:53:36**Alex-Helen-Cindy**   There seems to be two issues here: do we preserve this facade and freeze time? Or is ti that this facade is really beautiful and a crutial part to the appearance to the neighborhood. Is it nostalgia or isit really a wonderful piece of arch.?
>
> 17:57:10**Mario**   No, it's not a wond. piece of arch. But it's blow of fresh air in a quite vulgar neighborhood. It's also a reference point, a thing hard to do with new buildings. Either the new building is a master piece of achieving a vivid urban living or it just comes with time ...
>
> 17:58:12**Alex-Helen-Cindy**   It seems that the thing that intrigued us about the project was the opportunity to investigate a dialogue between the existing and the new intervention. This can happen at the scale of the facade - it would then happen in the zone where old meets new arc
>
> 17:59:34**Alex-Helen-Cindy**   ...it can also happen at the larger scale of the neighborhood - in that the new building instead of setting up this dialogue with the facade, sets up the dialogue with the street, the surrounding buildings etc.
>
> 18:00:25**Mario**   I didn't quite understood... Why intrigued?

18:00:44**Alex-Helen-Cindy**   ...The "zone" of dialogue, or architectural relationships - then increases in scale and starts to intrate and influence a larger realm of the neighborhood.

18:01:44**Alex-Helen-Cindy**   Intrigued: it is the challenge to build new into existing - at the simplest of levels (and already that is complex enough) [...]

18:02:18**Mario**   I think the issue will be the difference in saying "Hei, do you know what's IN the old Chocolate Factory" instead of "Hei, do you know what's IN THE PLACE OF the old factory".

18:04:28**Alex-Helen-Cindy**   but if you demolish the factory anyway, anything we build will be IN THE PLACE of the factory. the question i believe you will ask if keep the facade is, "what is BEHIND the old FACADE of the factory?", which is not as honest as the other two.

18:06:25**Alex-Helen-Cindy**   Also, Alex thinks that it is very pessimistic to think that no one in our time can hope to compete with the architects who designed the factory 60 years ago. is the fact that you do not trust contemporary architecture an issue here?

18:06:28**Mario**   I think your point is more the formal question, the etic problem of an architect doing that rather than the influence it will have in people's lives.

18:08:33**Alex-Helen-Cindy**   (Alex) so my question to you is that: is it really ethical to tear down the whole of a building, leaving only the bare facade? or is it more ethical to provide a new intervention in the lives of the people who live there?

18:09:58**Cesar**   an old man is a reference for his family,but he will die someday. Keeping his face isn't keep the old man, it's a violation of his body, something that 'anguish' family

18:10:27**JOIN**   justin-martha has joined. (18.38.1.122)

18:11:32**Alex-Helen-Cindy**   I (Helen) think that it seems to be lessof an ethical question than one of memory - is this facade actually preserving a neighborhood memory, and is there another way then that we could keep a trace of that memory without having to keep a superficial she

18:11:50**justin-martha**   hello Mario have you heard from isabel or susana?

18:13:24**Mario**   Alex: No not at all. at the contrary! I think (some!) contemporary architects have a much wider vision of the architecture issue and mark the city in a much more effective way. But the space is marked by the look (the facades) as well as by the living (the public space). The second one I think we've solved it great. It's the first issue i have doubts about. No suggestions have born on your behalf concerning the facade. And if it's for the worst i'd rather leave the face and bury the body...

18:13:41**Alex-Helen-Cindy**   Cesar brings up a good point: at what point are we keeping the facade for it sincerest value, and at what point do we begin to see it as only a symbol of what we wish was there?

(names have been changed)

In Schön's terms, the students reconciled their differences by value-laden "frame reflection" and not by revisiting factual information. This "frame reflection" involves the students "to get inside each other's point of view. They must try to discover what models and appreciative system lead each of them to focus preferentially on one set of facts and criteria, make their tacit cognitive strategies explicit to themselves, and find out how each understands the other's framing of the situation."[55]

Silent values were also embedded in the choice of materials used in communicating design concepts. For example, the Oporto students highlighted their rich graphic tradition by including many expressive hand sketches, while the MIT students demonstrated their technological biases with their digital models (Figure 64).

a. MIT's digital models

b. FAUP's hand sketches
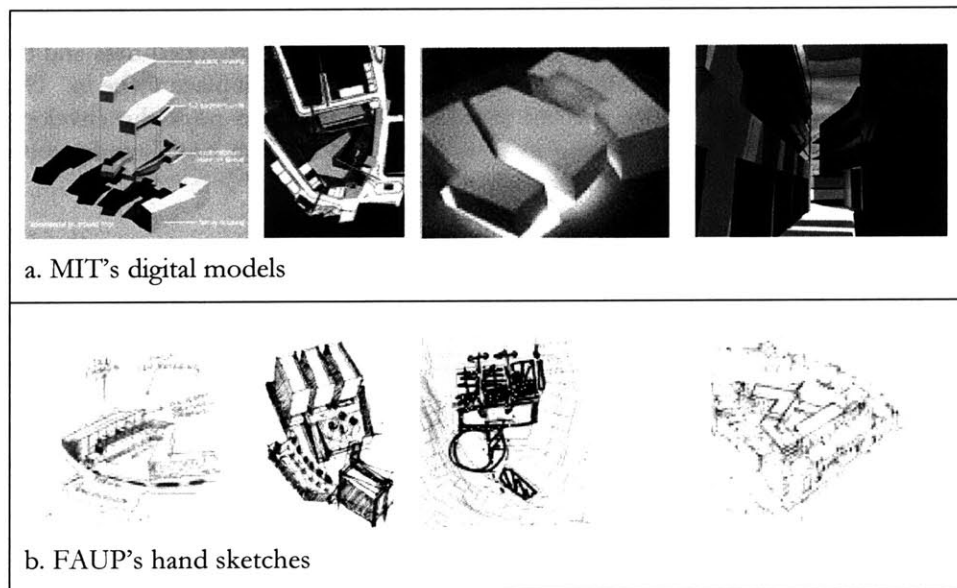
Figure 64: MIT students' digital models and FAUP's hand sketches.

The students also met differences in work habits, division of labor, and presentation techniques. One group had discussions on who would be the "boss" of the project:

[55] Schön, Donald A. 1987. *Educating the Reflective Practitioner.* San Francisco: Jossey-Bass. p. 218.

16:01:00**Alex-Helen**   /miguel M: I (helen) wasn't agreeing with one or the other, I was worried that you were meaning that one group would be the boss for our team, and didn't want that to happen
[…]
16:44:19**Alex-Helen**   We have a question about working:
16:46:11**Alex-Helen**   OKay, one more thing:we would like to work as follows: you submit drawings, ideas, whatever you have done for that day. We respond by the next day and post images etc. for you to look at. You respond to that the next day.
16:47:46**Alex-Helen**   Miguel and Cesar: what do you think about this way of working?
(names have been changed)

The project also made the students aware of their differing design approaches. One student was self-reflective of her team's process as she shared her thoughts with her remote teammate:

> "It will be a challenge to get [our design ideas] to fuse together. If we think of this in [these] terms …your approach gives it the grounded-ness and the ability to let this building be live-able and a wonderful place to be in. Our approach that we've decided to take is like trying to push the envelope, trying to make something in a way that people have not thought about before. Both are absolutely a key part of this project."

Cross-cultural learning occurred in these experiences of negotiating design decisions and reconciling design approaches. Differences arising from national cultures, the cultures of specific institutions, architectural cultures, and computational cultures affected the ways in which students interacted, designed, and learned.

Student-Student Negotiations

The computer mediation between the remote students affected the nature of their negotiation process. The students argued their design points with more conviction and confidence. To help understand this, let's imagine an alternative scenario. Imagine a group of MIT exchange students in Lisbon for a semester-long studio project. The students would certainly still be negotiating their design ideas with their teammates, but I suspect that the nature of that negotiation would be subtly different. Once embedded in the social environment of the Portuguese studio, the

student soon adapts and conforms to the design norms and attitudes of his setting over time.[56] He might even be inclined to put aside his own values to try the native values. But in a computer-mediated studio, the student remains strongly grounded in his own physical environment with strong social ties with the design ideology of his collocated classmates and instructors, while he designs with his long distance teammates. In their native setting, with the confidence of an established cultural base and the support of a network of strong relationships, the student negotiates his design ideas with more conviction.

In this respect, as much as the telecommunication technologies helped to create a new mutually directed social environment, they also permitted each individual social environment, with its own support mechanisms at each site, to thrive.

Student-Instructor Relationship

The computer mediation also affected the traditional student-instructor relationship. There were two types of student-instructor relationship in this project. The first was the traditionally strong relationship between collocated student and his instructor. At MIT, this relationship was nurtured since the students knew that their local instructor was their ultimate mentor and judge. They met often with him without the remote students.

The other student-instructor relationship was that of a student and the instructor of his long-distance teammates. This relationship was loose and filtered by their remote teammates. The remote instructors rarely met with the distance students, except for the more formal midterm and final reviews in which all the participants were present. The filtering process altered the learning environment because the instructor's criticisms were re-interpreted, sometimes multiple times, by the students. For example, a student from one school would relay the criticism of his

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[56] Similarly, the students in the engineering students from the Interdisciplinary Studio conformed to the dominant culture of the architectural studio.

local instructor to his remote teammates. He might also ask his remote teammates about the opinions of the remote instructor or even question their relationship:

> 17:41:14**Mario** About the facade. I really think it should be kept.
> 17:42:29**Mario** Does Professor Paul has such an influence on the decisions you make about the project?
> 17:42:31**Alex-Helen-Cindy** M: the facade: the situation is/was as following, during our last desk crit with Professor Paul, he suggested that we get rid of the facade. This is partly in responce to the organization of the site which seems to imply completely new buildings that do not
> 17:43:03JOIN cesar has joined. (193.136.51.8)
> 17:43:05**Alex-Helen-Cindy** Yes. (and no...)
> *(names have been changed)*

In the filtering and recounting of a set of criticisms, the student makes another reframing and reflection of it. He translates and reinterprets the remarks and tests them with his co-designers.[57] This iterative reframing may enrich design learning, but in some cases, this may also weaken the strong bond between the collocated student and instructor. In a traditional studio, the outsider is usually selected and mediated by the instructor, but in this case, the remote instructors' opinions were filtered instead by the remote students (Figure 65).

| a. Traditional strong collocated student-instructor relationship | b. New filtered student-remote instructor relationship |
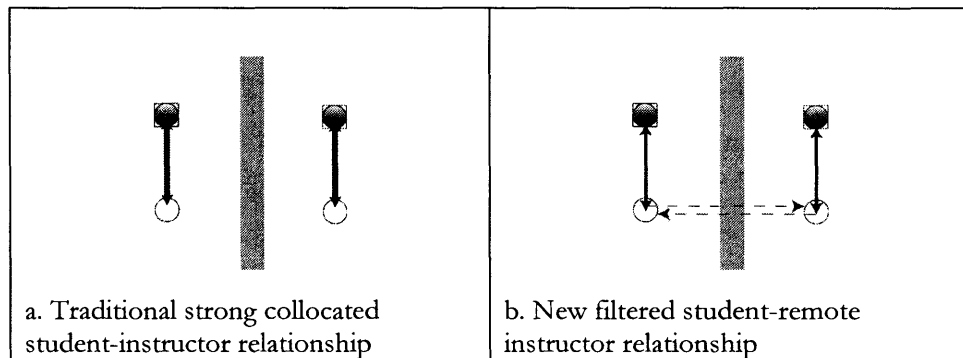
Figure 65: Student-instructor relationship.

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[57] We can compare this to the *anciens'* clarification of the *patron*'s remarks to the *nouveaux* in the *ateliers* of the Ecole des Beaux-Arts.

3.6.5 Building a Culture of Collaboration

The sustained environment supporting cultural exchanges between students helped to develop a culture of collaboration, one that was strongly influenced by the native cultures of the individual students, yet confronted and redefined by the collaborative project itself.

The project was considered successful by the high quality of the design proposals it produced. A Lisbon critic claimed that "all four solutions were considered to have more potential for further development than any previously considered by the local authority."[58] Alvaro Siza, the Oporto critic, also thought that the experience was insightful:

> "I am enthusiastic about this experience. I think it improves, no doubt teamwork, which is a fundamental aspect of design either in Lisbon, or in Oporto, or in the United States. The way it introduces a lot of different tools in the design process – physical models, sketches, 3d drawings, the computer, etc – contributes to stretch the boundaries of the process of designing. All of these tools, multiplies by different teams, affect the way we create and in which we are drawn into the process and the elements brought in: choice of program, layout of streets, organization of space, and so on. In short, it gives a milieu in which to evolve a design in all of these aspects."[59]

Having the design proposals and the design process judged to be promising was certainly a positive conclusion to the charrette. More importantly, however, the charrette gave the opportunity for students to breed a culture of collaboration, instead of competition, in the design studio. The nature of the project required all the participants to establish working relationships, both collocated and distributed ones, in order to achieve the shared goal of producing feasible and innovative design projects. The interactive sessions illustrated the importance of these informal and personal, and often delicate, relationships. They also needed to create a sense of shared ownership for the resultant design. The participants were able to create this

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[58] Bento, João. 1999. "Web-based design: do we need to formalize it?" in Duarte, José Pinto, João Bento and William J. Mitchell, eds. *The Lisbon Charrette*. Lisbon: IST Press. pp. 40-53.
[59] This was from Siza's commentary during the long-distance final review.

culture of collaboration in the studio through purposeful and practical shared design activities. The strength of the designs certainly came from the students' individual and collective technical design competences, but it also resulted from their ability and willingness to cross cultural boundaries and from their collaborative and experimental spirit.

3.7 MIT/FORD CHARRETTE

In the spring of 1998, I was the teaching assistant for an intensive two-week collaborative design project involving MIT and the Henry Ford Academy of Manufacturing Arts and Sciences (HFA) in Dearborn, Michigan.[60] Students, educators, architects, and researchers from MIT and HFA were brought together, via videoconferencing and Internet-based technologies, to design new educational spaces for the academy's future expansion.

This case study focused on remote designer-client relationships. The designers were eight graduate architecture students at MIT[61] and the client was a group of educators and fifteen ninth grade students at HFA[62] (Figure 66). The MIT/FORD collaboration created an environment in which:

- MIT designers learned to understand and design for the needs of a real client group and to develop effective ways to convey their design ideas through telecommunication technologies;

- HFA educators learned how to relate better to their colleagues and their own architects about their design concerns and needs; and

- HFA students learned a little bit about architectural design and collaborative learning.[63]

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[60] The Henry Ford Academy of Manufacturing Arts and Sciences is a charter school created through the partnership of the Ford Motor Company and the Henry Ford Museum and Greenfield Village.

[61] The students at MIT were Karl M. Daubmann, Singh Intrachooto, Juintow Lin, Saman Mahmood, Nilay Oza, Geraldine S. Ramos, Greg Russell, and Jing Yu with Professor Roy Strickland and myself. Six students worked individually and two worked together, however, the final project were integrated into one overall vision so the entire group had to work collaboratively.

[62] The participants at HFA were a group of educators and students. The educators were Charles Dershimer, Judith Endelman, Lynne Friman, Renee Lerche, Christian Overland, Wendy Pittman, Mike Schmidt, Scott Turner, and Joe Wolford. The students were Margaret Anderson, Michael Baber II, Rodney Day, Laura Elliott, Melissa Hampton, Jeffrey Jackson, Jennifer Klabis, Chris Lesnieski, Christopher Line, Justin Markowski, Candice Neuman, Carmen Parnell, Zubair Sarmast, Brandon Smith, and Matthew Speck.

[63] In fact, one of the HFA teachers told me that one of his students enjoyed the project so much that he wanted to learn more about design and becoming an architect.
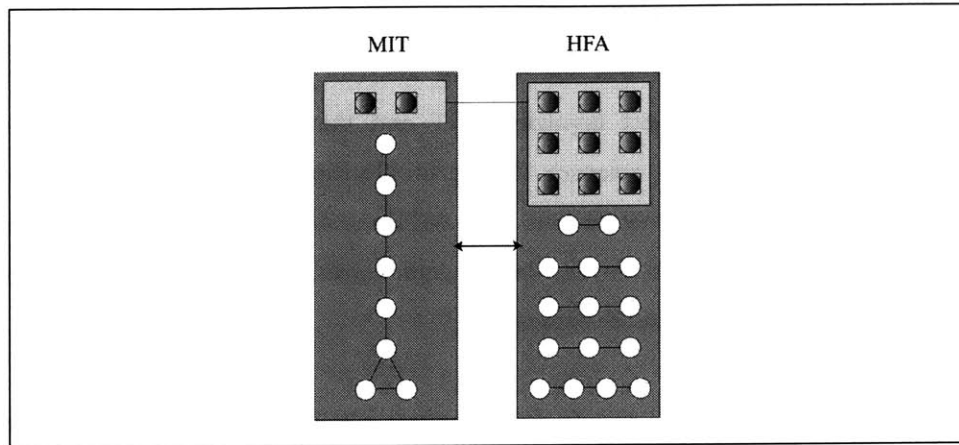
Figure 66: Designers at MIT worked together with the HFA client that included educators and five groups of ninth grade students.

3.7.1 Designer-Client Collaboration Process

The design problem was to propose design concepts for future educational experiences at HFA. The HFA educators conducted studio-like teaching and wanted a prototypical space or products that would help support their objectives of hands-on, integrated, projected-oriented, technologically enriched learning as the school expanded its physical campus.[64]

The organization of the collaboration was conceived jointly between the educators at MIT and HFA. It was enthusiastically agreed upon that the HFA ninth graders would take an active part in the project. To understand our clients, the MIT instructor and I visited the site of the new school and interviewed the teachers and administrators before the start of the charrette. We also conducted a short afternoon "design workshop" with a group of HFA students who were asked to

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[64] The design concepts generated in the charrette were to support the Academy community and communication, to link physical resources for learning and socialization, to empower students and teachers in the educational process, and to encourage varying forms of cognitive development within a context of metropolitan, regional, and global learning opportunities. The design proposals accumulated into a vision of a school in which the boundaries between architecture, pedagogy, and distance could collapse. At the same time, the concepts helped to shape a sense of place and identity for the Henry Ford Academy.

develop their vision of an ideal school (Figure 67).[65] The students described their school designs through sketches and collages and presented their ideas much like a final design review (Figure 68).[66]

Figure 67: HFA design workshop.
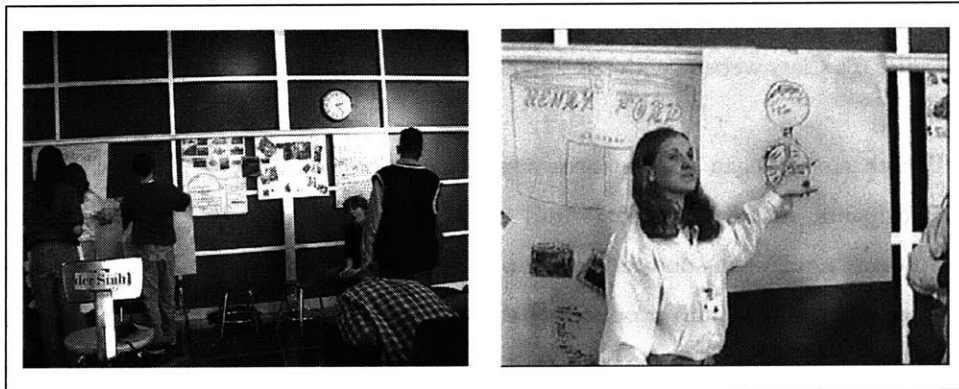
Figure 68: Presentation of design ideas by HFA students.

Understanding the Remote Client

Since the MIT design students did not visit the building site and they did not participate in the initial workshop at HFA, we needed to relay the site information and client needs to them. We made a class website (Figure 69) assembling photos and video clips of the site, CAD drawing, notes from the interviews, and a video of

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[65] This was a process of participatory design that Professor Strickland also uses with his other educational clients.

the HFA students' design workshop as well as their drawings and collages. This site was accessible to the HFA educators who added photos and documents describing the typical daily experience of the HFA students. There was also a discussion page where questions could be posted and designer-client conversations could be initiated.
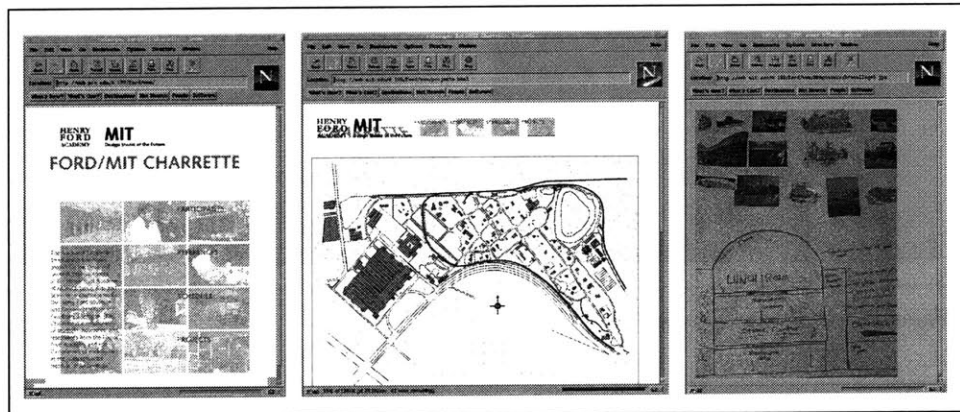
Figure 69: Class website with site and client information

The charrette began with a three-way videoconference (Figure 70) in which the participants, including students and teachers at MIT and HFA, as well as the Academy's architects located in New Orleans,[67] met to mutually agree on the objectives, process, and products of the collaboration. This was also an occasion for the MIT students to interact with the clients after having reviewed the information on the website.

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[66] In fact, many of the HFA students' drawings looked like plans and elevations.

[67] The architects for HFA were Steven Bingler and Matt Norton from Concordia Architects. They were at this first meeting, but did not return due to scheduling difficulties. They did, however, supply the studio with site information and CAD drawings. I suspected that they felt that there was not enough incentive for them to invest the time, away from their busy practice, needed to participate in the charrette.
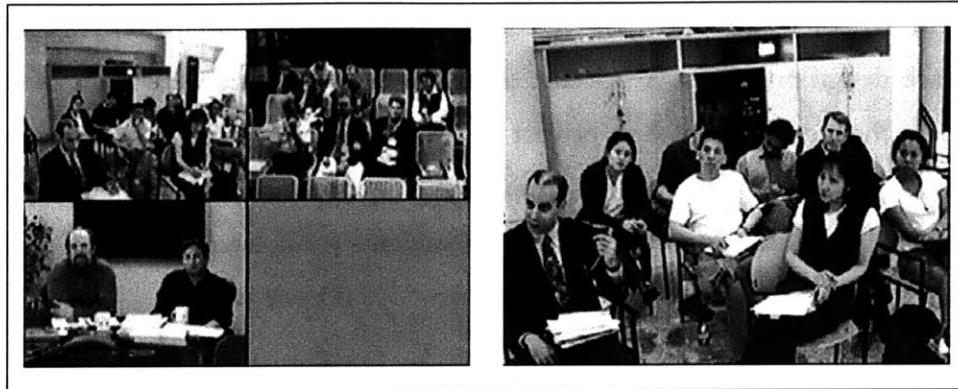
Figure 70: First videoconference meeting between MIT in Cambridge, HFA in Dearborn, and Concordia Architects in New Orleans.

The remainder of the charrette was devoted to synchronous and asynchronous sessions with individual MIT students and the client group consisting of the HFA educators and alternating small groups of HFA students. During the synchronous work sessions (Figure 71), the HFA teachers and students responded to the MIT designer's work-in-progress through videoconferencing.[68]
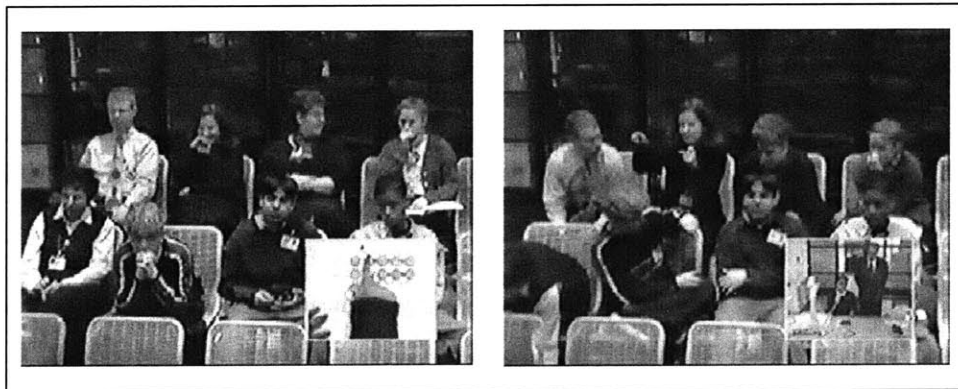
Figure 71: Synchronous client reviews

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[68] The technologies used in this case were identical to the previous cases. On the MIT side, we used the PictureTel Concorde 4500 with an ISDN connection. We used a face camera, a document camera to show sketches, and a scan converted signal from a computer to show the web presentations and other digital material.

The asynchronous sessions were conducted through the discussion page for each design proposal. At specific times, the MIT students were required to post their designs on their project webpage and the Academy's educators worked with their students to formulate and submit comments and questions on the discussion page where the MIT students could later respond. Often, the text was accompanied by simple illustrations (Figure 72).
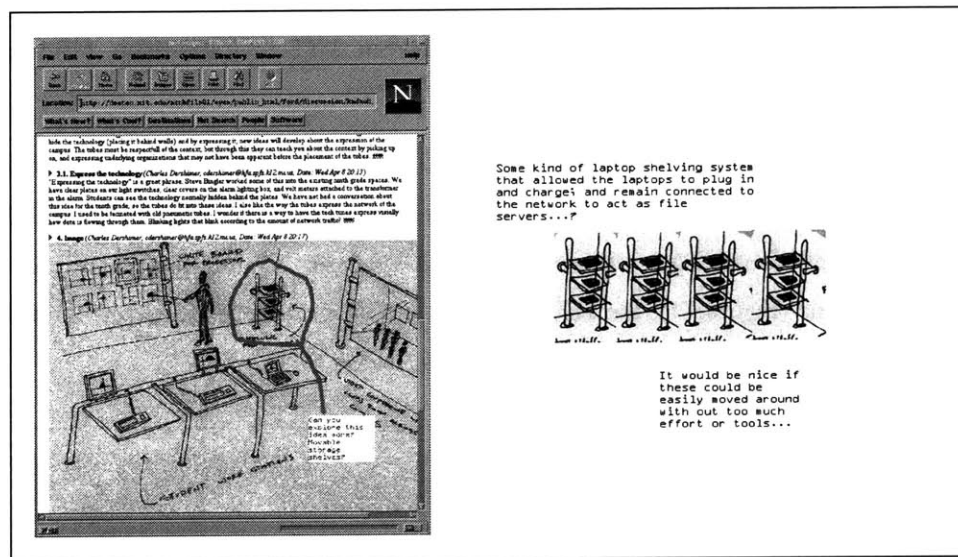
Figure 72: Discussion webpage for asynchronous communication between MIT students and the HFA client group.

The comments and questions from the Academy's educators were important for the learning process at MIT and HFA. The clients took time to study the proposals and gave suggestions on how the design could be used by their students. The discussion page served as a place to continue discussions started during a videoconference. It became not only a dialogue between an educator and a designer, but it was also a unique opportunity for the HFA educators to share their individual views about education and technology among themselves. One teacher wrote about the design of a mobile educational cart where she gives suggestions to the designer and also gets a better understanding of a fellow teacher's point of view:

"The idea of a portable classroom on a cart is a hit with me as well. [...] I am a science teacher, so these comments will be biased towards that discipline. My vision of the cart, after the videoconference, was a movable storage and display unit. It has a place for wet and dry samples, equipment, or lab needs. It also has a whiteboard (dry erase board) and a display screen (TV monitor or other) to present video/computer images to the class as a whole. Still dreaming, it has an attached microscope with a flexcam attached to the above screen. It also, of course, has a first aid kit. With the cart, class supplies can be carried and stored when the class is doing an outdoor activity. I was not sold on the idea of having a high tech cart. Computers outside in Michigan weather do not sound like a good combination. Also, the technology would be heavy baggage to carry around on those all-too-frequent days when it is dysfunctional. The power source would be a difficult situation to alleviate as well. (I have some other comments about the tubing system.) And I don't really see a large need for a printer or similar equipment when we are outside. However, in reading Charles's comments [a fellow teacher], I am seeing that the high technology might actually be worth it. I think Charles and I are on about the same page, though he is thinking one step closer to our goal of assimilating technology into the daily life of the school and classroom, wherever it may be. Perhaps with a guarantee of efficacy :) for the technological aspects of the cart, I would be sold completely! Otherwise, I still strongly agree with using the cart in at least the low-tech transport and storage and use in an outdoor setting.

Finally, like the other cases, the charrette concluded by a synchronous virtual final review (Figure 73) of the design proposals using web-based presentations (Figure 74).
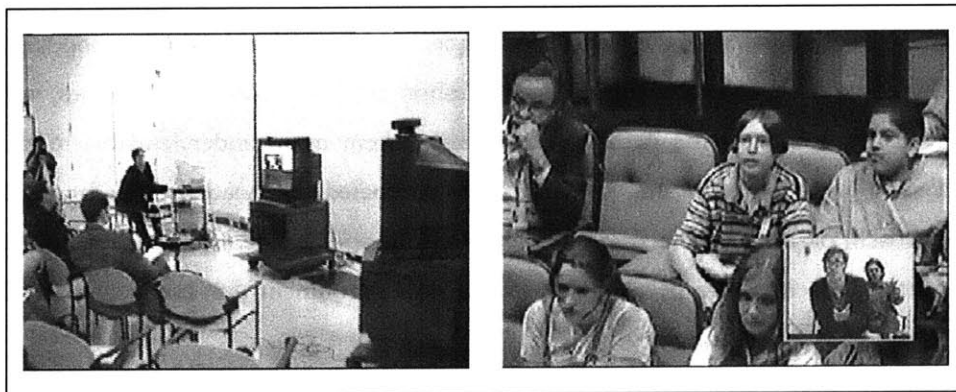
Figure 73: Final client review at MIT and HFA.
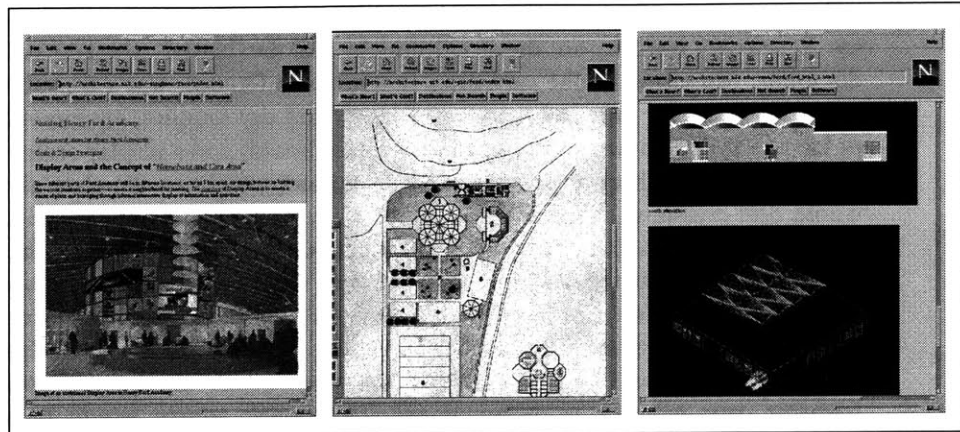
Figure 74: Examples of final web-based presentation.

3.7.2 Intersecting Curriculums

We began this project with the intention of giving the MIT student designers an opportunity to interact with potential clients in a real-life setting. The project had a real site and a real client. In fact, the HFA administrators were already pursuing a school expansion project with their own architects, so there was an urgency and relevance to the design problem. This project did give the MIT students some experience with a client, but it was also educational for the HFA students.

The design problem itself also coincided with the distributed design process. For both MIT and HFA students, the project provided hands-on experience that was similar to the kind of new learning experiences envisioned for the design proposals. This experience, as in the MIT/Oporto/Lisbon and MIT/XeroxPARC cases, was leveraged to inform the designs and to make them more understandable to the clients. Simultaneously, this project clearly embodied the Academy's pedagogical approach of using technology to link students and teachers with information, mentors, scholars, and peers to build a unique environment that can improve and expand high school learning.

Benefits to MIT designers

The MIT designers had a chance to rethink the idea of school and to test some design concepts, such as a classroom on wheels or a multi-media portable educational unit as well as wired conventional classrooms (Figure 75). They not only tried to fulfill the client requirements and give alternatives to them, but they also learned to relate to the client verbally and graphically. Over time, the design students developed techniques to retrieve opinions and insights from the ninth graders. The drawings they used to describe their interventions were simple and clear and they used scenarios to include the students' everyday activities. They were developing effective ways of communicating design to individuals traditionally outside of the studio process.
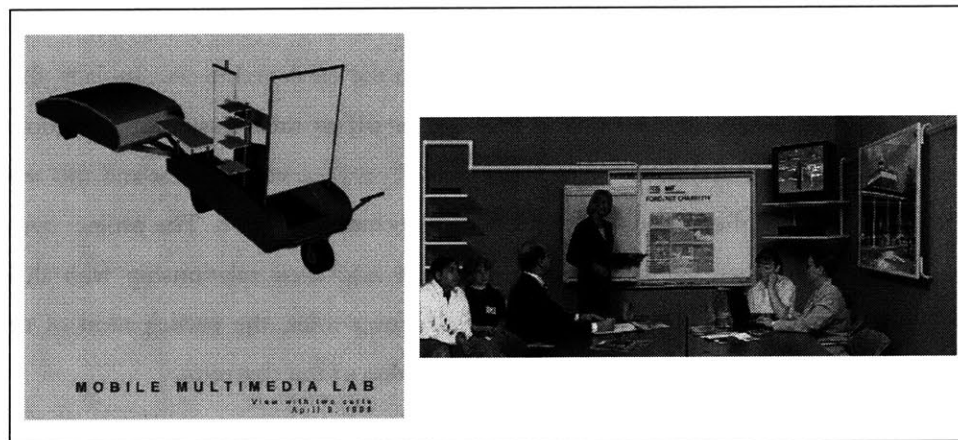
Figure 75: Examples of design proposals.

Benefits to HFA students

The HFA students had the opportunity to test their own ideas about education and see how they might be realized in an architectural way. During the design workshop at the Academy, they experienced a miniaturized process of idea generation and presentation. This prepared them for the charrette giving them a taste of what designers did and how they might respond from the other side as they later acted as clients for the MIT designers.

Also built into the HFA learning process was the requirement for the students to review the design proposals and to submit, on the discussion webpage, written or graphic criticism with the guidance of their teachers.

Benefits to HFA educators

The impact of the charrette on the HFA educators was unexpected. First, as one educator told me, the proposals opened their eyes to alternative visions of what their school could be. The other benefit was more practical. The educator told me that she had gained insight on how to be a better client to the Academy's own architects. She could now relate better to the design material and to the designers themselves.

Missed opportunity

We missed the opportunity of collaborating with the HFA architects. Initially, they were enthusiastic about the project, but it wore off as their busy work schedules took priority. The architects' roles in the overall process were unclear and this may have been one of the reasons for their sudden decline in interest. The project could have also been seen as an unwanted intrusion into their relationship with their clients at HFA. With better incentives and clearer roles, the participation of the architects could have added to the educational value of the charrette.

New partnerships

This project successfully demonstrated the possibilities of creating a mutually beneficial partnership between different levels of educational institutions. For both the Henry Ford Academy and MIT participants, this project provided a chance to intersect their educational environments and curriculums in ways that build a culture of collaboration and a community of learning that exists beyond the walls of each school.

A science educator at the HFA summed up the potential for such collaborations:

"This is a very historic occasion. Roy, you just gave an example of what a school of the future could be. (...) These students today arrived at the academy between 7 and 9 o'clock this morning and then before they have even gone to lunch, they have gone to Boston to connect with a group of MIT graduate students and faculty who have shared their act of learning with them and made the students part of that. You were asking how soon is this going to happen? It is happening today. This minute. (...) If, in the physical sense, these student cannot inhabit [these new spaces] in the next three years, they will probably be mentally inhabiting them for the rest of their lives, in terms of what a school can be."

3.8 MIT/MIYAGI UNIVERSITY WORKSHOP #1

In the summer of 1998, I was a long-distance instructor for a class of sixteen undergraduate students at Miyagi University (MYU) in Sendai, Japan for an intensive design workshop lasting six days. In this case, we focused particularly on:

- mixing synchronous and asynchronous communication, where we found that leveraging asynchronous tools to take advantage of time zone differences was important;

- testing a prototype of a simultaneous language translation system; where we found that translation-on-demand and text translations were more important than continuous voice translations; and

- conveying a sense of place through peripheral awareness tools; where we observed the students enthusiastically communicating their team spirits as well as their daily activities through playfully crafted webpages and photo diaries.

3.8.1 Distributed Instructor and Critics

Because of the short duration of the project, the design problem was simple and manageable and the coordination and schedule was intense. The project required the students at MYU to work in groups[69] to design an individual study space for a visiting Japanese student at MIT.[70] Each morning, for six consecutive days, the students began their day (and I ended mine) with a videoconference meeting where I gave deskcrits or explained the next assignments. I was located in a dedicated

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[69] The sixteen MYU students worked in five groups - Team A: Mika Itoh, Kaoru Miyuki, Keiko Nikaidou, Junichirou Taira; Team B: Yayoi Kimura , Rentarou Oku, Hiroko Sugawara, Satomi Wako; Team C: Eiji Muroichi, Hiroaki Satoh; Team D: Ikkan Shibuya, Kayo Shouji, Takatsugu Washio; and Team E: Yo Akishige, Natsuko Sukekawa, Yoko Yusa. They were guided primary by two faculty members, Professors Ryusuke Naka and Eiji Keyamura, and a technical staff.

[70] The Japanese students were enthusiastic and somewhat in awe of MIT and I wanted to give a small project that would fuel the inexperienced designers' enthusiasm. The project would give them a chance to place themselves at MIT, to virtually visit the spaces at MIT, and exert their own cultural needs onto that space. The students were asked to write a typical scenario to illustrate the needs of a hypothetical student. The groups of students proceeded to design the study space and define the materials to be used. Finally, they were asked to connect their written scenarios with the designed space.

room with the assembled technologies and the students worked in a computer room (Figure 76).

| a. Meeting space at MIT | b. Meeting space at MYU |
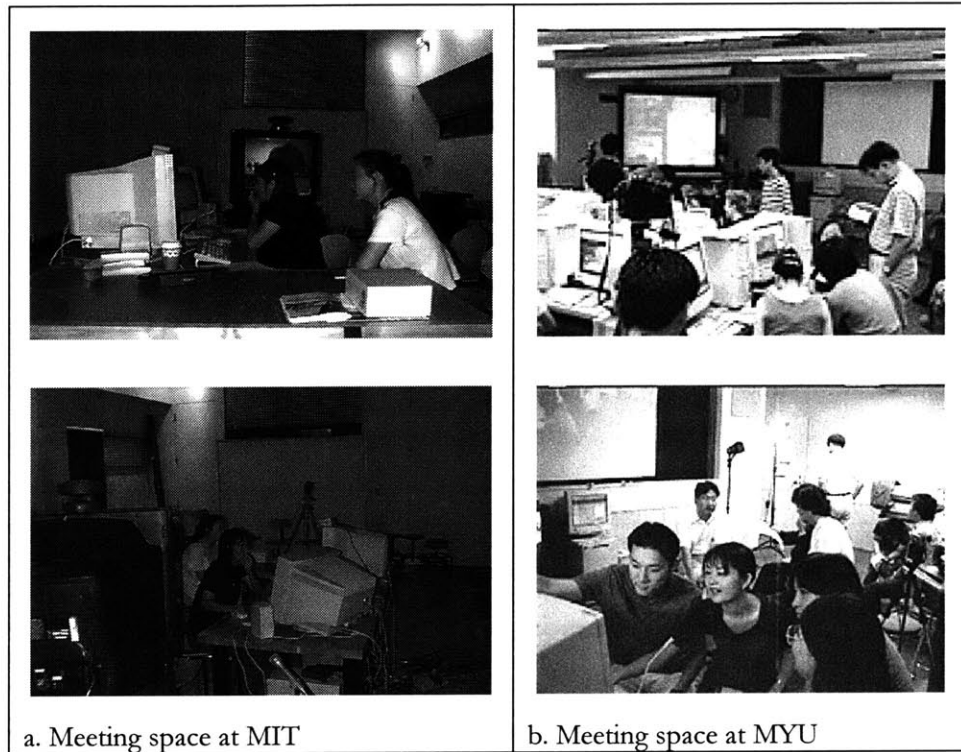
Figure 76: Physical spaces for synchronous meetings.

I interacted with the students through a desktop videoconferencing system with application sharing in which we viewed and navigated the same webpages together during discussions (Figure 77). This worked very well since I was sure that the view I had on my screen was identical to the students' and we took turns controlling the pages and using the cursor to point as we gave our explanations.
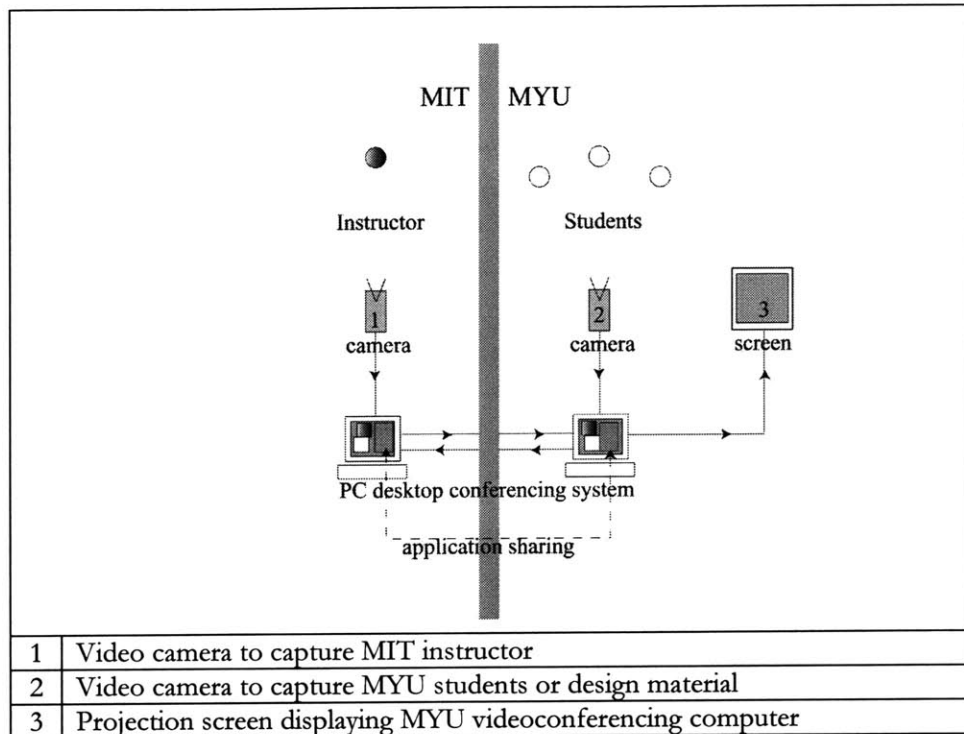
Figure 77: Desktop videoconferencing set-up.

The students were clustered around a computer, but their computer screen was also projected on a large screen so that other members of the class could follow if they wished (Figure 78). Unknown to me until the middle of the project, my private deskcrits were really public events on the MYU side.

These daily meetings with me were augmented by written critiques from the workshop's two virtual critics, a design instructor at the Technical University of Darmstadt (TUD) in Germany and another instructor at the Chinese University in Hong Kong (CUHK).[71] The virtual critics and the students never communicated synchronously during the project. Figure 79 illustrates all the workshop participants.

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[71] The virtual critics were my colleagues, Andrew Li from The Chinese University in Hong Kong and Martin Wilhelm at the Technical University of Darmstadt.

| a. Identical views for MIT and MYU | b. Projected computer screen |
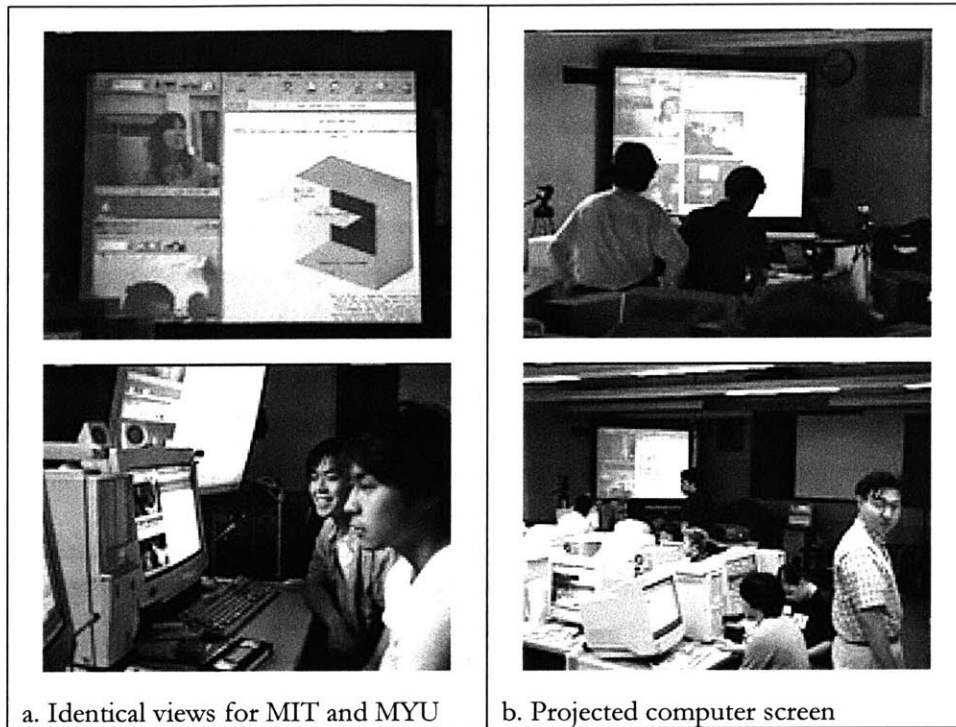
Figure 78: Digital space of meeting at the desktop and projected on the wall.
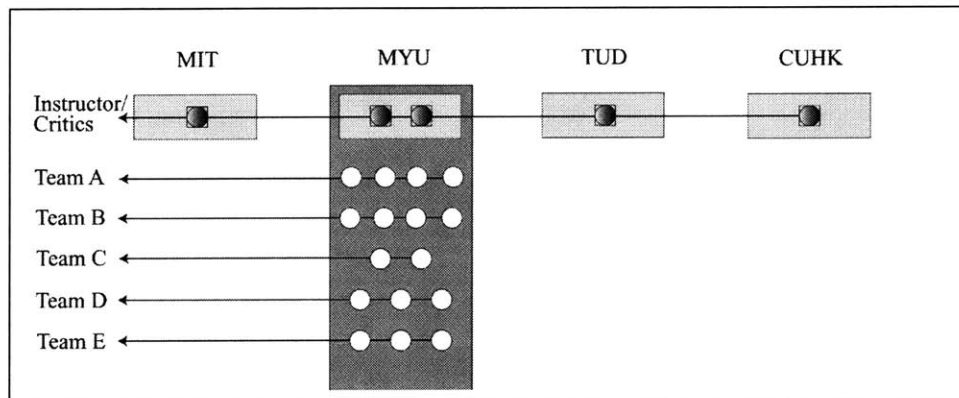
Figure 79: Distributed students, instructor, and critics.

The remote critics reviewed each team's webpage and had daily asynchronous conversations with the students via a threaded discussion area on the team

webpages (Figure 80). This discussion, different from the earlier ones,[72] was now placed in a frame adjacent to the team's work so that the design material and the comments could be composed and viewed together. It was also easy to add images to support the text commentary. Since this was the only channel of communication for the remote critics and the students, the discussion page captured and archived all their interactions. With the time difference between Cambridge and Miyagi, I, too, found it useful to review the discussion pages while the students slept and submitted comments before my synchronous meetings with the teams. The videoconferences were, as a result, more focused and time was better spent clarifying the designs and the written commentary instead of reviewing the material for the first time.
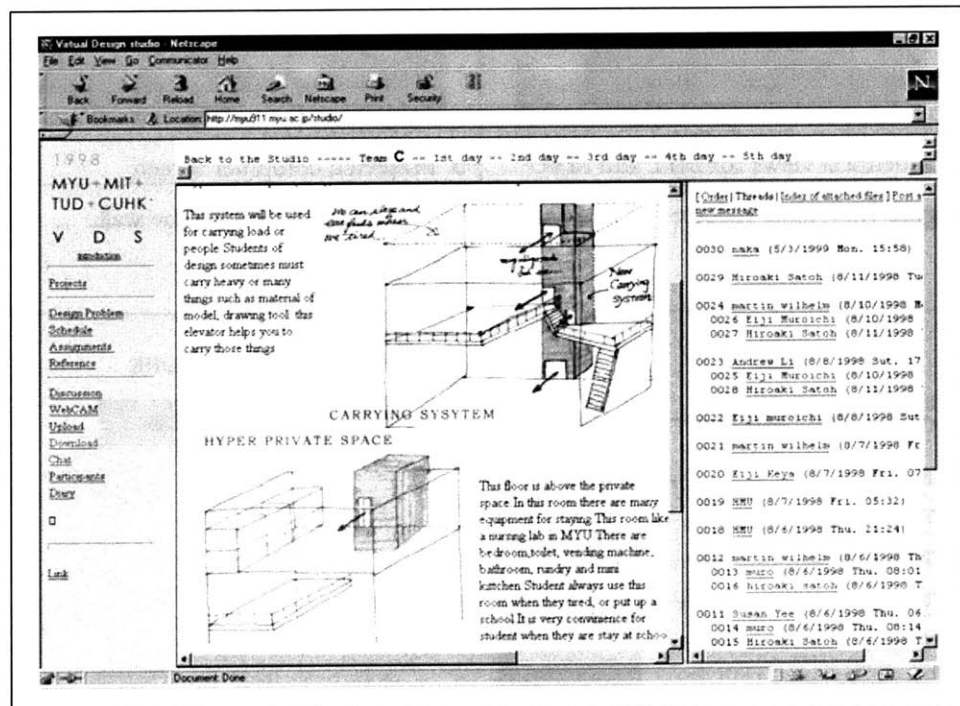
Figure 80: Threaded team discussion area placed adjacent to each team's design work.

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[72] Earlier versions of the discussion page were freestanding. It was a webpage that was accessed from the design proposals and not located adjacent to the designs.

The time zone differences and the discussion functionality allowed us to work productively in shifts, but it also required strict coordination and daily deadlines for both the students and the critics (Figure 81). After the daily two-hour videoconference meeting, the students spent the rest of the day working together on the assignment while I slept. At the end of their day and at the beginning of mine, they were required to post their work on their team websites. The critics and I would have the next nine hours to submit our comments ready for the students as they woke up the next morning. The fast-paced shifts of work and critiques energized the students.[73]

A	Videoconference between MYU (8:00) and MIT (19:00)
B	MYU students begin work after videoconference
C	Deadline for MYU students to post design work for critics (MYU time 21:00)
D	Deadline for critics to post comments on discussion area
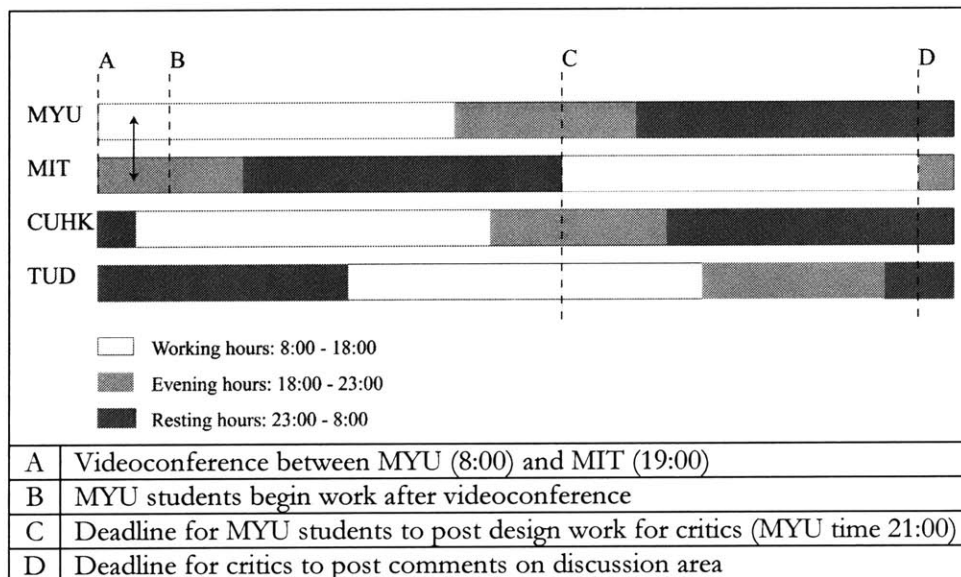
Figure 81: Daily 24-hour workshop schedule.

On the last day of the workshop, there was a synchronous final review between MYU and MIT with guest critics at both sides. Hours prior to the event, the virtual critics had already submitted their comments on the final web-based presentations.

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[73] This pace also exhausted the critics. As one of the virtual critics mentioned, it was a good thing that the project lasted only six days because the pace was hard to sustain for him. The effort in ensuring that his written correspondence to each team was clear and thoughtful took more time than he had first anticipated. He was accustomed to giving synchronous face-to-face deskcrits which required little preparation.

It was possible, then, for the local critics and the students to read these "pre-show" comments and take them into account during the final synchronous review.

3.8.2 Overcoming Natural Language Barriers

One of the goals of this project was to try to use a translation system to overcome the natural language barrier, a limitation that we experienced from the MIT/Kumamoto/Kyoto case. Shigeru Miyagawa, a Professor of Linguistics at MIT, and his research assistants assembled a simultaneous translation system from commercially available and affordable software. The workshop became a test-bed for the prototype system.[74]

The voice recognition program was first trained to distinguish my voice. During the daily synchronous meetings, I spoke into the voice recognizer and it transformed my words, with frequent and sometimes funny "misunderstandings," or processing errors, into an English database. This database was passed on to the language translator and made into a Japanese database that was read out loud by a voice synthesizer. Through the audio channel from the videoconferencing machine, the Japanese students were able to hear the synthesized Japanese translated from my speech (Figure 82). Originally, we had also planned to have a reciprocal system at MYU that would simultaneously translate spoken Japanese to synthesized English, but it was not implemented.

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[74] We thought that the deskcrits were particularly good as a test-bed because the sessions were unlike a lecture that could be a long and rehearsed monologue, but the conversations contained completely spontaneous speech and we anticipated the sentences to be short and interlaced with pauses when demonstrations or illustrations were made.
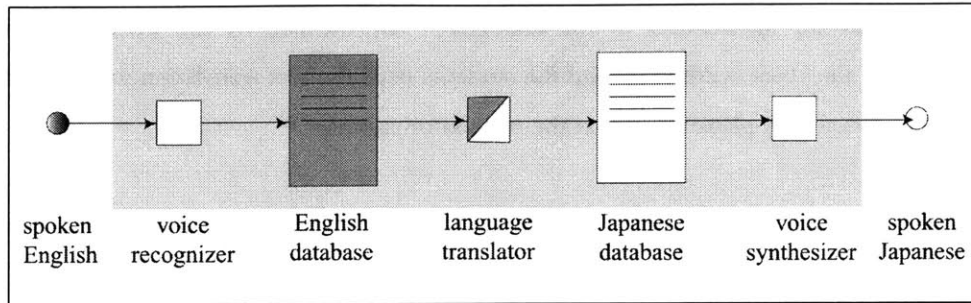
Figure 82: Simultaneous language translation system.

In the technical set-up, the translation system was installed on a dedicated machine at MIT, separate from the conferencing machine. We used application sharing to transmit the windows showing the English and Japanese databases to MYU (Figure 83).

| a. Translation system at MIT | b. Application shared to MYU |
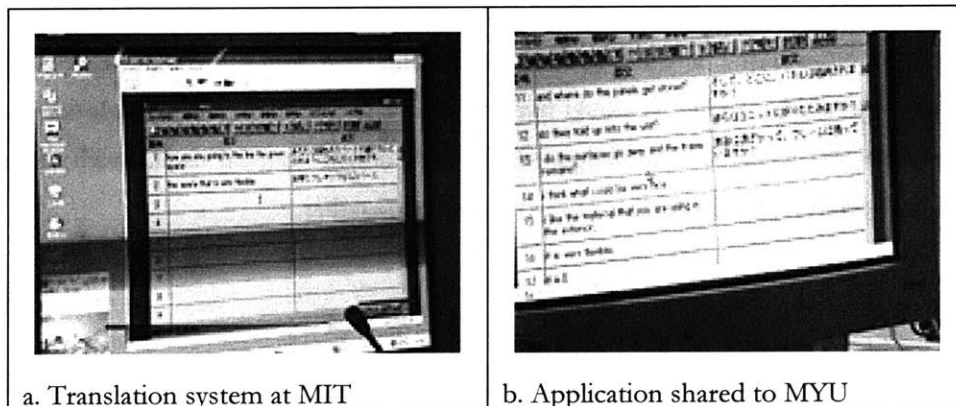
Figure 83: A computer was dedicated for the translation system at MIT and transmitted by application sharing to MYU.

In practice, the translation system was cumbersome to use. The system did not respond well to some specialized words, words as simple to the design community as "elevation" and "section." The system made many inadequate and humorous translation errors. For the users, the system was too slow. The delay between the moment I finished my sentence to the time a synthesized translation was uttered,

hampered the spontaneity of the dialogue.[75] By the end of the workshop, we disabled the voice synthesizer and the students used the text translation when and if they needed it by glancing over at the translation monitor.[76]

Our hope for a seamlessly and simultaneously translated conversation was not achieved, however this ambitious experiment did give some preliminary observations on how a translation system may eventually be used to support multi-lingual design studios. First, text translations for the asynchronous communication would have been useful and much simpler. Web-based presentations and written critiques could be translated as needed.[77] Imagine the German and Chinese virtual critics reading the Japanese students' work in their native languages. Second, for the synchronous session, we found that the text translations were the most useful. The students wanted to be able to save and print these records of our ephemeral conversation. These translated databases could be easily archived with the design material. And lastly, integrating this textual translation with the videoconferencing system would be useful. It would free the users from attending to multiple screens and the text would be superimposed onto the design material itself, much like a subtitled film. This could also be easily archived together.

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[75] The time latency, sometimes as much as ten seconds, occurred because of the immaturity of the technology and the lack of integration. The translator was actually three systems assembled together; the voice recognizer, the translator, and the synthesizer. This was also separate from the conferencing system. As a user, I was overwhelmed by the attention that the hardware and software required of me. After I finished a sentence, I had to hit a keyboard stroke. I would then look on another computer screen to see if the recognizer formed an acceptable English database, then I would check to see when the Japanese data was compiled. And finally the machine would send out the Japanese spoken words. The interface was cumbersome to say the least.

[76] In some cases, the students did wait for the translation because they did not understand the spoken English at all. In other cases, when the students had a good comprehension of English, they simply used the text translation to confirm their understanding or fill their gaps of understanding.

[77] It could be implemented as a toggle switch where the entire webpage could be read in another language or translations may be made on particular titles, words, or blocks of text as needed.

3.8.3 Conveying a Sense of People, Place, and Spirit

The enthusiastic MYU students were eager to convey their environment and their spirit as individuals, teams, and a class through asynchronous communication. They used the freedom of the team webpages to fulfill their need to represent themselves to critics whom they would never meet. The webpages playfully showed their images and team coherence (Figure 84) and linked a daily journal of images showing the studio life at MYU (Figure 85). I noticed the students' excitement when they received a picture of one of the virtual critics and realized that providing images of the real people behind the asynchronous text-based interaction was particularly important for the project. A virtual critic also mentioned that MYU's daily journal helped him to feel closer to the students, their environment, and their projects.

To give the students a sense of my own environment, I connected a webcamera in my office so they could spy into my activities while I was not working with them.

During the synchronous sessions, we also tried to convey a sense of place by adding another video channel allowing peripheral awareness of each location. The auxiliary video connection gave me a view of the MYU space and the other students' activities in the background. This complemented my primary video window that focused on the faces of students presenting their work. I also had a secondary video camera capturing my surroundings for the MYU students to see. Figure 86 shows this entire technical set-up.
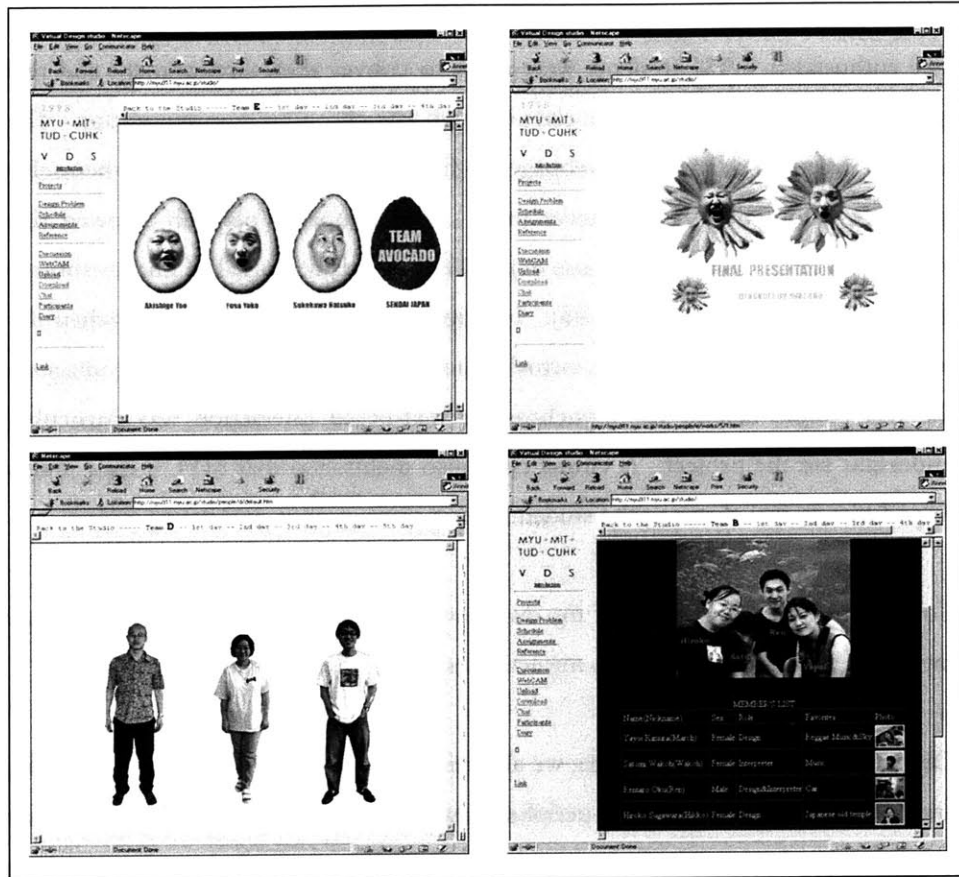
Figure 84: Playful self-representing team webpages.
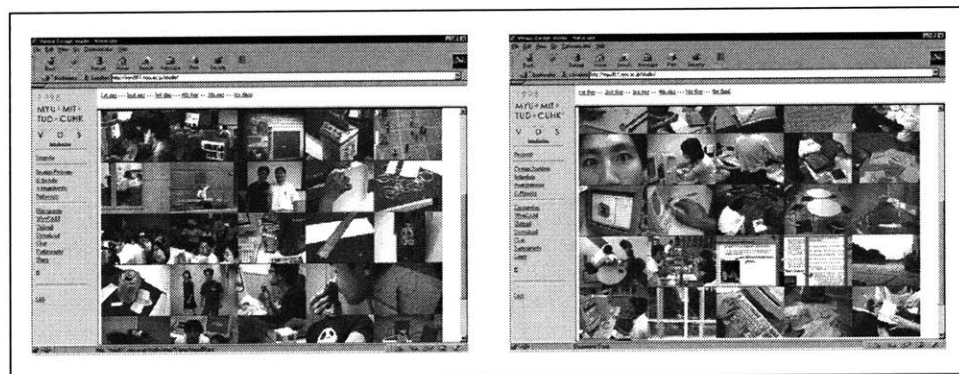
Figure 85: Photo journal of MYU during the workshop.

1	Video camera to capture MIT instructor
2	Video camera to capture MYU students or design material
3	Projection screen displaying MYU videoconferencing computer
4	Projection screen displaying MIT room view
5	Video camera to capture MYU room view
6	Video camera to capture MIT room view
7	Monitor displaying MYU room view
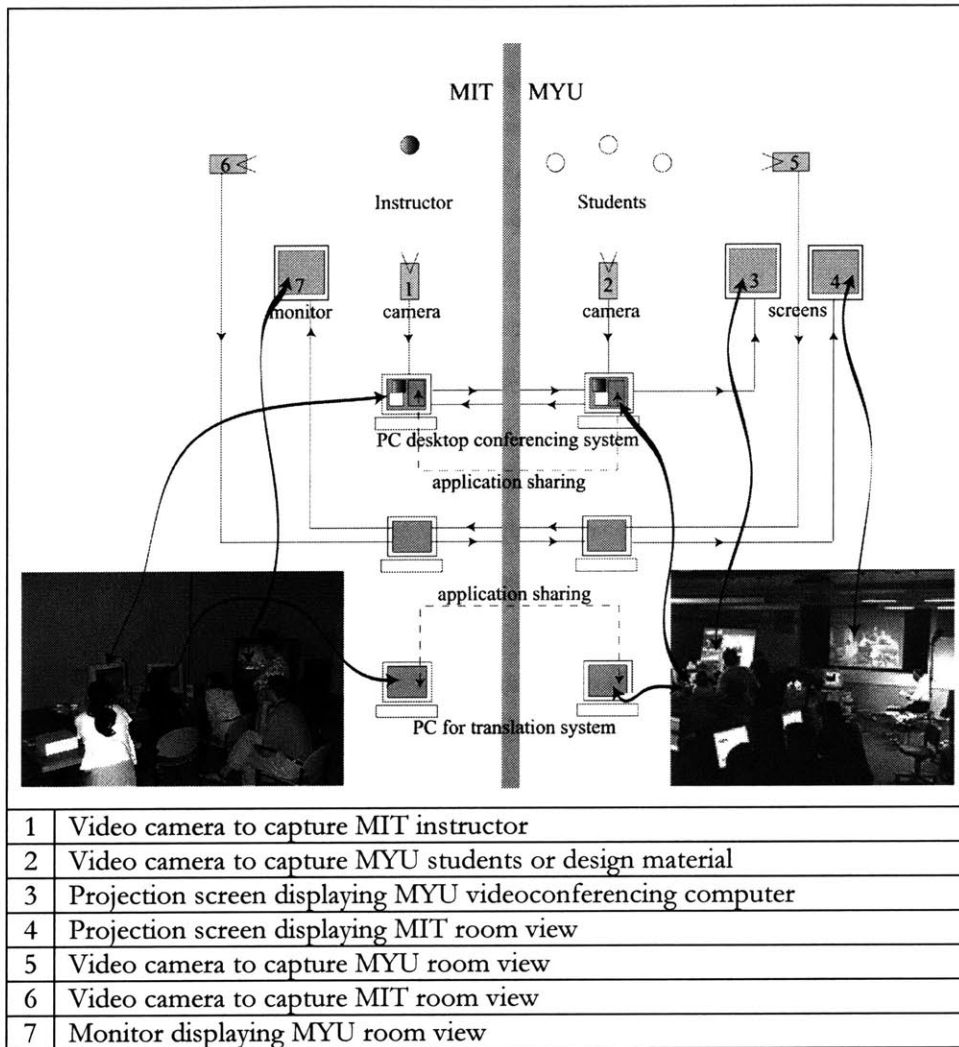
Figure 86: Entire suite of technologies.

3.9 MIT/F.O. GEHRY & ASSOCIATES STUDIO

In the fall of 1998, I was the teaching assistant for an upper-level graduate design studio at MIT involving ten students, a local instructor, and two remote co-instructors from the architectural design firm of Frank O. Gehry & Associates (FOGA) in Santa Monica, California.[78]

In this case of remote collaborative teaching, we looked particularly at:

- the students' appropriation of the distributed design environment, where we found that their interest in the project content, their respect for the remote instructors, the collaborative effort between the local and remote instructors, and the frequency, informality, and usefulness of the virtual meetings contributed to the enthusiastic acceptance of the remote setting; and

- combining face-to-face and virtual meetings throughout the studio, where we found that face-to-face encounters helped to clarify and reinforce virtual discussions and that deskcrits involving local and remote instructor working together created a setting where the students learned from the interactions *between* the instructors as well as their own interactions *with* the instructors.

3.9.1 Design Practitioners as Virtual Co-Instructors

As a studio offering within the regular design curriculum, this case was an opportunity to have a sustained semester-long collaboration with two prominent architects, Frank Gehry and Jim Glymph, acting as long-distance design instructors. The partnership began with a long-standing personal and professional relationship between the design practitioners and the local instructor. Together, they had a long history of design collaborations.

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[78] The MIT instructor was Professor Bill Mitchell and the two remote co-instructors were Frank Gehry and Jim Glymph. The students were Jim Bruneau, Ryan Chin, Benjamin Chung, Carter Johnson, Ho-Jeong Kim, Jae Kim, Eunice Lin, Rolando Mendoza, Dejan Miovic, and Marc Steinberg.

The design project involved the redevelopment of a large parcel of land in Oakland, California (Figure 87). The site selection and design problem was conceived collaboratively during meetings in Oakland involving the team of instructors and the major-elect of Oakland at the time, Jerry Brown. There was a sense of reality to the design problem because the site, then occupied by an army base facility, was being returned to the city for redevelopment and the major was particularly interested in design proposals that would use the site as the gateway to a revitalized city.
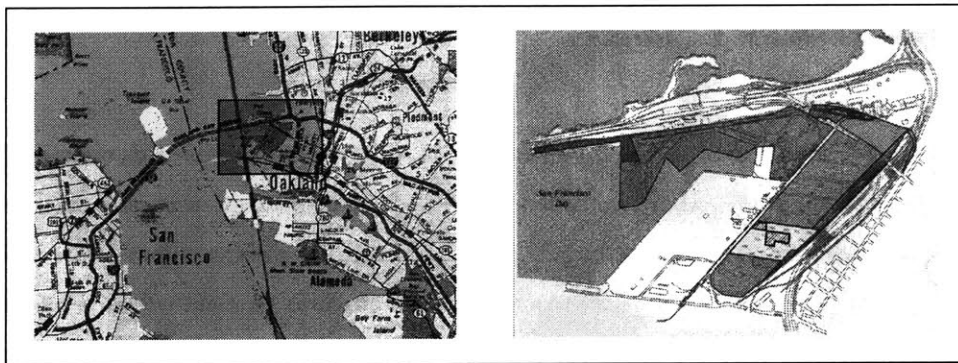
Figure 87: The design site in Oakland, California.

The design students joined the studio not only to tackle an interesting and complex design problem but also to have the chance to work and build relationships with the two renowned remote instructors. The students formed teams to address the design problem (Figure 88) and enthusiastically anticipated every interaction with their long-distance design coaches.
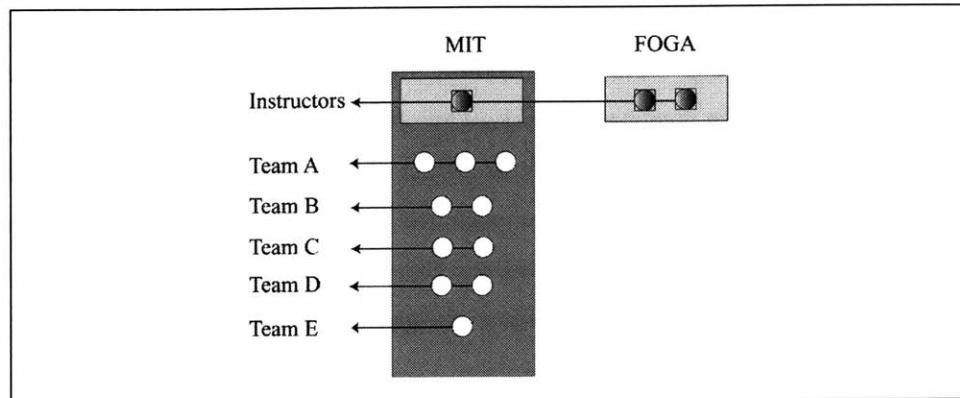
Figure 88: Student design teams.

Both the studio at MIT and the offices of FOGA were equipped with compatible telecommunication technologies (Figure 89) and the instructors were well practiced in working in a distributed setting.[79] With this familiarity and the enthusiastic studio atmosphere, it was not difficult to convince the students to meet with the remote architects for individual deskcrits or group discussions (Figure 90). The fact that the practitioners displayed so much commitment to the studio, despite their busy office schedule, motivated the entire studio.[80]

Because the virtual meetings ran so smoothly technically, we had more frequent and informal sessions with the remote instructors and we began to see instances where the mediated setting enriched the content of the design discussions by leveraging the immediacy of online design materials and the connection to professional experts and their personal design resources.

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[79] Jim Glymph had a great deal of experience with computer-mediated design environments since he conducted professional projects remotely, served as a reviewer in virtual design juries, and collaborated with us in our previous experiences with remote deskcrits. The local instructor, Bill Mitchell, of course, had much experience in these mediated settings as the pioneer of these virtual design studios.

[80] It was difficult to coordinate meetings during studio times because of the time zone difference and the work schedules of the practitioners. However, the students were willing to adjust their schedules to accommodate the remote instructors. We even had a very productive remote pinup session go past midnight EST without complaints.

1	Video camera to capture MIT students
2	Document camera
3	Video camera mounted on flexible arm to capture physical model
4	Video camera to capture instructor
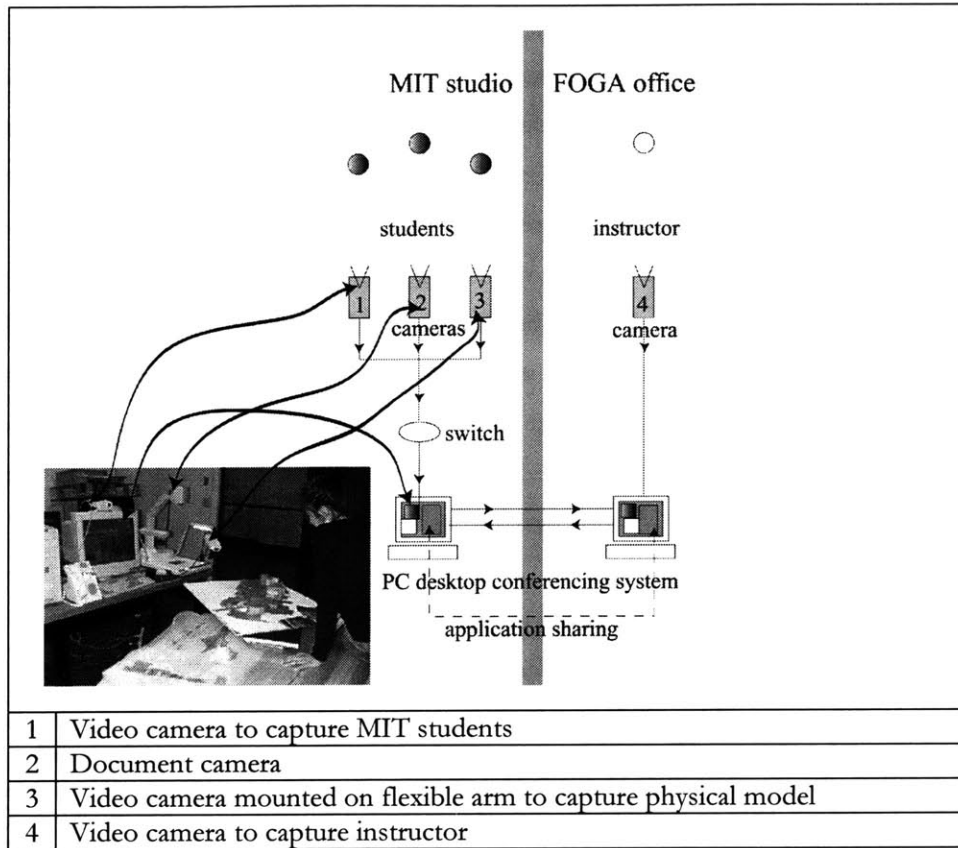
Figure 89: Technical set-up for deskcrits.
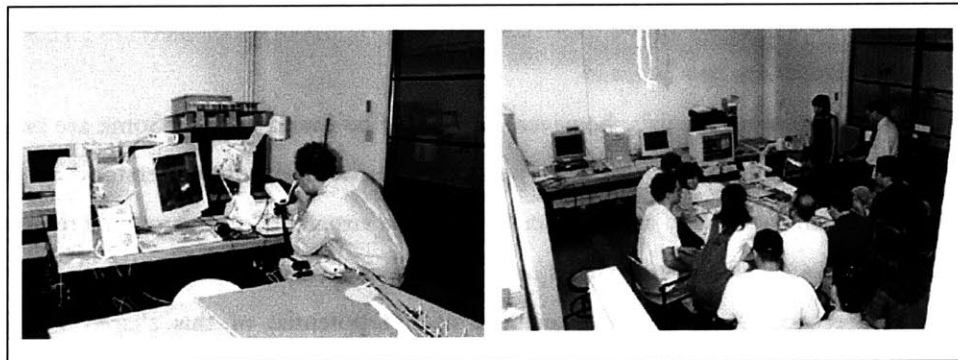
Figure 90: Computer-mediated individual deskcrits and group meetings were conducted in the MIT studio space.

Instant Access to Digital Design References

The immediacy of online design materials during virtual deskcrits helped the remote instructor to quickly show digital references to support his spontaneous reframing of the design projects. On a few virtual deskcrit occasions, the virtual instructor pointed the student to online reference materials for various purposes, such as comparisons to an existing building or analogies to an analytical process or simply for the appropriateness of a certain building material. He was not only able to talk about this reference material, as in a traditional deskcrit where the student would go in search of the material later, but he was able to instantly find the material online and use it to demonstrate his point. This immediacy helped the student enter into the interpretative process with the design coach when it is most valuable.

An engineering professor one talked to me about the importance of this immediacy in dealing with clients, but it holds true in design education as well:

> "For a working designer there is a threshold associated with getting at information. If you have to get up from your screen or your desk and go somewhere to find out something new, you might not do it. But if you have relatively instant access to that potential customer you are much more likely to find out the real truth and use it in your design. I think it will profoundly change the character of the design process, it will be more spontaneous, more fluid, and aimed more directly at what is needed."

Access to Experts and their Resources

All relevant design materials, however, cannot yet be found online. Some are only in the heads' of experts or in their personal libraries and only understood to be relevant when sparked by critical discussions. The virtual deskcrits provided remote and instant accessibility to experts and their work environment filled with these personal resources. One vivid incident of the potential of this shared virtual environment was when Gehry, during a virtual deskcrit, saw in a student's design a resemblance to the design principles of a distinguished structural engineer. He quickly ran into his adjacent office to retrieve a book about that engineer from his personal library and showed the student some relevant examples.

3.9.2 Mixing Real and Virtual Visits

Practitioners conducting studios is a familiar occurrence in design education. They usually do so by taking time from their practices and joining the studio in person for an entire semester. In this studio, the practitioners were able to stay close to their practice and remain closely involved in their students' activities through a combination of real and virtual visits to the MIT studio. Physical visits to the site by the students and meetings with city officials, community leaders, and other stakeholders of the project were also an integral part of the studio.

Inside the Studio

This was the first case study in which students met with their collaborators in person as well as through telecommunication technology. The first day of the studio began with a face-to-face meeting in the MIT studio space that included all the instructors and students. This first collocated meeting was important to ground the relationship of the participants by personal introductions rather than computer-mediated introductions. Glymph also made appearances in the studio to complement his virtual deskcrits throughout the semester (Figure 91). These interspersed face-to-face visits were important for the students to build a closer relationship with "Real Jim," as they referred to him, to help support their ongoing interactions with "Virtual Jim." It was an opportunity for the remote instructor to understand the students' design proposals better. The real visits allowed him to confirm, clarify, or reject some of the assumptions he had to make to understand the designs during the virtual encounters. The physical visits also gave time for the instructors to discuss freely the progress and process of the studio.

| a. Sessions with "Virtual Jim" | b. Sessions with "Real Jim" |
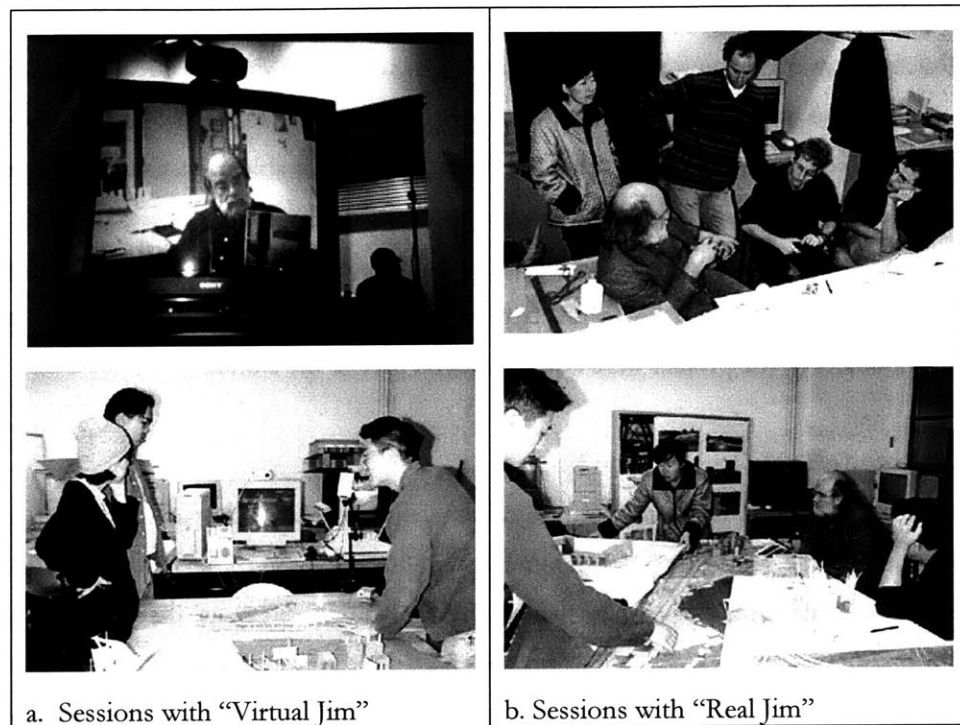
Figure 91: Students' anticipated meetings with "Virtual Jim" and "Real Jim."

This was also the first case where the local and remote instructors frequently conducted deskcrits together, either distributed or both collocated in the studio (Figure 92). This close collaboration between the instructors allowed the student to have the added benefit of learning from the interactions and negotiations between the two instructors as they reviewed his project together, in addition to learning from his own interactions with the instructors (Figure 93).[81]

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[81] I also observed the same peripheral participation phenomena while I was involved in a weekend charrette in which a team of distinguished architects worked, in one room, on generating design concepts for the MIT campus. Students were recruited to help with preparing drawings and making models. One student told me that the best thing about the charrette was to be with these talented men in the same room and to watch them collaborate and negotiate their design ideas with each other.

| a. Virtual deskcrit with both local and remote instructors | b. Local deskcrit with both instructors (during a real visit by remote instructor) |
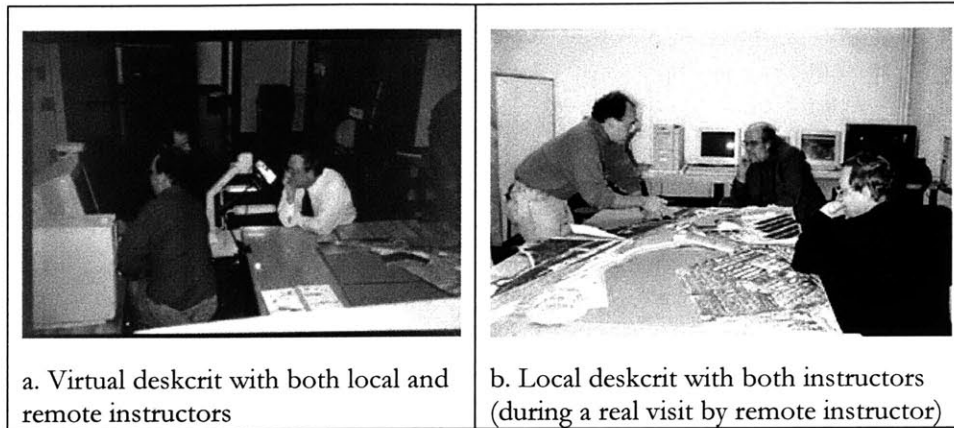
Figure 92: Local and remote instructors conducting deskcrits together.

| a. Traditional student-instructor learning relationship | b. Additional learning from observing instructor-instructor interactions |
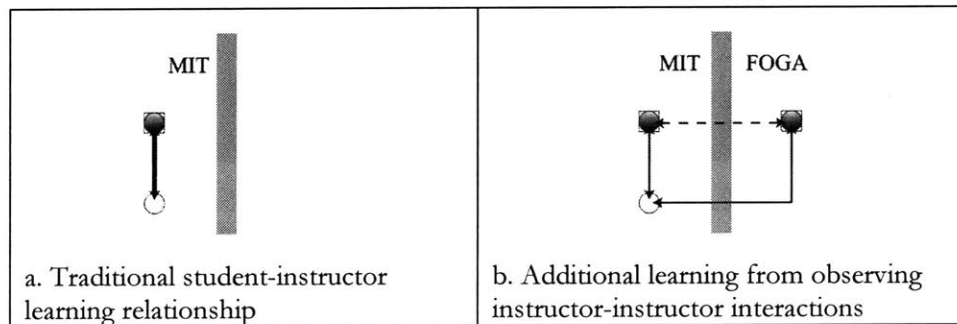
Figure 93: Student learning from interactions with an instructor and additional learning from observing interactions between the two instructors.

Outside the Studio

We also took the students out of the studio to visit the site and meet with various stakeholders of the project (Figure 94). The field trip, typically taken at the beginning of the studio, was taken instead in the middle of the studio, after the students had already worked on their initial design proposals. This gave the students the opportunity to confirm or reject the assumptions that they had to make to understand the site through only drawings, photos, and videos. They were also able to test their first design ideas by presenting them to various interested parties, such as the mayor of Oakland, members of the city council, and community leaders.

a. Presentation to the mayor-elect	b. Presentation to city council
c. Discussions with community leaders	d. Tour of site and discussions with army and port authority
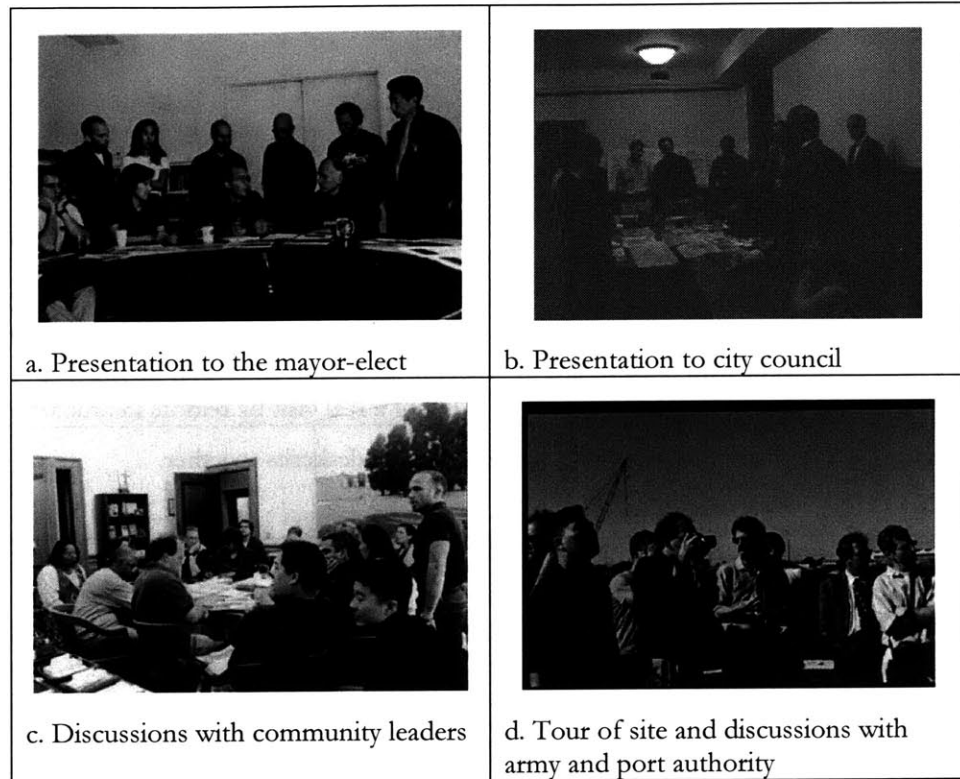
Figure 94: Visits outside of the studio with stakeholders of the project.

The students all agreed that the visit was one of the most rewarding aspects of the studio because it exposed them to a wide range of perspectives about the site, issues ranging from the vision of the city to the placement of bus stops to public policy concerns.

Another intention of the visit was to explore the idea of developing relationships with these various stakeholders at a distance. Although this did not happen for a variety of logistical reasons,[82] the overwhelming enthusiasm from different groups regarding the possibility of a sustained relationship demonstrated that building a community of interest around the project would be valuable. Finding the right

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[82] For example, many of the stakeholders did not have easy access to the Internet where the design proposals could be reviewed.

combination of people, practices, incentives, organization, and technologies that would permit this community to flourish would be the next challenge for enriching the studio learning process.

3.10 MIT/Miyagi University Workshop #2: An Integration-in-Progress

In the spring of 2000, I was involved in an intensive four-week remote collaborative workshop between MIT and Miyagi University (MYU) in Sendai, Japan. This project grew from our ongoing relationship with MYU and our previous design collaboration. Students, teaching and research staff, and client groups from both universities worked jointly on a series of structured design exercises.

In this last case study of this series, we particularly explored:

- integrating a structured design problem with collaborative processes, where we found that structured problems, that is ones that have a single correct solution, gave long-distance students a chance to engage in peer learning, cultural exchange, and team work that was important for building a relationship for subsequent less structured design exercises; and

- integrating technology and reciprocal environments, where we found that connecting sites with similar digital and physical spaces and using an integrated web-based system supported the collaborative learning process.

3.10.1 Integrating a Structured Design Problem and Remote Collaborative Learning

In this project, we explored for the first time a very structured design problem with a series of well-defined exercises and an equally structured collaborative organization in which peer learning was emphasized.

Structured Design Problem

The design students were confronted with a very structured design problem. The workshop focused on learning the concepts of shape grammar. [83] Shape grammar is a formalism that approaches the process of design as a specification of a set of

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[83] For more on shape grammar see Stiny, George, and William J. Mitchell. 1978. "The Palladian grammar." *Environment and Planning B: Planning and Design.* Vol. 5. pp.5-18 and Stiny, George. 1980. "Introduction to shape and shape grammars." *Environment and Planning B: Planning and Design* Vol. 7. pp. 343-351.

design rules. These rules are intended to describe the design moves of a particular designer. A corpus of designs following a particular architect or a particular style, such as Wright's prairie houses or Palladio's villas, may then be described by using a particular set of shape rules.[84] Jose Duarte, who was part of the teaching team at MIT, developed a system based on the concept of shape grammar to specify the corpus of Alvaro Siza's Malagueira houses.[85] Using the finite set of rules in his system would allow students to generate houses in the style of Siza. The students had the task of designing a house in this specific place in Portugal for a specific client according to Duarte's shape grammar.[86]

The workshop began with structured exercises to understand the basic concept of shape grammars[87] and Duarte's grammar in particular. It was not until the second half of the workshop that the students began to use the grammar to generate design solutions for a particular client (Figure 95). During these design collaborations, the structural language of the grammar helped the Japanese students to express their design ideas when it was difficult to explain them in English.[88]

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[84] See Koning, Hank, and Julie Eizenberg. 1981. "The language of the prairie: Frank Lloyd Wright's prairie houses." *Environment and Planning B: Planning and Design* Vol. 8. pp. 295-323.

[85] See Duarte, J. P. Forthcoming. "Customizing Mass Housing: The Grammar of Siza's Houses at Malagueira." *Environment and Planning B: Planning and Design*.

[86] In other words, the students used Duarte's system as a mechanism to learn about shape grammars in a practical way – by designing houses within his grammar and then later designing new houses by changing his rules.

[87] Professor Terry Knight at MIT gave the introductory lecture and assignment.

[88] Although the student used dialogue and visual material to communicate their ideas, they also used the rules of the shape grammar for expressing ideas when they could not easily communicate due to the language barrier. During the final review, one Japanese student reflected on how the shape grammar helped him to bridge the language gap. He could not express some ideas because he felt that his command of the English language was poor, but he could express them using the grammar and it could then be well understood by the entire group.
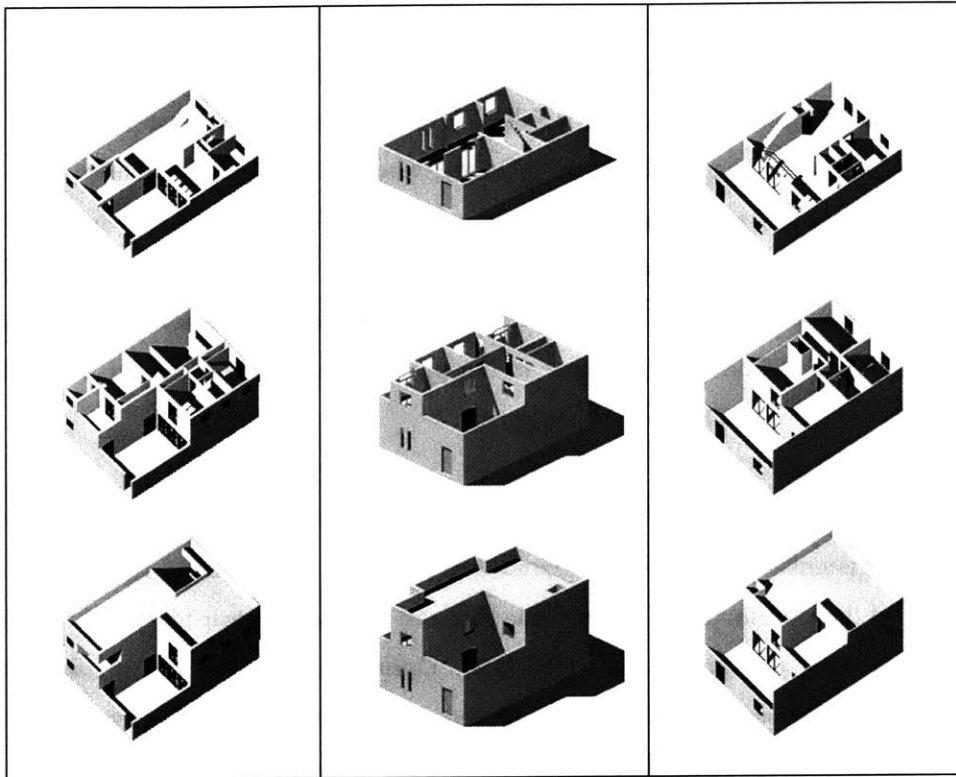
Figure 95: Examples of houses designed by the workshop students according to the shape rules.

Structured Collaborations

The organization of the workshop was also structured. The differences in curriculum, design experience, shape grammar knowledge, time zone, culture, and language required intense pre-workshop planning and coordination by the teaching staff. Instead of fighting these differences and approaching the project as an attempt to homogenize the student body, we carefully designed the collaborative process to make these differences to be an important part of the learning experience. The collaboration included peer learning through long-distance co-constructions, cultural exchanges by client interactions and visits to MYU, and structured weekly assignments with around-the-clock charrettes.

Peer Learning

The diversity of the students in terms of their design experience and their knowledge of shape grammar gave an opportunity to form design teams that would encourage collaborative peer learning. The MIT students were more versed in the concepts of shape grammar and more experienced in design. Within the group of eight MIT graduate students, four students had more theoretical and practical experience with shape grammars. In forming the four design teams,[89] we made certain that each team consisted of one expert in the topic who would act as the mentor to the other team members.

At MYU, the chance to work with MIT students brought sixteen enthusiastic undergraduate students to the workshop. The Japanese students, who had no experience with shape grammars, were divided into four teams[90] according to other factors, such as design skills, computer skills, and shyness level.[91] In each team, one student, who was proficient in spoken English, was designated as the language translator. There were also dedicated translators at both MIT and MYU during the workshop lectures and reviews to periodically translate English to Japanese as needed.

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[89] The MIT students were divided into the following teams: Team A: Gabriela Celani, Aradhana Goel; Team B: Haldane Liew, Franco Vairani; Team C: Rolando Mendoza, Mine Ozkar; and Team D: Michael Lark, Miranda McGill. The instructors were Jose Duarte, Professor Terry Knight, Professor Bill Mitchell, and myself.

[90] The students from Miyagi University included Team A: Masumi Nagano, Toru Nakagawa, Ayumi Tokuyama (translator), Ryuiti Watanabe (Tohoku Institute of Technology); Teams B: Rentaro Oku, Ami Ozaki, Ayako Yanbe, Yasunobu Kurokawa (Tohoku Institute of Technology); Team C: Toshimitsu Oishi, Natsuko Sukekawa (translator), Shinya Takeda, Aya Aida, (Tohoku Institute of Technology); Team D: Hiroko Abe (translator), Mika Itho, Hiroko Miura, Ikkan Shibuya. The students from Tohoku Institute of Technology were included due to the high demand to participate in this project on the Japanese side. However, they were the least immersed students probably due to the fact that they were not physically at Miyagi University on a regular basis. The instructors were Professors Akihiro Fujii, Eiji Keyamura, Ryusuke Naka, Soichiro Okishio, and Kumi Tashiro.

[91] Shyness was a factor that had to be acknowledged for the Japanese students. I had learned from the other projects that many of undergraduate students at Miyagi, often in awe of MIT and MIT graduate students, were not very vocal during the discussions because of their introverted nature. Professor Naka and other Miyagi instructors periodically reminded us about this shyness factor.

The four MYU teams were matched with the four MIT teams. Each team, therefore, had members with a range of skills providing opportunities for hierarchical learning reminiscent of the teamwork found in the *ateliers* of the Ecole des Beaux-Arts. The students with more knowledge of shape grammars acted as teachers and mentors, like the *anciens*. For some students, particularly the doctoral students, this was a welcomed new role. One team even gave their Japanese teammates extra elaborated problems to be solved during their synchronous work sessions to make sure that all the basic concepts were well understood at an early stage. That same group continued to have critical discussions throughout the workshop about the usefulness of shape grammars in design practice.

Client Interactions

The project included a diverse client group for which the student teams designed grammar-based houses. We decided to make clients from the people already involved in the project. They included four instructors from MYU, one from MIT, and one from the Chinese University of Hong Kong (CUHK).[92] These client roles helped to bring the Japanese instructors into the design process without having to be knowledgeable in the mechanics of shape grammar. The clients from MIT and CUHK were experts in shape grammar and contributed to the technicalities of using the rules to design as well as the design outcomes. Figure 96 illustrates the participants of the workshop.

Each team was assigned a specific client with particular requirements. The teams learned about the needs of their clients through questionnaires and taped interviews (Figure 97) that were placed online. Because the clients were also active members of the project, the students were able to communicate with them directly if needed.

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[92] The clients were Akihiro Fujii, Eiji Keyamura, Ryusuke Naka, and Kumi Tashiro from MYU; Terry Knight and George Stiny from MIT; and Andrew Li from CUHK.
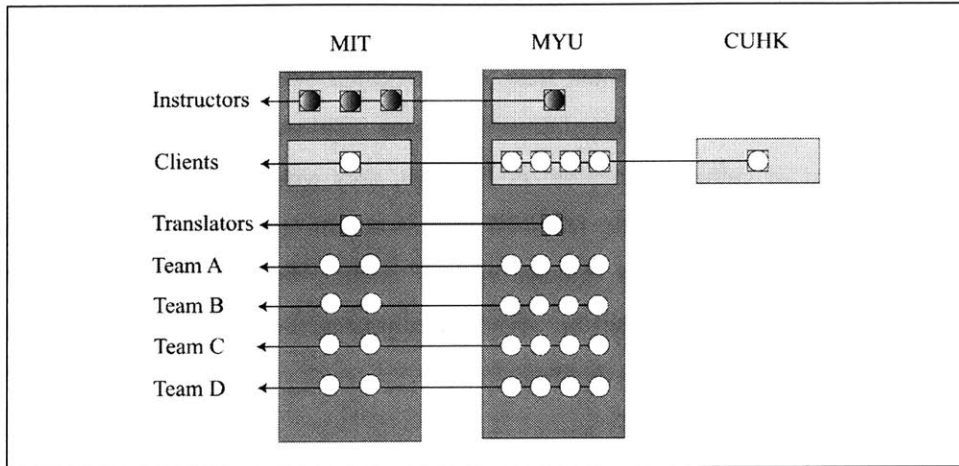
Figure 96: Workshop participants.

Figure 97: Client interviews were placed online.

The initial goal of having a client group was to provide a diverse set of program requirements for the different teams. The clients, along with the foreign site of the housing project, also provided a venue for cultural exchange. The students had to negotiate between the spatial needs of the clients and the culture represented by the clients, the remote designers, and the design site all within the structure of the Siza grammar. For example, the requirements of the Japanese clients in the Portuguese context made the MIT students acutely aware of differences in lifestyles, values, and behaviors. Two of the Japanese clients required multi-generational living arrangements that included grandparents, parents, and children under one roof. This provided an opportunity to begin a conversation about an aging population and new accessibility needs, a culture that values elders, and the accommodations of

individual and group activities in such households. One of the Japanese clients had the requirement of a traditional bath while another wanted an entry space for visitors to remove their shoes. I listened as one MIT student struggled with this displacement of culture: "They are in Portugal, they won't take off their shoes." Through discussions with his Japanese teammates, he quickly realized that their design was not about one singular site or culture, but it was the result of interpretations and negotiations between his teammates, the client, the program, and cultural, stylistic, and design attitudes.

Visits to MYU

The four-week workshop was organized so that each of the four MIT teams spent one week at MYU working together with their teammates. This was the first study in which we scheduled regular site visits, not to look at a physical design site or for a special meeting, but rather to explore the idea of intermittent face-to-face interactions coupled with computer-mediated interactions. Team A worked at MYU during the first week of the workshop. Teams B and C were at MYU for the second and third weeks respectively. Finally, members of Team D, who never met during the course of the workshop, only made a visit the week after the end of the class.

The visits to MYU added a social component of the workshop that provided opportunities for trust building, team coherence, and cultural exchange as the students worked side by side. Besides participating in many extracurricular activities together while at MYU, the students were able to learn about each other's national and work cultures. Many lived in the residences of the Japanese students and became fully immersed into their teammates' world for the week.

What I think was significant, however, was not the actual activities during the visit, but what happened before and after a scheduled visit. Before the trip, the students waited anxiously to meet their remote colleagues and this anticipation was enough to begin a close working relationship as students planned their future collocated

work and social activities. For example, one group decided to defer a difficult concept to the next week when they could discuss it face-to-face and they all trusted that the issue would then be clarified. The anticipation also increased the students' sense of responsibility to the project. Because they all understood that they would one day meet face-to-face, the students maintained a high level of commitment and quality of work prior to the meeting so as not to disappoint each other.[93]

While the collocated students did their assignments side by side, they were able to find ways of working together that could be exported back to their long-distance interactions. After the visits, the students understood better the expertise and work methods of each remote team member. The teams' work sessions were smooth and relied more on simple asynchronous communication, such as email, after their personal encounter. The teams were also more informal and displayed more playfulness in their synchronous communications. They had their own jokes, sayings, and rituals and understood each other's gestures better. One MIT student said to me during a videoconference session that she felt that one of the quiet Japanese students had concerns about the current design proposal simply by reading his stance. She was right.

After the visits, the students also had a better understanding of MYU, its spaces and technologies. They knew which students usually sat in the back during lectures at MYU, which students probably understood the lecture better and could later explain it to his classmates, and they could even guess why things were not working when we had technical problems. This understanding of the MYU social and physical space seemed to make the students more relaxed and patient in their virtual interactions.

The visits also gave opportunities for the teams to build relationships that would go beyond the workshop. For example, I found a group working on something entirely

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[93] The potential personal meeting made the projects more real and not only about the anonymous talking heads on the screen.

different during a synchronous session after the MIT team members returned from MYU. When I asked what they were discussing, they told me that one of the Japanese team members was entering a design competition and they were reviewing his current design. They had stumbled on his work during their week at MYU and agreed to continue to review his proposal until the competition was submitted. Some of the teams displayed so much coherence that at the end of the project, they sent congratulatory messages to each other regretting that the end of the workshop had arrived. Also, two Japanese students came to MIT to visit their teammates voluntarily after the workshop.

In contrast, the one team that did not meet until after the end of the project felt, by watching the informal and ritualized interactions of the other teams, that they were missing out on something special. Their own interactions remained formal and closely focused on coordinating the work.

Structured Weekly Assignments and Charrettes

The structure of each of the workshop's four weeks was similar. We began each week with a videoconference to introduce that week's work with a lecture and a review of the assignment to be presented by the end of the week. In between, the students worked together both synchronously and asynchronously. They scheduled their own videoconference work sessions and developed their own work strategies. As with the other Japanese projects, the teams took advantage of the time zone difference to work around the clock in shifts asynchronously. All the workshop material, including lecture notes, assignments, references, and student work, were placed on the Web.

3.10.2 Integrating Technology and Reciprocal Environments

The workshop was carried out in the physical spaces of MIT and MYU and the digital space of an interactive website called ArchNet.[94] One of the goals of the

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[94] See website at http://archnet.org.

project was to test the collaborative functionalities of the ArchNet system currently under development at MIT. Integrating collaborative capabilities within ArchNet and using similar technologies and physical spaces at both sites created a learning environment with reciprocal communication and collaboration opportunities.

ArchNet

ArchNet is a web-based community for architects, planner, urban designers, landscape architects, and scholars, focusing on the needs of the developing world. ArchNet is a place for resources, individual and group work, and community interaction. The main material resource in ArchNet is a large digital library of design-related books, journals, image databases, audio and video material, and computer generated models and simulations. The human resource of ArchNet is in its membership and the creative material it produces and makes available to the community.[95] Members of the community enter the system through their own personal workspaces, in which they may store their resources and design work. Each member represents himself to the community by maintaining a member profile that may include basic contact information as well as more detailed content such as professional interests, photos, publication lists, and portfolios of design work. Institutions may also represent themselves through similar institutional workspaces. Members have opportunities to participate in the community in varying degrees from casually browsing or searching the members' profiles, calendar events, job listings, or course syllabi or more actively by contributing events, jobs, or syllabi and posting in the discussion forum. ArchNet also allows members to work together in group workspaces. See Figure 98 for the entire structure of the ArchNet website.

Because we were building a prototype of the Group Workspace module to support long-distance collaborative projects such as the ones illustrated in this chapter, we

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[95] There is a distinction from the resources that are highly editorialized and centralized and those created and made available by individual members, workgroups, and institutions.

took the opportunity to use this case study to test ArchNet's group functionalities.[96] Each student became a registered member of ArchNet that gave him his own individual workspace from which he entered his team's group workspace (Figure 99).

With varying degrees of user-defined privacy controls, the group workspace provided areas for:

- real-time chatting in the meeting room;
- displaying and reviewing drawings on the pinup board;
- coordinating schedules in the group calendar;
- storing files, bibliographies, web links, and other resources in the groups' collections;
- storing contacts in the group address book; and
- assembling the team's final work in the portfolio.[97]

The students and instructors used the group workspaces for their synchronous and asynchronous group activities. Synchronously, the students used the meeting room to assemble their teammates for real-time chats. The instructor held "office hours" in the meeting rooms where the students were able to find him if they had questions. The room also provided opportunities for unplanned encounters because each member was announced "online" in the group's meeting room upon entry into the group workspace. Often, a student would enter the workspace in hopes of finding his teammates. If he found the meeting room empty, he would leave an informal message there for his colleagues to read later. The dialogue of the meeting room was saved and became automatically the meeting minutes. Figure 100 shows one of the meeting rooms in which a student was asking the instructor for some clarification in real-time. When her teammates later logged into the

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[96] The collaborative workspaces in ArchNet were conceptualized by Anne Beamish, managing editor of ArchNet, and myself.

[97] The portfolio functionality was not available for testing during this case study.

workspace, they could see that this dialogue had taken place and could also take advantage of the instructor's answers.

ArchNet Structure

Lobby • Register • Log-on • ArchNet Info • Community News	**My Workspace** • What's New on ArchNet (news, calendar, discussion, new members)	**My Groups:** listing of personal groups **My Calendar:** list personal event; ability to copy from calendar **My Collections:** images, files, bibliography, web, sketchbook **My Addresses:** personal address book; copy from profiles **My Profile:** Edit info, bio, CV, portfolio, privacy controls
	Group Workspace • What's New in Group (news, calendar, discussion, new members)	**Meeting Room:** live discussion/chat area **Studio:** Pin-up Board, discussion area, sub-groups **Group Calendar:** list personal event; copy from calendar **Group Collections:** images, files, bibliography, web, **Group Addresses:** group address book; copy from profiles **Group Profile:** Edit info, bio, CV, portfolio, privacy controls
	Digital Calendar • list by date, type, place • archives • add and copy events	**Current Events:** this month, next month, ongoing events **Upcoming Events:** list by month, category, country **Archives:** list by month, category, country
Members: - access to all areas - contribute to all areas - own workspace - group workspaces	**Digital Library**	**Images:** historical, contemporary, special collections **Names:** sites, places, people/organizations **Publications:** view by title, author, type; download copy **Files:** download drawings, CAD, maps, GIS, spreadsheets **Services:** FirstSearch, Avery **References:** glossary, academic directory, web, publishers
Non-Members: - can read most areas - cannot contribute - no private workspace - no group workspaces	**Discussion Forum** • question and answers • start new topics • search	
Help • descriptions • FAQ • how to contribute	**Member Profiles** • search • list by name, country, interests	
Search • simple search • advanced search	**Institutions** • search • list by name, country, research	
Course Syllabi • syllabi • teaching mat'ls	**Careers**	**Jobs:** list by position, employer, category, country **Internships:** list by position, employer, category, country **Candidates:** list those looking for jobs **Advice:** **Archives:** past jobs offered

Figure 98: ArchNet structure.

a. Individual workspace   b. Group workspace

Figure 99: Individual and group workspaces in ArchNet.

Figure 100: Meeting room for each group workspace.

Students used the pinup board extensively to post sketches and computer generated images of their designs so their teammates and instructors could review them asynchronously and post commentary next to the image in a threaded discussion format (Figure 101).
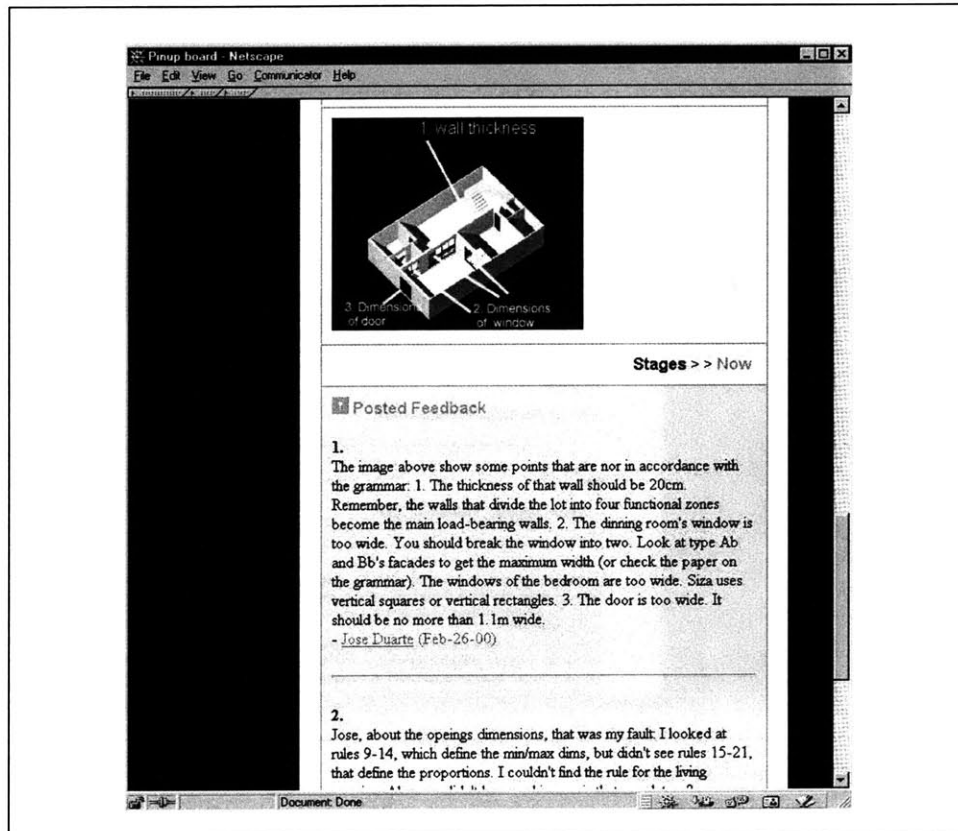
Figure 101: Pinup page in the group workspace.

The students and instructors used the discussion forum to initiate critical discourse during the workshop. Unlike the informal meeting rooms that were used for casual and brief inquiries and comments, the discussion forum was reserved for more formal and formulated dialogue about conceptual issues. For example, one group carried their debate on the usefulness of shape grammars in design practice from a videoconference work session into the discussion forum to share with the entire class (Figures 102). The instructors also initiated discussions to encourage the

students to reflect on their design processes as they used the grammar rules and on their collaborative processes as they worked remotely.
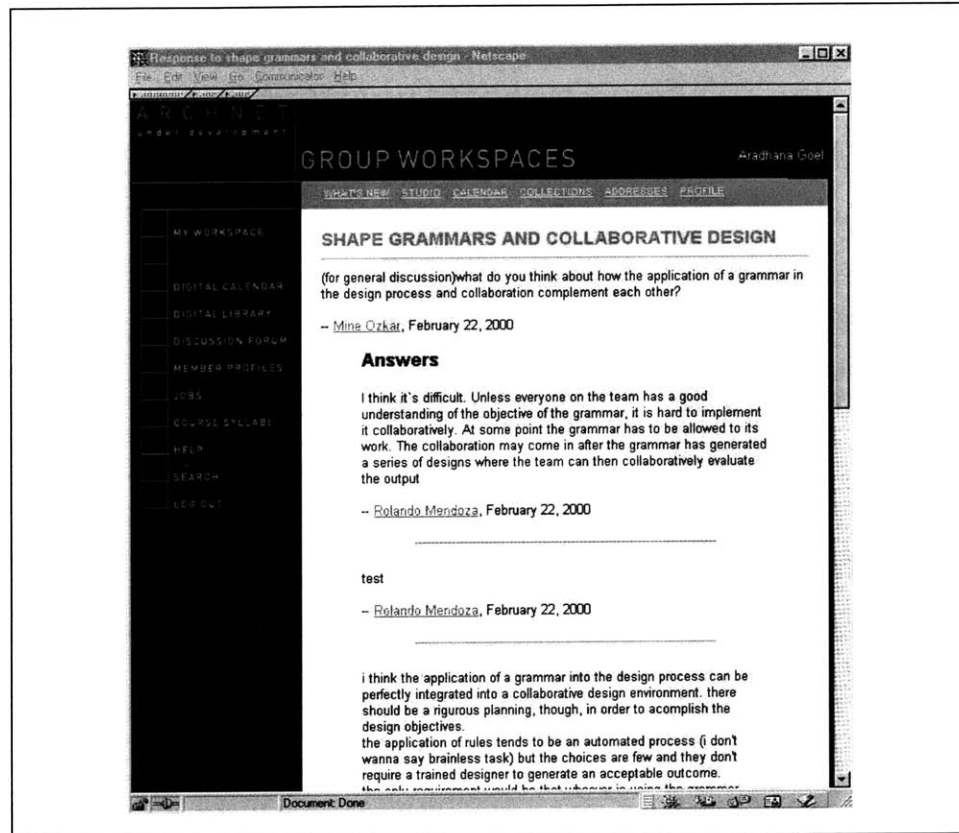
Figure 102: Discussion forum.

The teams used the group collections area (Figure 103) for exchanging files that needed to be accessed by all the team members. For example, a MIT student would leave a CAD file in the collections area before going to sleep at night so his MYU teammate could pick it up to complete during the around-the-clock charrettes. The versioning feature helped to keep clear who last revised and submitted each document. The file collections area was also useful when the MIT students made their visits to MYU because they did not have to worry about gathering and transporting all their design material, it was already easily accessible from the website.
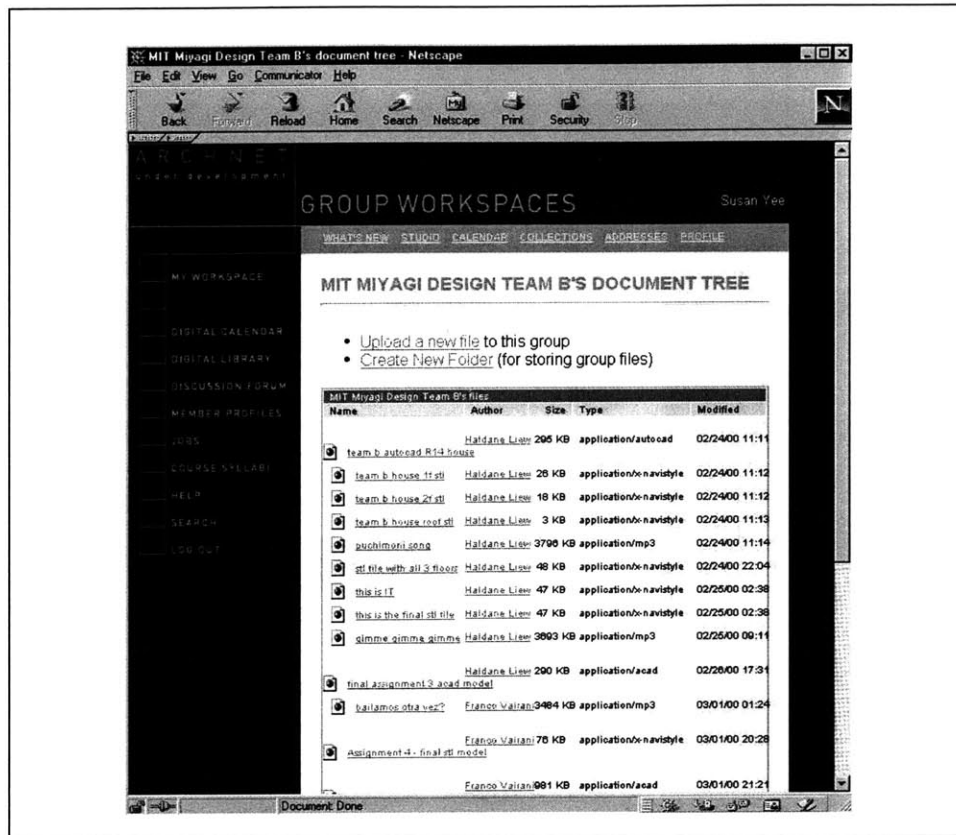
Figure 103: Collections page in the group workspace.

The instructors also had a workspace dedicated to placing all the course material for all the students to access easily. Solutions to the structured problems were posted once the students submitted their work. When additions were made in the instructors' space or in the team workspaces, the members were notified via email. In addition, upon entry into the workspaces, a "what's new?" area listed all the new entries since the member's last visit for easy access to the most current designs (Figure 104). This feature kept the team members and instructors aware of the activities in each project and in the entire class.
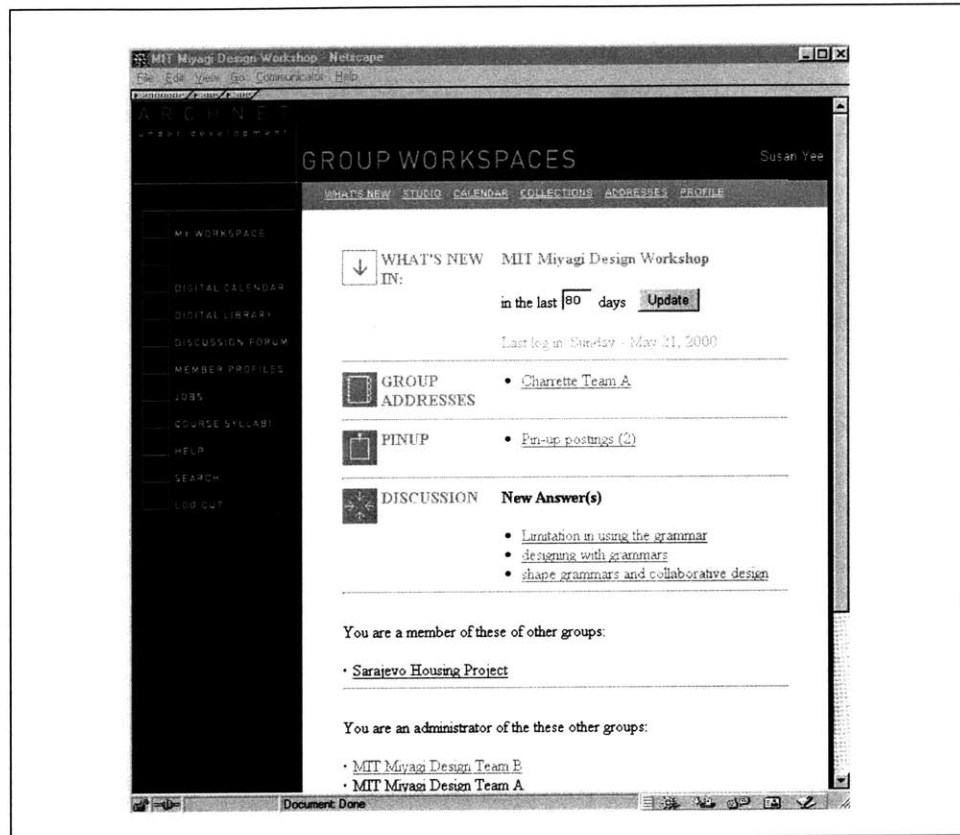
Figure 104: Entry into the group workspace with a "what's new?" section for easy access to the most recently added material.

At the end of the workshop, the integrated group workspace was an automatic archive of each team's results and supporting discussions.

Reciprocal Environments

The use of ArchNet helped integrate the two sites through the common group workspaces, but the two schools were also well integrated because they used compatible technologies in similar physical settings for synchronous interactions. In addition, the two sites were similarly staffed with experienced technical and teaching assistants who understand the studio process.

For the long-distance lectures at the beginning of each week and the assignment reviews at the end of each week, we used similar group videoconferencing setups (Figure 105).

1	Video camera to capture MIT students and instructors
2	Document camera to capture physical material
3	Video camera to capture MYU students and instructors
4	Projection screen displaying application shared design work
5	Monitor displaying MYU students and instructors
6	Projection screen displaying MIT students and instructors
7	Projection screen displaying application shared design work

Figure 105: Group videoconference setup.

At MIT, we gathered around a table seminar-style with a monitor showing the remote site at one end[98] and a screen displaying the class material above (Figure 106).

Figure 106: Workshop meetings at MIT.

At MYU, two projection screens in the open space of a computer workroom were used to accommodate the bigger audience (Figure 107).

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[98] An extra monitor was used at MIT during the final review to display the MYU room view.

Figure 107: Workshop meetings at MYU.

The synchronous group work sessions at both locations were conducted using a desktop videoconferencing solution over ISDN connections with Internet-based application sharing (Figure 108). The students worked with their remote teammates clustered around a computer in the public space of a design studio at MIT and a computer room at MYU (Figure 109). During these meetings, the students used ArchNet's group workspaces as the basis of their discussions (Figure 110).

1	Video camera to capture MIT students
2	Document camera to capture physical material
3	Video camera to capture MYU students (also used as a document camera)
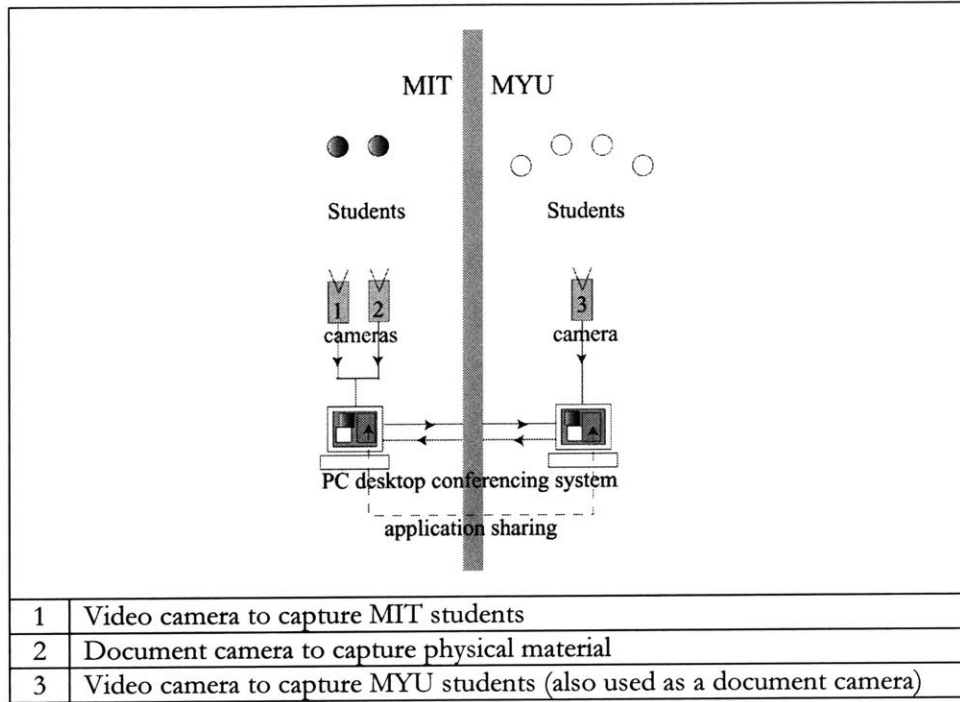
Figure 108: Technical setup for synchronous team work sessions.

| a. Team working at MIT | b. Team working at MYU |
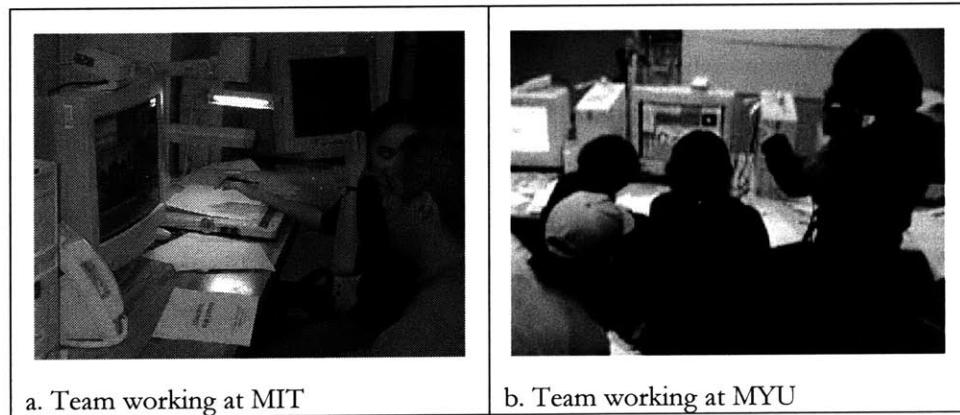
Figure 109: Similar physical spaces at MIT and MYU for the group work sessions.
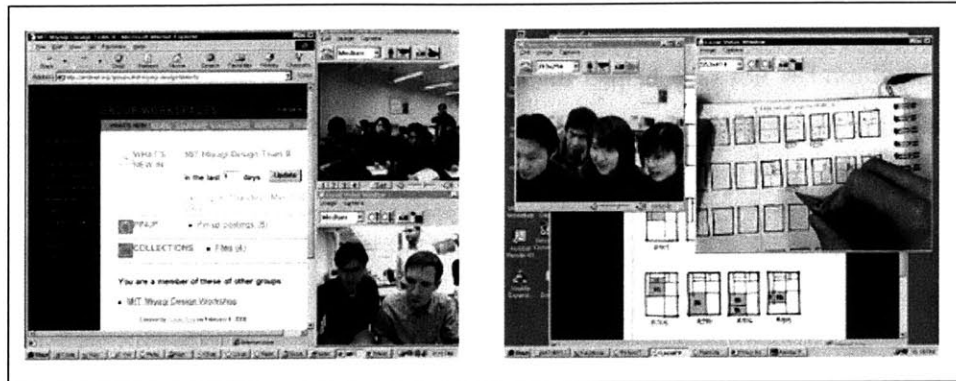
Figure 110: Screen shots of teams working via videoconferencing with ArchNet application shared between the sites.

In between these videoconference meetings, the students were in touch using an instant messenger system, ICQ ("I seek you"), with which they could pass quick messages while they worked individually. With the system's buddy list, the students could be aware of their remote teammates' online presence.[99] We also made cameras and microphones available to the MIT students so they could connect to their teammates through Internet-based conferencing systems whenever they liked.[100]

Another aspect of the reciprocal environment between MIT and MYU was the use of 3D printed models at both sites.[101] One of the limitations of reviewing design work is that physical models often only reside at one location. Even if each site builds their own hand-made models, they are bound to be different and can lead to misunderstandings. This was the first case in which we used 3D printers located at each site to generate identical physical models (Figures 111, 112). Each school printed 3D models from identical CAD files giving the opportunity for students and

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[99] ICQ's buddy list shows the user a list of his friends who are currently online and available to be contacted by an instant message or a multi-way chat.

[100] One MIT student met her Japanese teammates periodically using NetMeeting from her dorm room.

[101] At MIT, the students used a Stratasys Fused Deposition Modeler which drops hot plastic pellets into layers to build up the 3D models. At MYU, another layering manufacturing process, stereolithography, was used.

design reviewers to base their discussions on the same physical model. The 3D printed models not only helped the distanced collaborative process, but they also helped to bridge the gap between digital design work and physical prototypes.

| a. 3D printed site model at MIT | b. 3D printed site model at MYU |
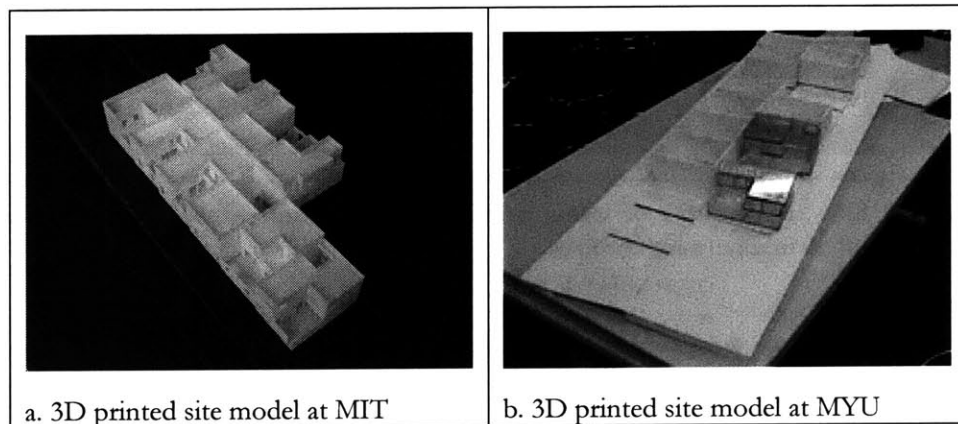
Figure 111: Identical 3D printed site models at MIT and MYU.

| a. 3D printed houses at MIT | b. 3D printed houses at MYU |
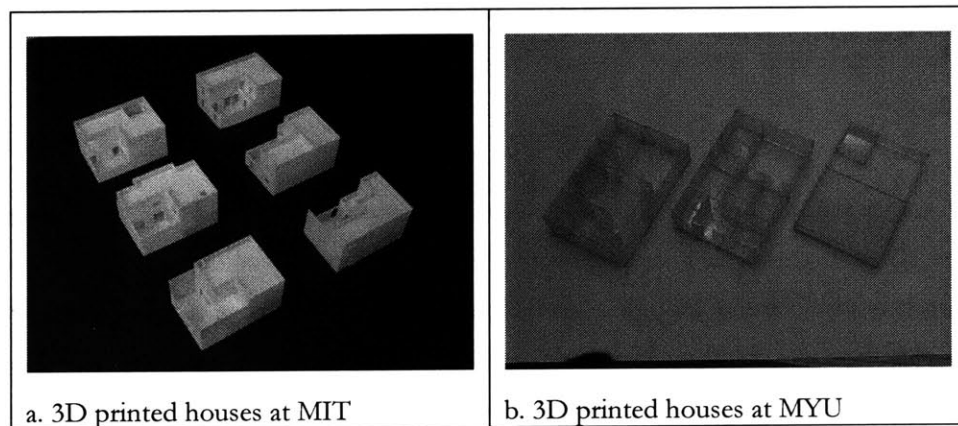
Figure 112: Identical 3D printed individual houses at MIT and MYU.

This last case study illustrates how the integration of people, technologies, processes, and design material can help to build a productive VDS environment. The setting included:

- a structured design problem and work process to encourage peer learning, client interactions, and organized work schedules;

- mixed physical and virtual visits;

- an integrated system for group design work which provides functionalities to store and exchange information, display design work, coordinate schedules, interact with team members, and give awareness of people and projects; and

- reciprocal environments and specialized production tools accompanied by skillful personnel.

Chapter 4
THE FINDINGS
Technical and Social Characteristics of the New Design Studio

Chapter 4: The Findings

Technical and Social Characteristics of the New Design Studio

We hypothesized in 1992, with the first use of telecommunication technology in the design studio, that virtual design studios (VDS) were technically and pedagogically feasible. Now, eight years later, we not only see their feasibility, but we also understand them better. We have seen these environments evolve with new advanced technologies and developed social protocols. The series of case studies conducted during this research has revealed some distinguishing characteristics of these studios. In this chapter, I integrate the findings and summarize these characteristics in terms of collaborative technologies and the studio's social system components as they begin to overlap (Figure 1). I offer this description as a snapshot of the current technical and social settings, conditions, and requirements of a remote collaborative design studio.
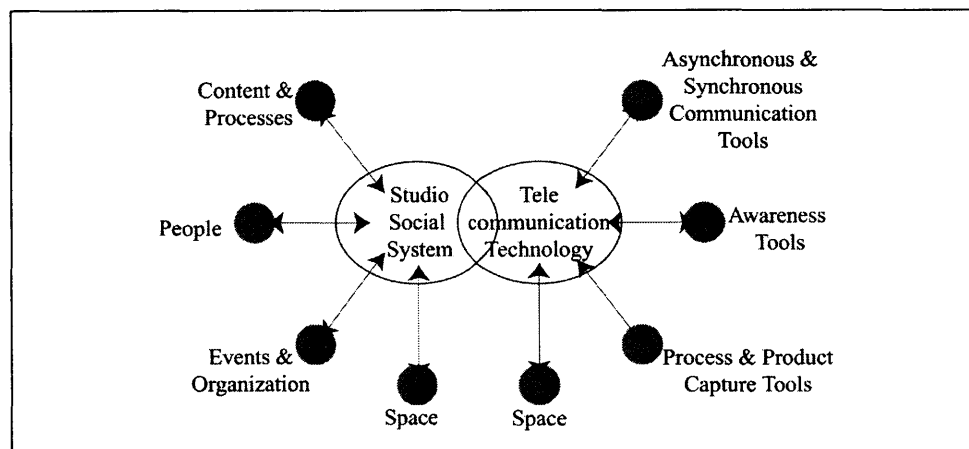
Figure 1: Characteristics of the VDS reside in the overlap of the studio social system and telecommunication technology.

This chapter is organized into two parts to illustrate the characteristics of the VDS and how they may affect design learning. The first section is a description of the collaborative technologies and their current use in the studio. The second part describes the changed social system of the design studio, including the studio's new

assembly of people, roles, and relationships, its changed content and processes, and the altered nature of studio events and organization.

4.1 TELECOMMUNICATION TECHNOLOGY IN THE DESIGN STUDIO

The baseline condition for a VDS is the ability for long-distance participants to communicate ideas effectively through telecommunication technology for critical design discourse. During these case studies, new technologies were used in the various studio events, from formal juries to serendipitous casual encounters, in which there were individual needs as well as group requirements. These events and activities needed an environment that could support a variety of interactions. This environment was created by assembling a suitable suite of technologies, by placing them thoughtfully into the physical setting, and by allowing them to evolve as the needs of the studio changed.

Located in the physical space of the studio, the basic set of technologies for a VDS included tools for (Figure 2):

- asynchronous and synchronous communications;

- awareness of people, places, and projects; and

- capturing of design product and processes.
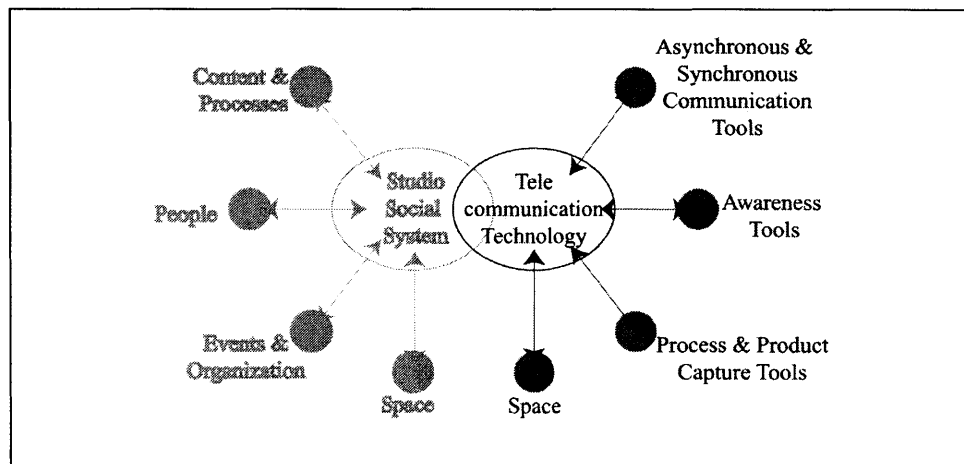
Figure 2: Basic telecommunication technology for a VDS.

4.1.1 Asynchronous and Synchronous Tools

We used a variety of technologies for asynchronous and synchronous communication in the studio. The tools for asynchronous interaction included email, ftp sites, shared databases, discussion forums, and integrated group workspaces on the web. We used synchronous tools such as instant messaging systems, chat rooms, full audio and video conferencing, and application sharing systems.

The technologies and their use evolved as we gained practical experience in remote collaborative design environments during the series of cases. The first simple cases focused on using the technologies:

- individually;

- for particular instrumental tasks with emphasis on design material;

- in formal situations and in formal rooms; and

- for one-time special events.

For example, in the Harvard University/University of British Columbia pilot project, the shared database of CAD drawings on the digital pinup board was used to exchange component parts of a design. In the first trials of the virtual jury, we used videoconferencing only to display the talking heads for formal verbal discussions. The first virtual deskcrits were formal and held in specialized rooms.

The later cases became more intricate as the dispersed members needed not only to communicate and cooperate, but they also needed to collaborate as they worked together on a single design proposal. To build long-distance personal relationships, mutual understanding of design products, processes, practices, and values, a broader range of technical functionalities was needed in the VDS environment. These later cases focused on integrating a suite of technologies to be used:

- in combination and on-demand;

- for particular design communication activities with emphasis on people, their relationships, and interactions with each other and the design material;

- in informal and playful situations and in the physical space of the studio; and

- for frequent interactions in the studio's everyday activities.

For example, the MIT/Oporto/Lisbon charrette interweaved the various synchronous and asynchronous technologies to create a productive, yet playful VDS environment in which informal and cross-cultural learning was possible. In the MIT/XeroxPARC studio, the virtual deskcrits at the students' individual desks became frequent everyday occurrences that brought the distributed critics closer to the physical and social environment of the studio. In the MIT/Miyagi University Workshop #2, the integrated group workspaces of ArchNet were used daily and focused on communicating design and the design process.

Different types of technology were more useful at different stages of the design cycle. In the initial stages of remote collaborative design projects, videoconferences were important if face-to-face visits were impossible. These encounters for introducing people and ill-defined complex design problems, for brainstorming, and for consensus making were critical because they formed the foundations of personal relationships for remote work. Full audio and video provided cues to help the participants understand each other through the subtleties of eye contact, body language, and voice intonations. These sessions also helped to better understand design ideas because they allowed views of people pointing, gesturing, and interacting with design objects. Coupled with the informality of chat rooms, important working relationships and rituals had the opportunity to form.

At later stages of the design cycle, once these relationships were made and a shared understanding of design proposals and design practice was possible, the asynchronous interactions through email, discussion forums, and pinup boards became more valuable. The asynchronous technologies allowed time for individual

work to progress and helped members in different time zones to maintain coordination and sustain work shifts around the clock. Integrated web-based environments, such as ArchNet, allowed all the work to be aggregated for easy access, review, and revision.

At the end of the studio cycle, when participants felt comfortable with the project and their co-designers and when the main activity became production and presentation work, near-synchronous tools such as instant messengers, became important.[1] In the case of the MIT/Miyagi University Workshop #2, the students used instant messaging systems to keep in close contact and sent short messages to each other intermittently while they worked individually.[2]

4.1.2 Awareness Tools

Lave and Wenger argue that in apprenticeship situations, social learning occurs through "legitimate peripheral participation"[3] in communities of practice. In the studio, design learning results from focused critiques by an instructor as well as from being in the studio context surrounded by design objects and activities. Tools, such as webcameras, buddy lists, and notification systems, can give remote collaborators the opportunities to peripherally participate in distant creative contexts by maintaining awareness of remote people, places, activities, and their common projects.

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[1] I call instant messaging systems to be near synchronous because they may be used for both synchronous and asynchronous conversation depending on the situation and the accepted norms of the group. For example, I have used instant messaging systems like ICQ for fast paced synchronous dialogue and I have also used it to leave asynchronous messages waiting for the recipient to log in. Depending on the accepted norms of the groups, I may respond immediately to an instant message or I may choose to reply at a later time, as with using email.

[2] Synchronous systems, such as videoconferencing, chat rooms, or application sharing programs, require full attention. In contrast, users of instant messengers can focus on other activities while receiving intermittent messages.

[3] Lave, Jean and Etienne Wenger. 1991. *Situated learning: Legitimate Peripheral Participation*, Learning in Doing: Social, Cognitive, And Computational Perspectives. Cambridge: Cambridge University Press.

In the later case studies, we used these tools extensively to maintain continuous awareness of distant locations. We used webcameras for visual awareness of people and places. It allowed opportunities for spontaneous interactions such as the drop-in deskcrits during the MIT/XeroxPARC studio. In the MIT/Lisbon/Oporto charrette, the webcameras gave a method for team members to find distant partners for quick inquiries and unplanned group meetings. For these student collaborators, it was also a mechanism to maintain an informal and playful studio environment with visual bantering.

Webcameras were also used for context awareness to supplement synchronous events such as deskcrits and reviews. During both MIT/Miyagi University Workshops, we used auxiliary cameras to give a sense of place to our remote colleagues. During the final review of the MIT/XeroxPARC studio, we used webcameras to show a visual overview of the event so outsiders could peer into the room through the Internet.

In the MIT/Miyagi University Workshop #2, we used buddy lists to allow members to know when their remote colleagues were online and available for interruptions. The students used these lists to find teammates as well as instructors. Even without initiating a message, the students and instructors used the buddy lists to monitor the presence of other studio members and gained the security of not feeling alone while sitting physically alone in the studio. Coupled with instant messaging systems, buddy lists allowed quick access to all the studio participants.

Also in the MIT/Miyagi University Workshop #2, we used a notification system, within ArchNet, in which participants were notified when additions were made on their group workspaces and discussion areas. For example, when a team member placed a new drawing onto the group's pinup board, all his teammates received a notification email. The notification system kept the team coordinated and updated on the progress of the design. These mechanisms for continuous awareness helped to maintain important contacts between synchronous events.

4.1.3 Design Process and Product Capture Tools

Communication and collaboration in the design studio are concerned with the exchange of ideas by presentation of textual and graphic materials coupled with verbal dialogue. It is about showing and telling. Providing accessible and appropriate tools for capturing, storing, and intelligently retrieving design products and the processes that lead to them were important functionalities for showing and telling in our remote collaborative environments.

For synchronous interactions, it was important to have a variety of visual channels to transmit different views of the design objects in order for the long-distance participants to assemble an adequate understanding of the remote activities. Depending on the needs of a specific event and type of project, they included (Figure 3):

- a portable video camera to capture large physical models or drawings;
- a small lipstick camera to enter into these physical models;
- a document camera to show smaller sketches and models;
- a face camera to capture expressions of particular people, such as presenters and critics, and
- a camera to show an overview of the event for context awareness.

For asynchronous interactions, it was important to have:

- readily available digital cameras and scanners to capture the intermediate stages of the design proposals making for easy submission onto digital pinup boards;
- accessibility to 3D printers to fabricate identical physical prototypes at each location from a single CAD file, as we did in the MIT/Miyagi University Workshop #2; and

- facility to capture the "process ephemera"[4] of reviews and deskcrits which supplement the learning process by recording and indexing the interactions between students and critics for later viewing by the original participants or other studio members, as in the MIT/XeroxPARC studio.[5]

| a. Face camera | b. Document camera |
| c. Lipstick camera for models | d. Lipstick camera used for documents |
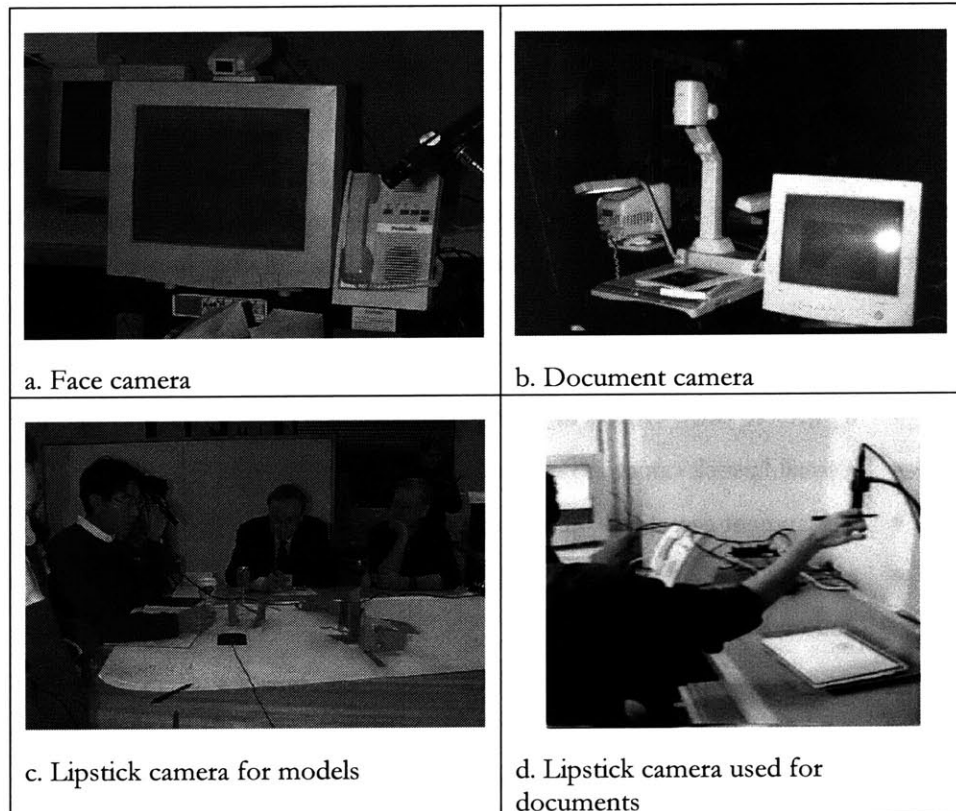
Figure 3: Face camera, document camera, and lipstick camera.

It was only when we assembled and customized the individual technologies into an integrated setting that we experienced the true collaborative power of a VDS environment. To build such an integrated setting, it was important to understand the subtleties of interactions between people and design materials at different stages

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[4] "Process ephemeral" was the term used by the XeroxPARC researchers to describe the important but fleeting interactions during a deskcrit.
[5] The instructor may be reminded of his own comments to the student and the student may review and reframe the criticism of his instructor at another time and with other people.

of design activities, the capabilities of the technologies, and the particular physical and social contexts in which the technology was to be integrated. Most importantly, it was essential to listen to the participants and to understand their needs as the VDS progressed.

4.1.4 Overcoming Technological Barriers

From lost connectivity to lost files, from muffled audio and low resolution images to incompatible cables, we felt the limitations of the technology; hardware, software, and bandwidth. Regardless of the suite of technologies being deployed, we confronted technical difficulties. With some patience and technical experience, these problems could be easily resolved. Moreover, with time and new technological developments, these limitations will disappear. Already in the duration of these case studies, we saw tremendous technical advancements as we used upgrades to existing collaborative software, acquired new hardware devices, and experienced faster and easier connectivity. With each new affordable and commercially available collaborative technology, we assembled a better suite of tools to facilitate our long-distance design activities. These improvements will continue.

However, simply assembling telecommunication technologies and placing them in the studio environment does not result in the participants' appropriation of them in their everyday activities. How can we encourage the use of telecommunication technology in the studio? What technical characteristics of the VDS environment are needed to encourage the use of collaborative technologies?

Vitruvius' remarked that successful works of architecture displayed characteristics of firmness, commodity, and delight. We can use the same criteria to evaluate the technical environment of a VDS and to help encourage its participants to appropriate the new setting. In other words, the VDS environment should display:[6]

- firmness, where the technology is stable, reliable, and robust;

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[6] Bill Mitchell and Mitch Kapor, in their MIT seminar "Digital Communities" in the fall of 1994, first used Vitruvius' criteria for good buildings to evaluate software.

- commodity, where the technology shows its usefulness; and

- delight, where the participants enjoy using the technologies.

Firmness

In our experiences, the first step in encouraging the appropriation of a VDS environment was to ensure that the technologies were stable, reliable, and robust. Are the technologies readily available? Do they work? Do they work consistently? VDS participants' first encounter with the technology was especially important because it made an initial impression of its firmness. When participants' first impressions were positive, they were more likely to try to accept the technology into their own practices.

The technological firmness of a VDS relied not only on the technologies of one site, but it relied heavily on the capabilities of each of the individual partner institutions. Does each collaborator have adequate technical support? Are the hardware and software used on each side compatible or complementary? Reciprocity helped to avoid technical problems and streamlined the collaboration process. For example, this technical reciprocity was apparent in the MIT/Miyagi University Workshop #2 where similar physical locations were connected with compatible software and hardware and supported by an experienced technical staff. This was an important factor in creating a stable VDS environment.

Commodity

Studio participants were more likely to embrace a VDS environment if they could clearly see its value. The suitability, flexibility, and integration of the collaborative technologies in the studio determined its technical usefulness.

In terms of suitability, how well does the suite of technologies match the needs of the collaborative task and the skills of the group of collaborators? In terms of flexibility, how easily can the participants modify the suite of technologies to accommodate different learning styles, scenarios, and design media? In terms of

integration, how well are the technologies grouped together to serve the VDS participants? The technology should facilitate the collaborative process not hinder it. They should support design events and activities with varying levels of:

- privacy
- formality
- interactivity
- spontaneity

Suitability, flexibility, and integration should be found in:

- software
- hardware
- physical location of the technology

Are the functionalities needed for a collaborative activity seamlessly integrated into one application and platform or are they spread over different programs, machines, and spaces? An integrated set of suitable and flexible functionalities helped the collaborative process in our cases. For example, the integration of a chat system, a discussion area, a pinup space, and file storage site in ArchNet and used in the MIT/Miyagi University Workshop #2 facilitated the collaborative process by offering a single entry to all the needed communication functionalities. It provided a shared space for synchronous and asynchronous interactions with user-defined privacy controls for a variety of individual and group design activities. At the end of the project, it also served to be a nice archive of the process and products of the workshop.

Location also mattered. The physical space in which the VDS participants interfaced with the technologies and interacted with their remote colleagues determined the tone of the collaboration. For example, when the virtual deskcrits were brought back to the informal and intimate surroundings of a student's desk in the studio, there were more frequent, relaxed, and spontaneous long-distance interactions

(Figure 4). The location of the monitor displaying a remote critic during a review also mattered. In the earlier cases, we placed this monitor with the presenters. This emphasized the remote critics as more prominent than the other local critics. One local critic thought that the monitor became a distractingly part of the presentation. In the later cases, we moved the mediated critic back into the audience where he became simply part of the jury and the focus was returned to the presenters and their work (Figure 5).

a. Deskcrit in formal room	b. Deskcrit in the informal studio
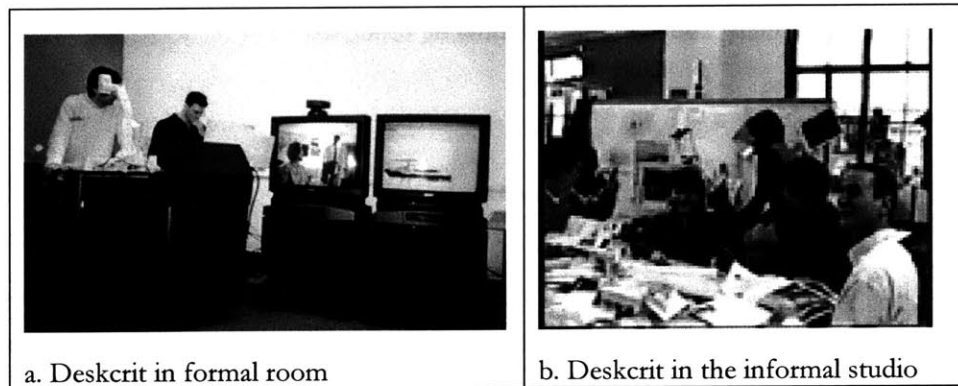
Figure 4: Location of the technology determined the formality of interactions.

a. Remote critic awkwardly part of the presentation	b. Focus returned to presenters when remote critic returns to the audience
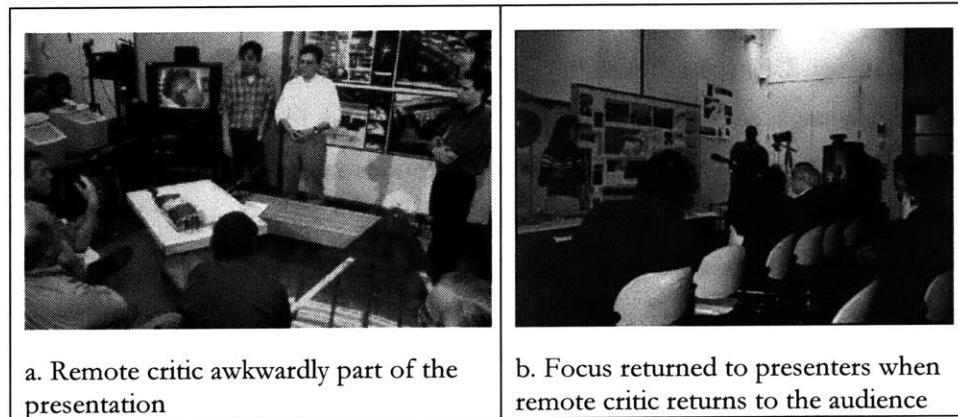
Figure 5: Location of the monitor displaying remote critics changed the focus of the review.

Delight

Delight in the use of technology has an important role in its appropriation. In our cases, when studio participants enjoyed using the telecommunication technologies

for their everyday activities, they not only made the new technical setting their own but they also helped to push the development of new technical set-up by pointing out, sometimes loudly, the technical shortcomings of the environment and even by enthusiastically modifying the technology themselves.

We have tried to make the technologies enjoyable to use by encouraging:

- group use;
- playful and informal use; and
- opportunities for self-representation of individuals, teams, and institutions.

For example, group use of the collaborative technologies in the MIT Interdisciplinary studio encouraged students to help each other in mastering the technology and to feel comfortable and confident in the new technical environment. The chat systems and webcameras allowed students in the MIT/Oporto/Lisbon charrette to play with the technologies as they communicated informally with their remote teammates. The individual and group workspaces in ArchNet gave students freedom to express and represent themselves to their teammates and to a broader audience.

4.2 THE NEW VIRTUAL DESIGN STUDIO

In our series of cases, the virtual design studio slowly evolved with each successive appropriation of telecommunication technology. We experienced incremental changes in the social system of the design studio that could improve design learning. They included explicit and implicit changes in the participation and relationship of studio members, the content and processes of design work, and the events and their organization (Figure 6).
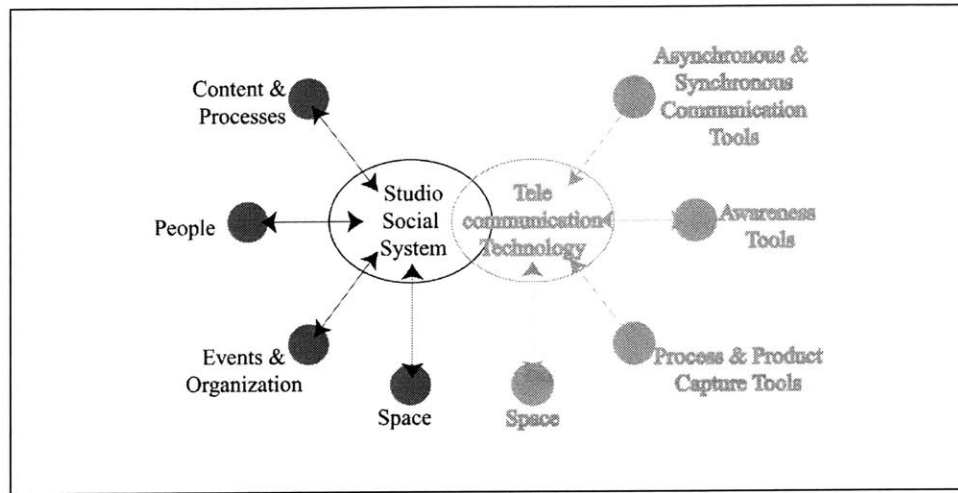
Figure 6: Studio social system components.

4.2.1 New Studio Membership, Roles, and Relationships

Telecommunications technologies help bring people together. In the virtual design studio, they helped to bring new participants into the design process. These new players, from students to superstar practitioners, brought with them new expertise and created new roles and relationships as well as altering existing ones. The new membership of the VDS was both the most interesting and the most challenging to manage.

Bringing new kinds of participants to the design studio was the first-level efficiency effect of telecommunication technology. It was considered more efficient because the technologies assembled experts from distant places. It saved travel time and costs while allowing participants to be involved in multiple distributed projects yet still remaining physically in their respective home-bases. This was particularly important for prominent practitioners or "superstars" such as in the cases with Frank Gehry and Alvaro Siza. In our studies, we have brought different students, instructors, critics, consultants, and clients together. Figure 5 summarizes the types of new participants that have been introduced by the VDS. They have been introduced through computer-mediated visits or combined physical and virtual visits. Some remote participants entered into the studio on a one-time basis, such as

a guest critic at a final review, and others were connected throughout the entire studio, such as a remote instructor or remote groups of students.

With the addition of these new participants, studio members took on different and multiple roles in the learning process. This was the second-level social system effect of using telecommunication technologies in the studio. The remote setting altered the studio context and provided opportunities for building new relationships and adjusting old ones to accommodate the varying levels of participation of the new members.

Cases		Additional Participants:	Students	Instructors	Critics	Consultants	Clients
1	Harvard/UBC Project		▒	▒			
2	MIT/Cornell Virtual Jury				▒		
3	MIT Interdisciplinary Studio		█			▒	
4	MIT/Kumamoto/Kyoto Workshop		█		█		▒
5	MIT/XeroxPARC Studio			█	▒	█	
6	MIT/Oporto/Lisbon Charrette		█	▒			
7	MIT/Ford Charrette						█
8	MIT/Miyagi University Workshop #1			█	█		
9	MIT/F.O.Gehry & Associates Studio			█	▒	▒	█
10	MIT/Miyagi University Workshop #2		█	▒		█	

Legend:	
	No additional participants
▒	Little or intermittent participation
█	Sustained participation throughout the studio

Figure 7: Types of new studio participants

Multiple Roles for Learning

With new studio members, there were new explicit and implicit roles. In the first cases, such as the MIT/Kumamoto/Kyoto workshop, we made explicit task roles

for the students to facilitate coordination and communication between the remote sites. During the MIT/Cornell Virtual Jury, new roles such as the technical director and the review coordinator were needed. In the later cases, such as the MIT/Oporto/Lisbon Charrette, instead of pre-determined roles, the students developed their own roles and responsibilities depending on their individual and collective expertise. In that project, a teaching assistant's role of a cultural interpreter helped to reconcile differences in cultural understanding. In the MIT/Ford case, the students took on the role of designer to a client group made up of ninth graders and their teachers. In the MIT/Miyagi University Workshop #2, the students took on the role of teacher to their teammates and developed a situation of hierarchical learning similar to that found in the *ateliers* of the Ecole des Beaux-Arts.

In these studies, the student no longer had a static role, but he gained experience from shifting perspectives between multiple roles and responsibilities. Design learning occurred then in this dynamic negotiation and experimentation of role making and role-playing.

Building and Adjusting Relationships

With new roles came new relationships between the studio members. In the cases where there were remote student collaborations, such as the MIT/Kumamoto/Kyoto, MIT/Oporto/Lisbon, and the MIT/Miyagi University Workshop #2 projects, the students learned to build cohesive relationships, to develop common design languages, and to manage time, technical, and human resources that could sustain an environment for effective collaborative design.

Instructors also had to make adjustments to their relationship with students in cases of co-teaching, such as in the MIT/XeroxPARC project. We saw redefinitions of the mentor-student relationship where the instructor was no longer the sole master of the studio but he became part of a team of design coaches with complementary expertise or opposing views. At the worse case, the power struggles caused conflict in the studio, but in the better cases, having multiple coaches helped the students to

integrate expertise, negotiate between different views, and observe instructor-instructor interactions that help to explode the master-mystery relationship sometimes found between students and their studio master.[7]

4.2.2 New Studio Content and Processes

How has the use of telecommunication technologies affected the content and processes of the studio? In our cases, we saw changes in the types of design problems specified, the types of group work processes required, and the kinds of design discussions and negotiations generated. These changes have encouraged students to share ownership of design ideas and products as they collaborated with others, to reflect on their individual design practices, and to actively seek and acknowledge influences from other cultures and disciplines. These studios also permitted new connections with external educational programs and professional practices.

Types of Design Problems

The choice of design problem for a VDS may be independent of the technologies such as in the MIT/Kumamoto/Kyoto and MIT/F.O. Gehry & Associates projects. However, some of the problems, such as in the MIT/Oporto/Lisbon and the MIT/XeroxPARC cases, were specifically designed so that the students' could reflect on their own experiences in using the technology and apply them to the design problem. The relationship between the student and the technology was no longer simply instrumental, that is, to use the technology to connect to remote partners, but the students used their own process of appropriating the VDS environment to reflect on and to inform their designs and their act of designing.

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[7] Imagine the design student who is confused by his instructor's teachings. He traditionally has nowhere to turn except for his peers who may be equally stuck. In the new virtual studio, he may ask the additional remote experts for their interpretations of the situation. The remoteness may give the right amount of distance for the student to ask for this kind of assistance.

Group Work

Our VDS cases provided the students with opportunities for group work, either collocated in there own studios, remotely with distant students, or in combination. The collaboration changed the nature of the relationship of the student with his design product and process by requiring him to share authorship and acknowledge different perspectives and influences on the project.

The collaborative process also illuminated the design process. If we think of the individual design process, as Schön did, as a dialogue with our design material, then collaboration in the studio gives more voices to this conversation. The "back-talk" from the drawing is the process that a designer uses to reframe the design and to see it in a different light. In collaborative situations, this internal "back-talk" process is externalized since the designer must take it out of his head and into the negotiations with his design partners. It made this "back-talk" more apparent to the designer as he tried to communicate this most intimate part of his design process to his remote collaborators.

Group work placed an emphasis on negotiating design decisions. When these negotiations were between remote collaborators of different cultures or disciplines, methods of reframing the design were grounded in cultural traditions and norms and reinforced by a strong local community of participants. The MIT/Oporto/Lisbon case was a project that focused on culture-based interpretations and provided opportunities for critical design discourse. This discourse challenged the students' assumptions about people, places, and design and made them reflect on their design practices and learning relationships with each other and with their design coaches.

Parallel Curriculums

Computer-mediated studios provided opportunities for students to connect with other students from different departments inside and outside their host institution. These partnerships, such as in the MIT Interdisciplinary studio,

MIT/Kumamoto/Kyoto, MIT/Oporto/Lisbon, and the MIT/Miyagi University Workshop #2 cases, required the different programs to find common educational goals and methods in developing joint projects that could benefit and motivate every student. Designing parallel curriculums that add value to the educational process needed intense instructor collaboration and an inclusive studio atmosphere.

Connections with Professional Practice

VDS projects with design practitioners and their offices helped to make important connections between academia and the profession. Projects such as the MIT/F.O. Gehry & Associates case gave students opportunities to work and build relationships with practitioners and peripherally participate in their remote social environments. Throughout a student's career, he may have multiple and simultaneous experiences working on collaborative projects with distant design firms. The VDS also gave opportunities for practitioners, with their own repertoire of human and material resources located in their office, to be part of the learning process of students who may potentially be part of their design firms in the future. If client groups came into the scene, the virtual mentorship would be enriched as the student observed and learned from a practitioner's interactions with a client.

4.2.3 New Studio Events and Organization

The integration of telecommunication technology into the events of the studio began by trying to emulate face-to-face meetings. In doing so, we evolved technologies and developed practices that reconfigured these events with their own mediated characteristics, activities, and rituals. The new activities and technologies provided new learning opportunities during the final reviews, informal deskcrits, and in the everyday organization of the wired studio. Web-based presentations and critiques encouraged focused and thoughtful feedback and accommodated different learning styles and relationships.

Web-based Reviews

Final reviews are performances where design proposals and ideas are challenged and debated. Although the reviews often last hours, the intensity of the discourse is ephemeral and the educational value of the event is short-lived. In our cases, the virtual final review using Web-based presentations and associated asynchronous discussion forums extended the discourse and learning opportunity beyond the timeframe of the actual review. In the MIT/Cornell Virtual Jury case, the students took control of their synchronous design reviews by preparing coherent and well-organized Web-based presentations. Design work prepared in advance for the Web provided opportunities for:

- pre-review study of the design proposals by the jury who could formulate focused feedback and project comparisons prior to the actual review;

- post-review on-line reflections by the students and instructors to clarify and continue discussions from the event; and

- automatic archiving of the design materials and associated Web-based critiques.

If these final reviews were also broadcast live on the Web or recorded and indexed for later viewing, the discussion would be accessible to more participants encouraging unexpected critics to join the discourse.

Asynchronous final reviews could accommodate a range of communication and learning styles and scenarios. Imagine the quiet student who would never share an opinion during a formal review setting, but would more comfortably post a well-written critique online. Or imagine the design practitioner, absent from the actual review, watching the video proceedings of the review with his student and using it as the basis of their remote deskcrit session.

Recorded Informal Deskcrits

In the MIT/XeroxPARC studio, we saw how recording and indexing technologies could enhance design learning by capturing informal deskcrit interactions that could

be later used for clarification or reinforcement by students and instructors. This placed emphasis on the designer's interactions with people, making design communication and negotiation an important part of design, just as significant as the design product itself.

Charrettes and the Wired Studio

The everyday activities of the VDS needed strict coordination to accommodate the different time zones, schedules, and work ethics of the new remote participants. The students learned to manage their human and production resources, especially during the charrettes. The student design teams organized their time, expertise, computing power, and specialized equipment to take advantage of each member's skills and each location's tools to work around the clock effectively.

The highly organized and coordinated work schedule was balanced by the playful long-distance camaraderie that the students displayed synchronously, asynchronously, and through technologies for awareness. In cases such as the MIT/Oporto/Lisbon charrette, the opportunities for socializing helped the members to build trust and coherence within their teams and to informally establish work relationships and a team spirit that allowed them to experiment with and reflect on different collaborative design techniques.[8]

4.2.4 Overcoming Social System Barriers

During our VDS case studies, the studio's social system was constantly being challenged by new technologies and new ways of organizing people, processes, and events. Compared to the technical difficulties encountered, the social barriers were much more difficult to overcome, but it was precisely the resolution of these social system challenges that could make the studio a more powerful place for learning.

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[8] Some design teams worked on different sections of the design and then came together to work out the overall. Some teams designed in relay format where the design was passed from member to member for individual elaboration. Other teams designed in an internal competition where all members worked on the same aspect of the design and one proposal would be selected for further development.

The social barriers included power struggles, conflicting visions of collaboration, differences in design approaches, cultures, work ethics, and curriculums, and incongruities in motivation levels, award incentives, and financial and technical support. These challenges exist on the individual, studio organizational, and institutional levels.

Individual Level

One of the biggest challenges of the VDS was to instill a mindset that valued the idea of remote teamwork. Students and instructors who were accustomed to working individually in the safe and insular environment of their studios did not welcome the new setting that required collaboration. In theory, the students and instructors understood that practical design work was a group effort and that skills for remote collaborative design were important for entry into the future design workforce, but in practice if the technology and its social system changes felt like intrusive interventions into their well-established practices, then the VDS setting would be underused or rejected.

Teamwork is simply difficult even in the best settings with the best collaborators. Teamwork for remote participants with different levels of motivation, enthusiasm, collaboration skills, and design competences was even more challenging. Technology helped by providing accessible, suitable, and flexible communication capabilities for the studio members to have freedom in expressing and representing themselves. Although the technologies helped in the *process* of the collaborative efforts for our case studies, the actual *practice* of teamwork differs from case to case according to the individual team members and their visions of collaborative learning. Some general strategies we used to encourage the members to build a collaborative spirit included:

- integrating and introducing telecommunication technologies and new remote practices incrementally within a studio so that the existing social environment could evolve slowly;

- introducing complex and interesting design problems that all studio members could acknowledge as ones that could be better solved by remote cross-disciplinary and cross-cultural collaboration than by any individual efforts;

- making explicit the educational advantages of remote group work for each individual; and

- encouraging informal interactions and relationships that keep members motivated, interested, and coordinated in the collaborative design process and the design project.

Studio Organizational Level

On the organizational level, the eclectic assembly of people from around the world posed communication, coordination, and collaboration problems. Communication challenges due to natural language barriers were met with computational and human translators. Coordination problems due to time zone differences between geographic locations forced students to learn to manage their time better and take advantage of asynchronous communication tools for a continuous work cycle. Collaboration difficulties due to differences in experience level, domains of expertise, design cultures and approaches, and curriculum requirements were overcome by encouraging students to take on explicit roles, such as webmasters or coordinators, or to try different and multiple implicit roles, such as designers, facilitators, negotiators, peer teachers, clients, site guardians or cultural interpreters, as needed for the collaboration.

In our cases, an effective remote studio organization began with the collaborative efforts of the teaching, research and technical staff. By expressing their pedagogic solidarity and mutual respect, a collaborative spirit was conveyed to the students. Some organizational strategies used to encourage appropriation of the VDS environment were:

- introducing new members, including remote students, instructors, and clients, who were viewed as valuable to the overall learning process by all the studio participants;

- forming design teams that leveraged differences in expertise, language, design approaches, and culture;

- providing activities that combine individual work with group work;

- designing events in which participants used their existing communication skills to scaffold new ones; and

- giving freedom to members in taking on different and multiple roles, perspectives, and responsibilities within the design team.

Institutional level

VDS can help cross institutional boundaries and enter into uncharted educational territories. Many of the cases in our series began with personal relationships with remote participants and were conducted with the efforts, enthusiasm, and motivations of talented, dedicated, and experimental individuals with little support on the institutional level. When these projects were interdepartmental or involved multiple schools or professional practices, the challenges were compounded by institutional differences. Difficulties included academic calendars that began at different times and had varying durations and curricular goals, practitioners with demanding schedules and commitments, and institutional incentives and grading systems focused on individual competences rather than collaborative skills.

How are the individual students judged, graded, and credited? How do we develop sustained synergies between various disciplines and institutions? What incentives do faculty members have to develop collaborative curriculum? What incentives do design practitioners, especially recent graduates, have to maintain ties with educational institutions and to play a role in design education? How should content, process, and reward systems be developed to give benefits to all parties?

If remote collaborative design learning is to be fully integrated in design education, these basic questions need to be addressed and institutional mechanisms need to be established to help VDS participants to:

- gain recognition for their collaborative efforts, dynamic learning strategies, and creative experimentation;

- receive financial and technical support to conduct and maintain collaborative projects;

- access technical and organizational knowledge accumulated from previous collaborative projects;

- initiate, develop, and maintain long-distance relationships for learning and research beyond a particular project;

- maintain an overall social infrastructure that allows participants to discover and take advantage of unanticipated connections; and

- sustain a sense of belonging to a design community that provides challenging and creative learning opportunities.

Chapter 5
CONCLUSION
Building Design Communities

Chapter 5: Conclusion

Building Design Communities

Telecommunication technology can provide new opportunities for design learning. The opportunities begin by using the appropriate technology to bring new participants to the studio process. In the best cases, this new membership broadens the scope of learning and reshapes the social system of the studio in ways that can enrich design education. With new participants, both inside and outside the studio, traditional power structures and learning relationships in the studio are reconfigured giving students the flexibility and motivation to develop multiple roles and perspectives. The new relationships help to generate creative topics of inquiry, new collaborative learning practices, and new methods of design investigation, exploration, and evaluation. The new content, methods, and practices find their way into studio events, such as reviews, deskcrits, and charrettes, and enhance them as students learn to collaboratively negotiate multiple viewpoints, cultural biases, time zone differences, and various approaches to design, work ethics, and technology appropriation. Telecommunication technologies can also provide complementary digital spaces that connect and alter existing physical spaces creating hybrid places for these studio events in which creative design practices may flourish.

These learning environments and opportunities do not come easy. They require special reciprocal coupling of the technology and the particular community of practice it is intended to serve in order to allow both the technology and the practices of the members of the community to develop together. Achieving this reciprocal relationship is difficult and requires talented, dedicated, and ambitious participants who intimately understand both the technology and the community.

During our series of case studies in computer-mediated design studios, we experienced the new opportunities as well as the accompanying challenges of finding and developing our own individual and collective grounding in the new virtual environment. As we navigated the new territory, we made incremental

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changes in both the technology and the studio's social system. We assembled a suite of technologies and observed it evolve according to the needs of the studio and, conversely, we experienced changes in the studio's social system as the technology was integrated into studio practices. As we gained experience with the new virtual studio, the technology and the social system of the studio became intimately intertwined and inseparable. The functionality of the technology became the social system as it gave structure to the events and activities of the studio and encouraged certain behaviors, interactions, and design practices while limiting others. The social system became embedded into the technology as we determined its evolution by appropriating it in new and unexpected ways. Ultimately, the technology and the social system combined to form the virtual design studio with its own unique characteristics (Figure 1).
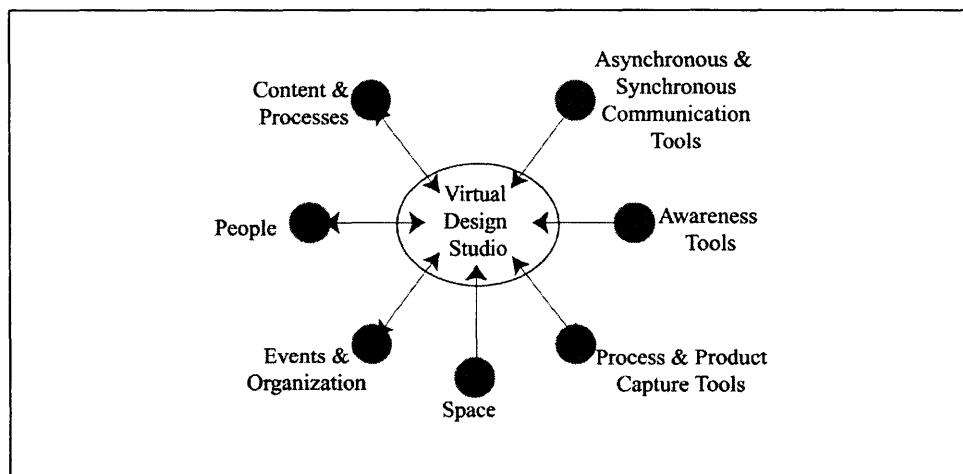
Figure 1: The virtual design studio emerged from the strong symbiotic relationship between telecommunication technology and the social system of the studio.

As the virtual design studios continue to mature with new advanced technologies and experienced participants, they will become common in both learning and professional settings. In fact, they may help to bridge the gap between design education and practice by creating combined environments in which boundaries of school and work are blurred and professional life-long development is possible.

When we eventually view the specialized virtual design studios as simply generic everyday design studios, how will they continue to add value to design learning? What new strengths shall we leverage? What new opportunities and challenges will they bring? What kind of new research questions will we be asking? One way of approaching these questions is to situate the experiences from our virtual design studio cases into a continuum that ultimately leads to the construction of creative communities for learning and practice.

5.1 The Continuum: From Exchanging Files to Building Communities

To understand the broader significance and application of virtual design studios, let's consider the series of cases presented in this study as part of a continuum for developing valuable long-term learning environments. The cases, as they increased in technical and social complexity, highlighted the path we built and navigated to arrive at the current virtual studio. Along this path, different communities emerged, ranging from loose networks to tightly woven groups with common interests, understandings, and goals achieved through joint design activity and mutual learning. It began with environments in which participants exchanged files and shared tools – the focus was on leveraging technical capital. Later, we evolved these environments into ones where members could feel a sense of purpose and belonging to a community – the emphasis was placed on leveraging social capital.

Exchanging Files

At the beginning of our series of case studies, we were concerned with the possibility of long-distance design work. Could we successfully conduct virtual design studios at all? We assembled a suite of technologies that allowed studio participants to exchange files safely, quickly, and efficiently. The emphasis was placed on the technology and how technical functionalities could increase productivity.

The important network was the one that connected fast and reliable machines with high bandwidths. The success of the virtual studio was measured by the degree with

which design correspondence could be delivered immediately and precisely by the technical infrastructure.

Collecting Information and Sharing Tools

Next, we became concerned with the content of these files. The success of the virtual design studio relied on the quality and accessibility of design information and tools to be shared and collected. How could we find relevant references to inform us about our work? Could we post our own information or design work to share with others? Could we locate rare and unique software and hardware to help us visualize and interact with our design work? The emphasis was placed on the material resources, their delivery and retrieval, and how the material could help us be better informed as we designed. These resources included digital collections of books, journals, images, and CAD models contributed by individuals and institutions from all over the world, such as the digital library found in ArchNet, as well as a distributed assemblage of special programs and machines to support design, such as expensive three dimensional output devices and analytical tools.

The important network was the one that connected extensive databases of design materials and gave access to specialized design simulation tools and production equipment.

Assembling Experts and their Environments

With an increasing amount of design material and equipment, not all equally reliable or useful, it became important to know and understand the individuals behind the information and the tools: the design experts. Successful virtual design studios were attributed to the people assembled to share their particular expertise on complex problems. How can we bring together dispersed design experts to contribute enthusiastically and consistently? What kind of environment engages remote participants to interact with each other and with the design material in meaningful ways?

When these experts were electronically connected from their respective workplaces, the collective skills and resources found in each distributed environment accompanied the individual expert, making an even larger pool of experts from which to draw. The emphasis, then, was placed on personal interactions and establishing technology and social protocols for people to communicate and cooperate for reviewing designs and sharing technical knowledge.

The important network was the one that connected specialized experts and their technical expertise and individual resources, both human and material, from their physical environments into a global talent pool.

Designing Together in Project-Based Communities

Assembling experts into loosely connected networks, however, is not enough to build intellectual and social capital. Although the group of global experts may have common interests and practices, they often have different goals and traditions. How can we bring these loosely associated experts into working relationships to take advantage of their individual talents and to create new intellectual resources? To go beyond networks of experts, we began to conduct virtual design studios to try to build purposeful tightly knit communities of practice through collective design activity. Many of our cases required long-distance participants to share their expertise, collect information, and exchange files in order to work on collaborative design projects. The challenge of complex design problems was the catalyst for bringing talented and enthusiastic people from different places, disciplines, and cultures to work together in creating sensitive design solutions that could not be conceived by any one individual. Although the success of virtual design studios was often measured by the quality of these design proposals, the real educational value of the new studios lived in the intense collaboration and negotiation between remote participants with different cultural backgrounds, technical expertise, and design approaches. Together, they engaged in vigorous critical discourse leading to thoughtful design solutions.

The emphasis was no longer placed solely on the technology, the information, or even the specific results, but it was placed on the people, their collaborative efforts, and the production of new knowledge through collaborative design projects. The important network was the one that connected different people, with their unique design insights and sensibilities, into a design community that cultivated its own practices, rituals, and spirit through collaborative creative work.

Further research may be conducted to refine these project-based communities. For example, we may continue to develop new collaborative and educational technologies to help bridge the distance between participants or we may find new social protocols or organizational strategies to enhance collaborative learning and team building in the studio or we may explore different designs of the physical space to support a digitally mediated studio workplace. These are all important directions to deepen and reinforce our technical, social, and educational understanding of virtual design studios.

No matter how elaborate or refined these project-based virtual studios become, the short lifespan of the communities that they create still remains as an important limitation. As we experienced in the case studies, much time, money, and care is taken to initiate geographically distributed studio projects and the participants devote much energy to create a set of coherent design proposals as well as to build up productive working relationships and a distinctive team spirit. However, the collective design knowledge, located in the members' design materials as well as in their relationships, is often lost after the end of each project. Without the challenge of a concrete design problem, participants interact less and those social relationships, so carefully, and often painfully, crafted and nurtured during the projects begin to weaken. These small-scale communities of practice, however strong and vibrant during the intensity of design activities, are difficult to maintain for the long-term.

Another way, then, to continue this research is to use the experience gained from our project-based communities in the virtual design studio to create large-scale sustained communities of learning in which intellectual and social capital may be leveraged, maintained, and actively developed.

Large-Scale Learning Communities

We may consider large-scale learning communities to be the larger framework in which our smaller project-based communities are situated. As an umbrella educational environment, these larger communities then should provide a large technical and social infrastructure to encourage opportunities for many different types of learning situations and styles, collaborative virtual studios being just one of them.

What kind of overall environment needs to be maintained to encourage long-distance participants to initiate creative collaborative projects and continue cooperative ties after completing projects? As a starting point, we may hypothesize that the same general principles for encouraging and sustaining a small-scale community in virtual design studios could also be important for these large-scale learning communities. For example, the technical infrastructure, although much more complex, still needs to be stable, robust, and reliable. The system functionalities also need to be suitable to the needs of the particular participants, flexible enough for a variety of learning styles, projects, and types of interactions, and integrated for easy access into the digital community. The larger scale, however, requires more institutional support than our smaller virtual studios in terms of technical maintenance as well as new incentives and programs for individuals and groups to enter into the collaborative projects that cross departmental and institutional boundaries.

For these large-scale learning communities, it will be important to maintain an infrastructure for a large, permanent, and diverse membership that provides enough critical mass to develop valuable social capital. What are the social mechanisms that

attract members and hold their interest and loyalty in the digital community? They may be very different for different learning communities and the best way to determine them is to gain practical experience in these situations. However, we may begin by understanding why a student might join a particular university campus or why an *aspirant* joined a certain *atelier* at the Ecole des Beaux-Arts. He becomes a member of these place-based learning communities not only to gain technical competences, but he joins them and stays in them because the people and atmosphere are enjoyable and productive and the social interdependencies are strong. The setting has unique opportunities to associate and interact with a diverse, dynamic, and sometimes prestigious group of people and their intellectual products. It is precisely this intellectually stimulating atmosphere that keeps scholars on campuses and designers in the *ateliers*. Digital environments with these characteristics may provide the appropriate initial setting to build opportunities for collaborative cross-disciplinary and cross-cultural projects. Interactions during these projects set the foundations for establishing group trust and a sense of belonging, that in turn help to sustain a community in between these active projects.

Understanding the technical, social, and organizational characteristics of large-scale learning communities is important if we are to live up to the hype of long-distance education and virtual universities. The current focus of virtual education on delivering online multi-media course content and web-based lectures is useful but insufficient in building communities that support critical discussions and generate creative group work, such as those communities formed, but short-lived, in our case studies. If our efforts are directed to building and sustaining these creative communities, opportunities may emerge for developing parallel curriculums between disciplines and institutions, integrating related subjects within departments, and forming long-term alliances with alumni, professional practices, and industry for life-long learning.

Creative Communities for Life-Long Learning

Creative learning communities may be further developed to include participants from outside educational systems. Virtual design studios and sustained digital communities may help to bridge the gap between professional training and practice and design education. These mediated environments may help resurrect the advantages of apprenticeship learning while remaining within the structure of an university system.

Providing a permanent technical infrastructure and institutional and professional incentives for every student to participate actively in the community, even after graduation, helps to build diverse and large-scale networks for life-long learning. Participation of alumni and other practitioners may include taking computer-mediated professional development classes, virtual mentoring of undergraduate students, and reciprocal learning through mutually beneficial creative projects.

As we progress along this continuum, from loose communities exchanging files to large-scale creative communities for life-long learning, we are certain to find new educational opportunities, some of them anticipated, but many unexpected and only conceivable through collective experience and rigorous experimentation.

5.2 Opportunities for Reflections and Visions: From Creative Learning Communities to Creating Identities

Virtual design studios and the possible creative communities they foster can give rise to a variety of opportunities for design learning that impact the everyday activities of the design studio and the relationships of studio members. The most important aspect of the new educational environments, and of the case studies presented here, is the opportunity they give us to stop and reflect on current studio practices and design learning processes. Conducting virtual design studios may help us to critically examine the traditional design studio, to see more clearly both its advantages and limitations, to redefine key learning relationships, to reevaluate content and processes, to reorganize events, and to reconfigure physical and digital

spaces. Since we fundamentally define ourselves by our activities, relationships, and interactions with people, places, and things, we are essentially reflecting on ourselves as learners, teachers, and designers as we examine the studio social system. As Turkle suggests, the technology allows us "to see ourselves differently as we catch sight of our images in the mirror of the machine."[1]

Although using technology for self-reflection is powerful, it is only part of the bigger opportunity presented by virtual design studios: the opportunity to redesign design learning. Technology remains ultimately in the hands of its users. We developed the technologies for the virtual design studio ourselves as we placed requirements on it and appropriated it into our own practices. Since the technology determined and embedded the social system of the studio, we took control of this system by developing the appropriate technology. The benefits of the virtual design studio environment, then, depend ultimately on our own sensibilities to technology design, organizational strategies, and institutional policies that promote our visions for design education. Therefore, the virtual studio experiences not only help us to reflect, but they also give us the opportunity to actually implement our visions for design education, to collectively develop traditions and value systems, and to cultivate a particular professional ethos. Because we construct ourselves through our value systems and learning activities,[2] we are ultimately socially constructing our identities by engaging in virtual design studio experiences.

As we continue to conduct virtual design studios and create digital design communities, we will understand them better, implement them better, and discover more ways in which they may be useful to designers, the design process, design education, and professional practice. Questions will no longer be focused on the virtual studios: Are virtual studios possible? How can we conduct them successfully?

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[1] Turkle, Sherry. 1995. *Life on the Screen: Identity in the Age of the Internet.* New York: Simon & Schuster. p.9.
[2] Berger, Peter L., and Thomas Luckmann. 1966. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge.* New York: Doubleday.

Or even: What educational benefits do they create? Instead, we will focus, more fundamentally, on questions about our own visions and identities as seen through the lens of the virtual studio: What is the future of studio learning and design education? What kinds of identities do we want to create for designers?

Although there are many interpretations and possible futures for design education, the concept, implementation, and practical experience of virtual design studios may promote a collaborative culture in which we may develop and embrace diverse approaches and styles to design learning. I hope that the case studies in this research not only add to our understanding of current design studios and design practices, but that the experiences also contribute to our collective reflections and possible visions for what design education might be and what kinds of professional identities we might want to build for the future.

Notes on Methodology

This research was a qualitative study of computer-mediated design studios in architectural education based on ethnographic observation and iterative design. I approached this research as a participant observer and as a designer. My methods of studying the virtual design studio were those that I have learned and practiced, and essentially grown up in, during my own architectural education. These methods derived from my own "learning-by-doing" as I worked on design projects as a student in the studios of McGill University and Harvard University, as I practiced as an architect, and, more recently, as I taught digitally-mediated design at MIT. As for any design project, my design methods were guided by my own background, knowledge, experience, preferences, judgments, and biases. As a result, the main instrument of investigation in this work was my particular sensibility as a researcher and a designer. This research, then, is an interpretive study of the virtual design studio.

Each Individual Case Study

I considered each individual case as an exploration that would reveal different aspects of the virtual studio and contribute to my continuously developing understanding of the context that would iteratively inform and guide my further explorations. The studio, therefore, was a moving target since it was constantly being challenged and altered by unplanned circumstances and events and by purposeful interventions. I participated in the day-to-day activities of the studio and gathered data as I listened to and observed students, instructors, critics, and clients while they worked in the new remote collaborative learning environments. I recorded my observations, informal conversations, and formal interviews in the studio and videotaped and reviewed the participants' mediated interactions. Interpreting this data gave me a better understanding of the studio context and the participants' relationship with each other and the design materials. This understanding provided a way of seeing the studio that informed the problem-

setting stage of my process. I proceeded to make small and large interventions in the technologies, social organization, or physical environment of the studio. As a result, the studio was continuously tweaked to better serve the remote and local members of the studio and provided a new setting to be observed. This tightly woven iterative cycle of observation, analysis, and interventions constituted the research, and design, process in each case study (Figure 1).
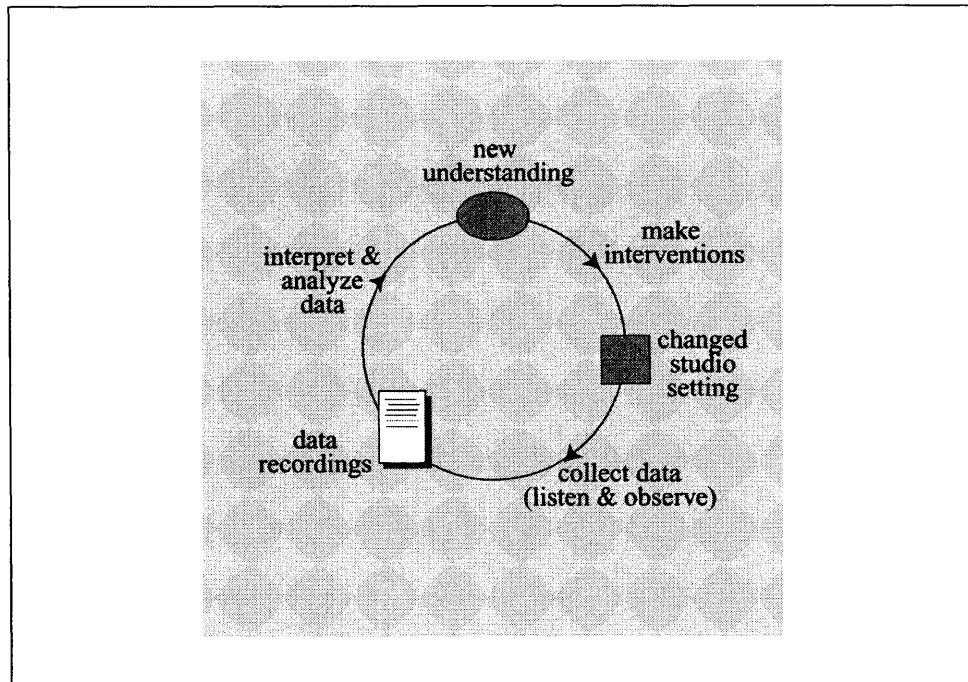

Figure 1: An iterative research process was used within each case study.

The Series of Case Studies

The same iterative design approach was also applied to the series of case studies as a whole (Figure 2). With each new case, a set of observations, interpretations, and insights for understanding the studio contributed to the growing body of knowledge on how to conduct the next virtual studio.
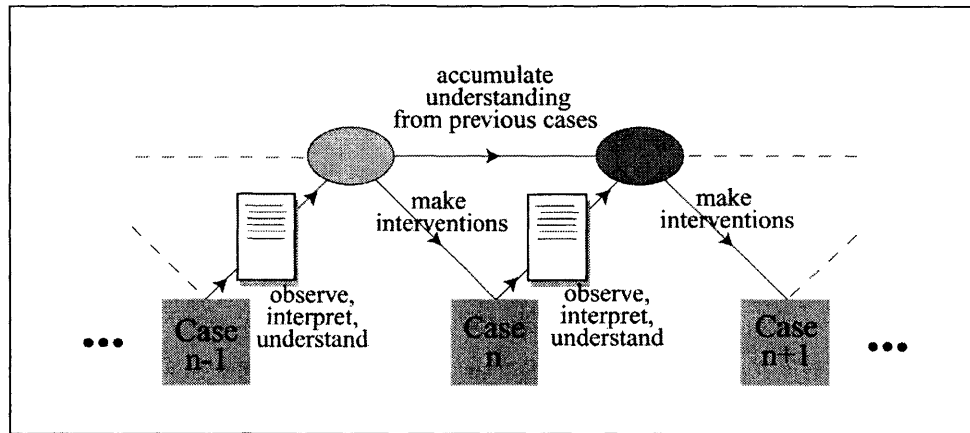
Figure 2: The same iterative research process was used on the series of case studies as a whole, resulting in a collection of insights derived from each new studio experience to be added to the overall knowledge for informing the design of the subsequent virtual design studios.

Each studio in the series was unique in its members, content, and organization and each case explored different long-distance collaboration issues. Some cases focused on the technologies, others gave emphasis to the social organization, and others still looked at particular design activities and events, such as the remote final review and the virtual deskcrit. In considering the series as a whole, these differences were important to give a comprehensive understanding of the new studio.

My own role in each of the studios was also different. In one case, I participated as a student, in another I was an instructor, and in many others I was a teaching or research assistant. My degree of participation also varied from being a quiet observer to an active participant assuming an integral role in the studio as an active advocate, designer, and developer of the action research. Despite the various hats I wore during the series of case studies, I maintained consistency in using my judgment as an instrument of the exploration. In fact, these various roles, and the act of cycling from one role to the next, provided a variety of perspectives with which I could better understand the virtual design studio.

Reporting

I have chosen to document my findings of this research by interpreting ten case studies conducted between 1992 and 2000. The stories, episodes, triumphs, and frustrations I share contribute to my overall understanding of virtual design studios. During the course of this research, there were many reoccurrences of particular events, processes, conditions, and behaviors within a case and between cases. Instead of focusing on these similarities, I have concentrated on describing different salient aspects of each case in order to construct a comprehensive view of the current state of the virtual studio. I also chose to describe the cases in chronological order to illustrate how the studios have evolved as we introduced new advanced technologies and gained more practical experience.

The reporting of this research is simply a pause in a continuous process. Conducting each new studio yields new knowledge about computer-mediated design environments and contributes to the growing collection of insights derived from the set of previous studies (Figure 3).
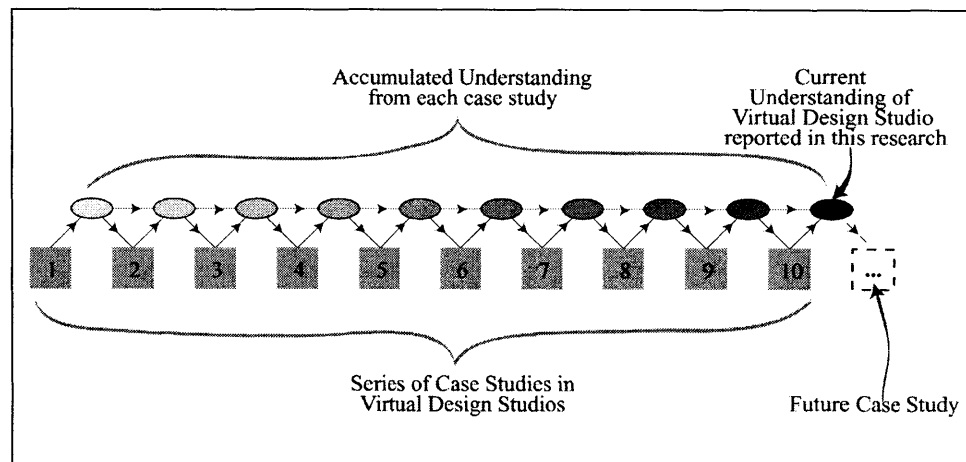

Figure 3: Each case study contributed different and complementary insights to my overall understanding of virtual design studios resulting in the comprehensive findings of this research.

During this short pause in the continuous progress of these educational environments, I offer this dissertation as a snapshot of my current understandings and interpretations of the virtual design studio in the hope that they may initiate many more challenging cases producing unexpected and valuable learning and research opportunities in the future.

Postscript

During the past eight years, I have had the great opportunity to be part of the first generation of virtual design studios in architectural education. Looking back at the ten case studies of remote collaborative studios presented here, I realize that I have gained a great amount of knowledge, experience, and sensibility about, collaborative technologies, design processes and practices, and community building in the studio.

As a pioneer of this new learning environment, I was required to take on many roles and responsibilities in creating the settings – understanding the technologies, managing the participants, designing the learning practices, and developing and nurturing a certain collaborative and experimental spirit in the studio. It was in performing these tasks, often simultaneously, that I developed skills and expertise in crafting the necessary symbiotic relationship between the particular technologies and the communities formed in each unique virtual studio. At the beginning, my role was often that of a technician trying to piece together the appropriate suite of hardware and software and to keep long-distance connections alive. This helped me to understand the technical capabilities and their possible development and appropriation by the studio members. Sometimes, I took on the more traditional role of a design consultant and gave advice on the students' work and how they could communicate, cooperate, and collaborate effectively in the technology-mediated environment. When needed, I was the collaboration advocate trying to bring local and distant participants together for valuable group efforts, especially when they strayed back to the more comfortable position of solitary work. At times, when group discussions became overheated, I was often asked to be a mediator. My understanding of the technologies, the studio processes and practices, and the particular community helped me to design, coordinate, and orchestrate the activities and events of each studio.

Recently, many aspiring conductors of virtual studios have asked me for guidelines for creating successful long-distance design environments. Because I have become undaunted by the complexities of running these projects, I realize that I have internalized much of my knowledge and I sometimes give the impression that these environments can build themselves with the appropriate mixture of technological capabilities. This is not the case. More than a suite of reliable, robust, and flexible technologies, virtual design studios require skillful, dedicated, and enthusiastic leaders and participants with open minds and sensitivity about technology and its appropriation in the design practices. Building such a community of practice is challenging and involves a great deal of time, patience, and energy.

The virtual studio, however technologically advanced, is fundamentally about the people and the creative learning communities they actively construct together. During the course of this research, I have been very fortunate to teach, learn, and work with bright, thoughtful, and experimental collaborators – students, instructors, practitioners, clients, technicians, and researchers from all over the world. To be part of this growing community with diverse, ambitious, and talented members dedicated to exploring new and interesting environments, opportunities, and visions for design learning was the greatest reward for me. I look forward to collaboratively creating the next generation of virtual design studios with this community.

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