INHABITING THE INFORMATION SPACE:
Paradigms of Collaborative Design Environments

By

Ali Shakarchi
B.Sc., University of Baghdad, 1990

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

MASTER OF ADVANCED STUDIES IN ARCHITECTURE

in

THE FACULTY OF GRADUATE STUDIES

School of Architecture

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
November 1999

© Ali Shakarchi, 1999

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of SCHOOL OF ARCHITECTURE

The University of British Columbia
Vancouver, Canada

Date NOV. 2nd 1999

Abstract

The notion of *information space* (iSpace) is that a collective context of transmitters and receivers can serve as a medium to share, exchange, and apply data and knowledge between a group of human beings or software agents. Inhabiting this space requires a perception of its dimensions, limits, and an understanding of the way data is diffused between inhabitants.

One of the important aspects of iSpace is that it expands the limits of communication between distributed designers allowing them to carry out tasks that were very difficult to accomplish with the diverse, but not well integrated current communication technologies.

In architecture, design team members, often rely on each others' expertise to review and problem solve design issues as well as interact with each other for critic, and presentations. This process is called *Collaborative Design.* Applying this process of collaboration to the *iSpace* to serve as a supplementary medium of communication, rather than a replacement for it, and understanding how design team members can use it to enhance the effectiveness of the design process and increase the efficiency of communication, is the main focus of this research.

The first chapter will give an overview of the research and define the objectives and the scope of it as well as giving a background on the

evolving technological media in design practice. This chapter will also give a summary of some case studies for collaborative design projects as real examples to introduce the subject.

The second chapter of this research will study the *collaborative design* activities with respect to the creative problem solving, the group behaviour, and the information flow between members. It will also examine the technical and social problems with the *distributed collaboration.*

The third chapter will give a definition of the *iSpace* and analyze its components (epistemological, utilitarian, and cultural) based on research done by others. It will also study the impact of the *iSpace* on the design process in general and on the architectural product in particular.

The fourth chapter will be describing software programs written as prototypes for this research that allow for realtime and non-realtime collaboration over the internet, tailored specifically to suit the design team use to facilitate distributed collaboration in architecture. These prototypes are :

1. pinUpBoard (realtime shared display board for pin-ups)
2. sketchBoard (realtime whiteboarding application with multi-sessions)
3. mediaBase (shared database management system)
4. teamCalendar (shared interactive calendar on the internet)
5. talkSpace (organized forums for discussions)

Table of Contents

List of Figures

Acknowledgement

Think twice, and say nothing. (Imam Ali)

In an effort to put this thesis together, focusing on the chosen subject without or if I may say “within” the seduction of the evolving new technologies that is changing momentarily, I would like to show my gratefulness to Dr. Jerzy Wojtowicz who helped me narrow down the scope and elaborate in many aspects of the information technology and architectural design, sharing his pioneering knowledge in Virtual Design Studios, and encouraging me at the same time to experiment with new things in my research; showing his concerns at times and his cheers in others. I also would like to thank Mr. Christopher Macdonald for his support and valuable input.

Thanks to my wife for her support and apologies to my beloved son for not having enough time to spend with him during the last few months.

I dedicate this work to my parents who lit my way and kept inspiring me all the times.

Ali Shakarchi Nov. 1999

1

Overview

With the growing complexity of the design needs, collaboration is becoming more complicated whether in managing the project data or controlling the compatibility of different inputs by design team members or minimizing the revision cycles. The role of the information space as much it promises a great potential in streamlining the collaborative design, it adds to the complexity of the process as a whole. *Architects will increasingly confront practical choices between providing for bodily presence and relying on telepresence* (Mitchell 1996). In many occasions, face-to-face interaction is an expensive way to communicate in terms of time and resources. Design team members distributed over different geographical locations, separated by different time zones often need to exchange and share project data in real-time and non real-time occurrences. Video conferencing solutions are providing a substitute for a face-to-face human interactivity. Chatting systems and whiteboarding are alternative interfaces that allow for real-time discussions and reviews. Bulletin Board systems are allowing for real-time and non real-time technical support. Above all, the design process has been influenced by the information technology in many ways. Whether, as a technical process; where enhanced visualization techniques and testing of functional performance can be done at the very first stages of design; or as a social process where character perception and human interaction is taking another form between design groups. The traditional boundaries of private and public spaces are no longer valid under the definition of the physical space. The information space is a new habitat that design professional are required to inhabit before homelessness. It is the new medium for more possibilities of human creativity and social endeavor.

1.1 Objectives

The main objective of this paper is to examine the role of the information technology in design collaboration and study the technical and social impact of using that technology as a medium for design collaboration, as well as constructing number of prototypes for real-time (synchronous) and non real-time modes that support collaboration between design team members located in dispersed geographical locations. There are number of issues that have been considered before designing these applications. Firstly, the amount of traffic through the networks has to be reduced as much as possible. Binary media transfer on real-time basis between collaborators would mean high traffic and slow response if not a threat to the stability of the connections especially when we start dealing with large files. That means synchronous communication will be very impractical. To avoid such difficulty, we allowed the media transfer to be asynchronous while keeping text as the only type of media to be transferred synchronously. In other words, the application will be able to perform uploading and downloading media in the background while collaborators keep their communication without heavy traffic. The key issue here is the allocation of resources (front-end and back-end). One way to minimize server load is to allow clients to perform some of the activities instead. In this case, client applications can access the server database that has all the references to the media that need to be shared in the conferencing session as well as access to the media folder to preload the media before the session starts.

1.2 Scope of Research

This research will study the role of collaboration in design and the activities associated with it, by analyzing the flow of data between team members, and examining the group behaviour in that environment as well as giving a brief description of how designers work based on literature on the psychology of design. It will also raise important questions about the distribution of information amongst collaborators trying to understand the structure of the process.

It will also focus on the distributed collaboration and how the advancement in communication technology has reshaped the landscape of the work environment.

The notion of the information space will also be examined as a medium for knowledge and information to be transmitted through between collaborators. A detailed framework of its primary dimensions; the E-space (Epistemological Space), the U-space (Utility Space), and the C-space (Cultural Space); will be given.

The last part will be focusing on some prototypes (software programs) written specifically for this research to establish an outlook for promoting this type of environment where human creativity can reach farther horizons.

1.3 Background on Design and Technology

The world has arrived at an age of cheap complex devices of great reliability; and something is bound to come of it. (Vannevar Bush[1], As We May Think July 1945)

This section will preview some related concepts and technologies that brought the attention of architects and designers into the paradigm of computation. Pioneers of the information technology versus prominent architects describing the role of this technology in providing the means and media to the creative work of people.

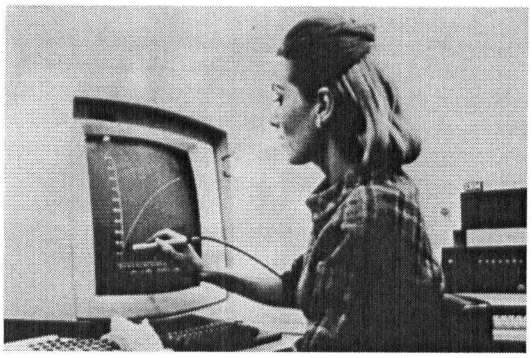


Fig. 1: Display system which incorporate the Light Pen, IBM 2250 Model 4

Historically, the level of interactivity that computers allowed has determined its acceptance by the design community. The alphanumeric keyboards, the push buttons, the tablet and stylus (Fig.2), the light pen (Fig.1), the 3D ball (Fig.3)

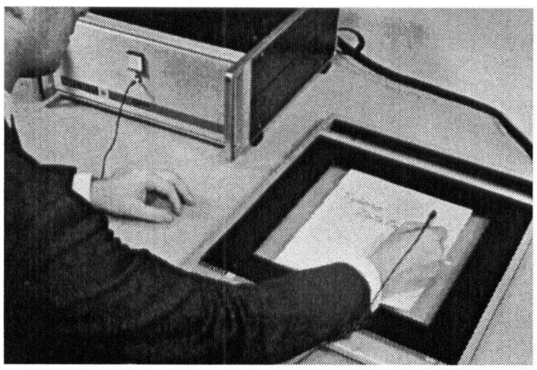


Fig. 2: Electronic stylus that can be moved across a flat surface to pick up positional x-y data

and most importantly the mouse, were all wonderful tools of human interaction with machines. Display devices were the eyes of the machines. The motion of a designer's hand is replicated by a cursor or a point of light on the monitor. The

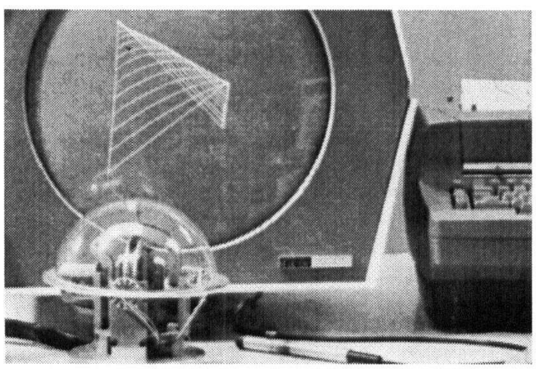
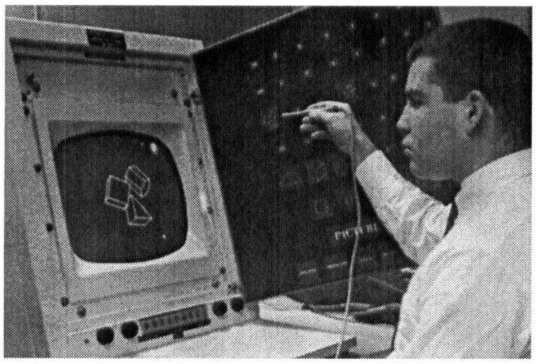


Fig. 3: MIT 3D Ball used to rotate a 3D perspective image on the screen

other important factor is the market value of such technology. More than 250 years ago, Leibnitz invented the calculating machine, but it could not then be in use because of its outrageous cost by the time what it could accomplish can be duplicated by sufficient use of pencil and paper.



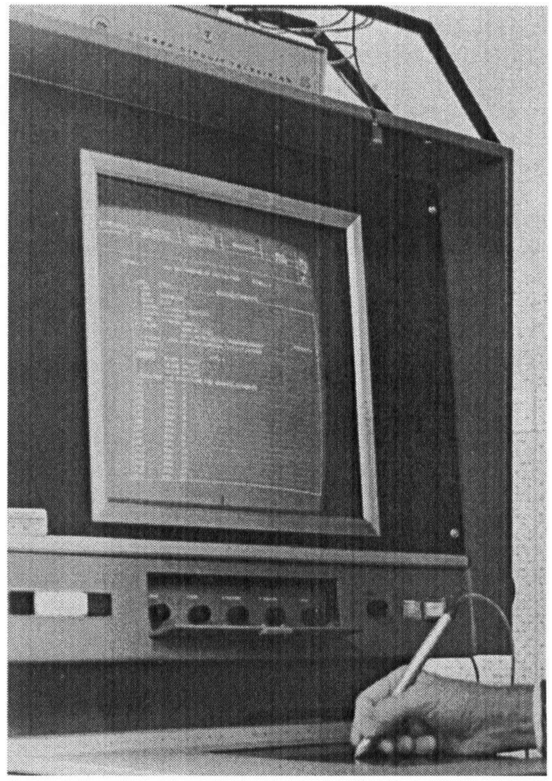


Fig. 4: The Lincoln Wand is a sonic pen which provides the 3 coordinates of its location in space.

Fig. 5: GRAIL, an on-line interactive system developed to help programmers work.

Another important advancement in the historical development of the computer technology is the speed of processing and compiling data into readable form. By the time computers became extensions of the human mind, the need to talk and communicate emerged as human to human though machines, or machines reporting to human, or human interacting with machines elsewhere. The accomplishment in the networked environments are probably one of the greatest in human history. Its fundamental potential of changing the way people live, work or even reproduce is a serious matter.

In a panel discussion entitled " The past and future of design by computer" [Published by the Yale School of Art and Architecture in 1968: *Proceedings of the Yale Conference on Computer Graphics in Architecture, Held in New Haven, Connecticut, April 1968*] Louis Kahn explained his view point toward the role of machines in design: [Machine can communicate measure, but the machine cannot create, cannot judge, cannot design, these belong to the mind.] He also talked about the source of its need [Today, we are talking about need mostly, not about desire. I say, could anyone have needed Beethoven's Fifth before he wrote it? Did Beethoven need it? It was desire that wrote it and when it was written it was needed. Desire is the inspiration of the new need.]

That statement can be interpreted as a passive one towards the role of this emerging technology in the designers work and underestimating its potential, yet it can be seen as a wise argument that tell us to look at it as a supplement, a medium with unlimited tools rather than a substitute to the human mind. The new need for better media, and higher altitudes in creativity could inspire new desire for designers and architects to accomplish.

Just another fascinating outlook to the computer role in design had been addressed in the same panel discussion by Charles Moore: [Our techniques limit what we do, in the same way that any language limits what we think about. Our techniques also describe, by default, our goals. The standard instance, I guess, is zoning, which we must suppose was invented by city planners. As a result of their use of Zip-A–Tone, which is hard to cut unless your knife is sharp. Therefore, if you are describing urban land uses by applying colored Zip-A-Tone, you are likely to assign greater virtue to large areas which do not need cutting than to nuisance-filled areas where a variety of contiguous uses would wear out the knife blade and the finger tip.]

Indeed, our techniques limit what we do, but it could extend the limit of what we can do as much.

A final remark for this panel discussion made by Steven Coons (a pioneer in computer graphics) said: [when I tell you in few years it will be possible for you to sketch in the air and have the thing you sketch in the air come to your eye, solid and real, so that you can walk around it, so that you can scrutinize it from any direction and any view point you please. I am telling you the truth. This will be, perhaps the first implementation in a very rudimentary way of the potentiality of experiencing and involving oneself with reality as the computer is able to generate it.]

Today, where virtual reality imaging can represent the architectural product well prior to its reality in the physical world, designers are be able to simulate and perceive the exact spatial configuration of the project on the projection screens of the immersive environment. In the near future it will be possible to experience the virtual reality design environments at a distance.

1.4 Case Studies

1.4.1 Case study 1: International Airport Design

Eight years ago, the developers of what would ultimately become the new Hong Kong airport were handed the following charter: Destroy the small islands of Chek Lap Kok and Lam Chau near Hong Kong. Shape their remains into an enormous flat field (Fig.6). Hire 20 architectural firms to design one of the world's largest airport terminals. Hire 40 construction firms to build it. Create a network that weaves the contractors together with the Hong Kong Airport authority, which must approve and distribute every drawing and design. You have seven years. Get to work.

Fig. 6: Hong Kong Airport (Aerial view)

The only means to this end was to plan for collaboration from the beginning.

"The design of the airport terminal building was very much a collaboration between various consultants," says John Park, the design project manager for the airport authority. " The design contract was won by the Mott Consortium, comprised Mott MacDonald, Norman Forster and Partners, and BAA in Hong Kong. These individuals were joined by engineers from Ove Arup [for roof design] and Mott Connel [for structural engineering]". After revisions and reissues, more than a million documents-designs, drawings, and CAD models- were shared among architectural firms in the United States, the United Kingdom, Hong Kong, and Australia.

At the helm of this collaborative effort was Foster and Partners that advocated the use of a single CAD program: Microstation from Bentley Systems. With more than 60 contracting firms associated with the project, standardizing on one CAD program reduced the need to translate and convert CAD data between disparate software platforms.

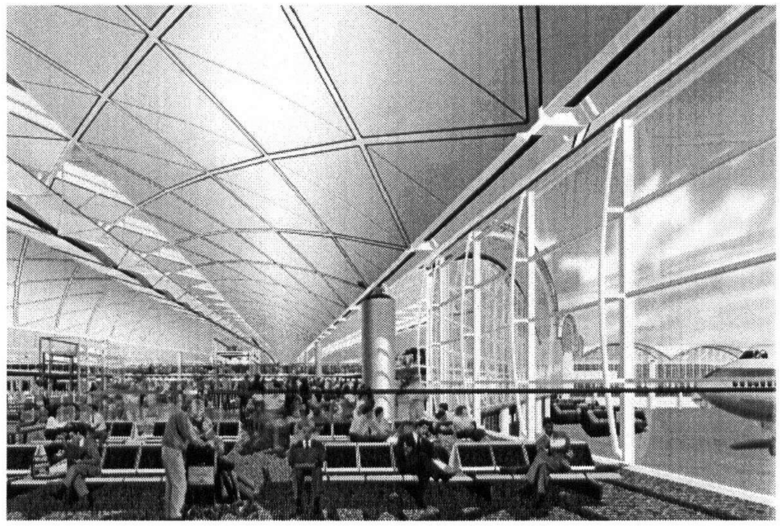


Fig. 7: Hong Kong Airport, Interior view.

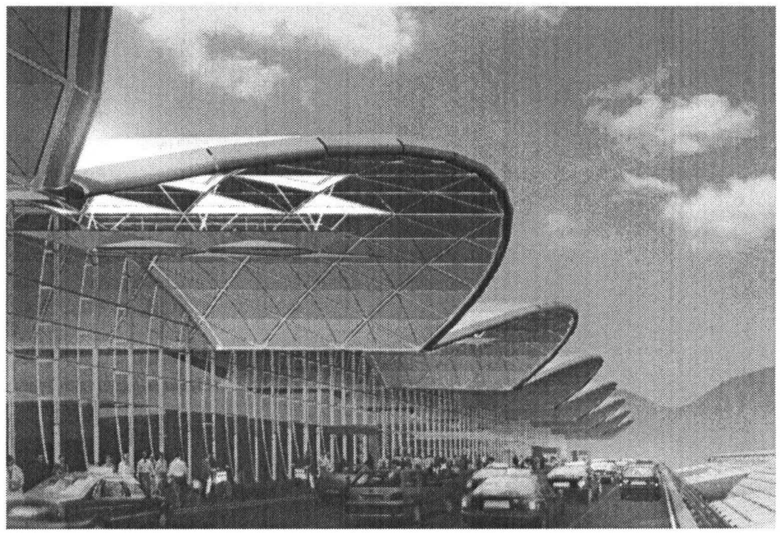


Fig. 8: Hong Kong Airport, Exterior view.

MicroStation with a standardization of the models, and the introduction of a smooth procedure for tracking, moving and sharing them amongst the enterprise participants over time and space. 2D and 3D information (Fig. 7, 8) moved via the Internet from the designers to the Airport Authority and from there to the construction teams. An Oracle database was used to log and automatically distribute each model, as well as any other necessary engineering and architectural data.

The information was gathered through MicroStation, managed through the Oracle database system, and is now available to the Airport Authority for daily operation, maintenance, ongoing construction, and facilities management. Computers not only helped produce the airport on schedule and on budget, not only made possible a revolutionary design, but also gathered and stored the vital data necessary to operate and expand the airport for years to come.

About 120 architects were employed on the design team overall- only a small percentage of the 20,000 total workers involved. " With so much information being distributed to so many different people, data administration alone became such a huge problem that we developed an Oracle database to log and track every drawing," says Park.

Before the project was over, more than 100,000 original drawings and designs has been created, and each on of these had to be passed from the designers through the airport authority to the construction firms.

1.4.2 Case Study 2: Virtual Design Studio (VDS)

As an educational model, VDS utilized the advancement in communication technology as well as computer graphics to build a collaborative architectural design environment, where students from different schools share design projects and exchange ideas, while professors act as consultants.

This model has relied on two important aspects in design collaboration, time and place. Distributed over different time zones and placed on different geographical locations, groups were using asynchronous collaboration mainly to control the distribution of information and in other occasions they were collaborating in real-time (i.e. video conferencing and chatting over the networks) Fig.9. Bulletin board systems managed the discussions between design groups, private email system handled most of the communication between collaborators. Web sites acted as a pin up board system where people publish their work allowing others to review it and give them feed back on it. In other occasions, a database management system was used to handle the published data in a structured manner (Fig.10, 11). Software agents were also used in the form of CGI scripts to allow students publish

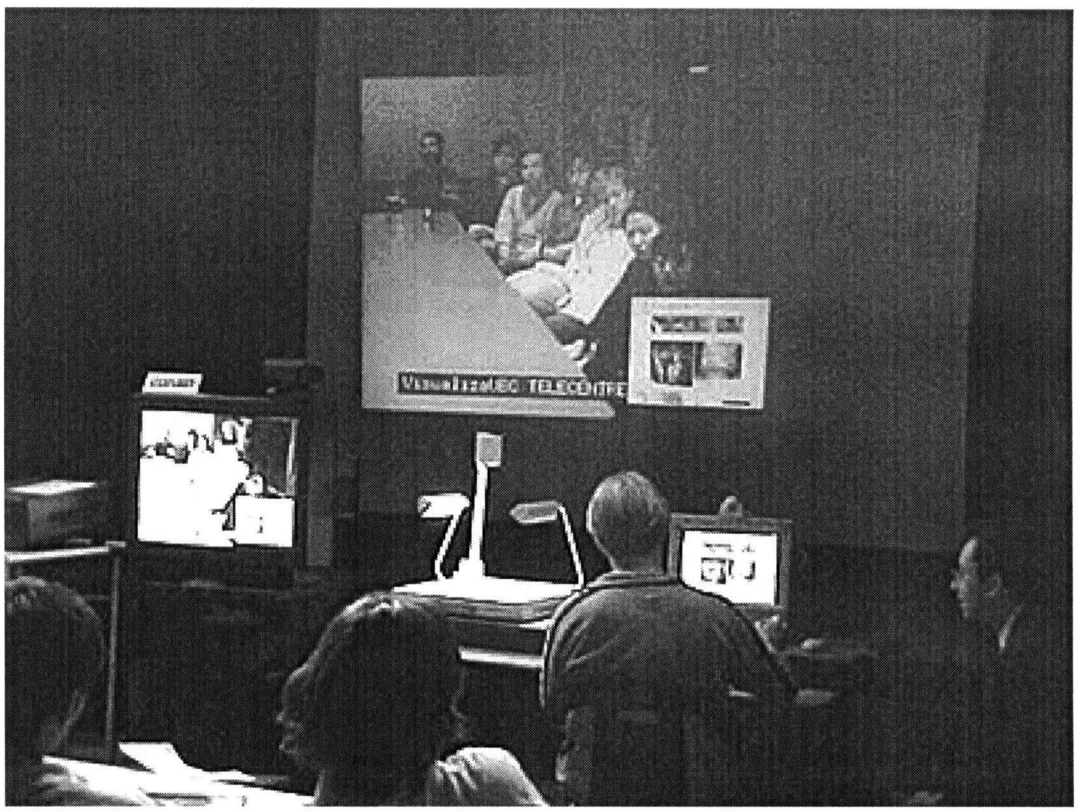


Fig. 9: Virtual Design Studio, 1998 [Video Conferencing Session through PictureTel, Inside the room: Participants from U. UNIACC, On the projection screen: Participants from UBC

their files to the database server which is located somewhere else in the world. Design data were mostly submitted out of the digital environment in a digital form, while other data were digitized.

One of the important issues that have emerged during collaboration is the cultural dimension that is associated with it. Students from various cultural backgrounds, speaking different languages, and designing from different approaches, has allowed them to obtain additional experience.

Above all, this model and during the last six years has prepared generations of designers to work confidently; side by side; with information technology tools and media.

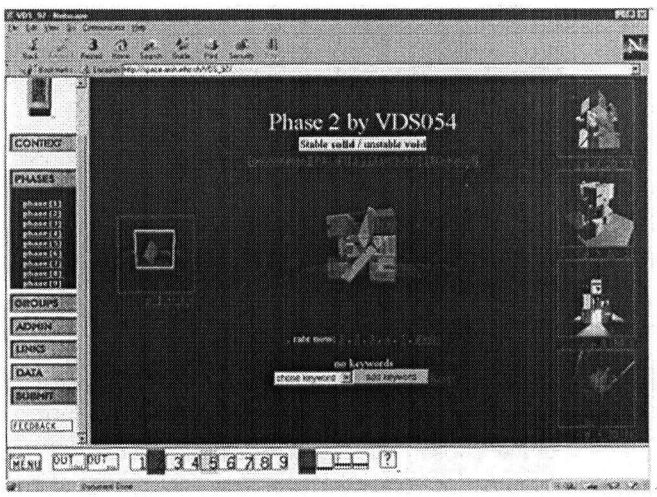


Fig. 10

The common design database and the browser interface of VDS

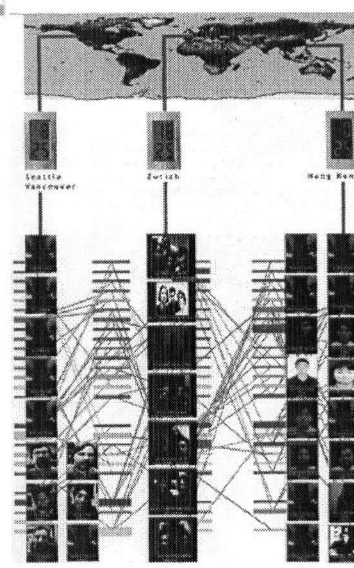


Fig. 11

The Virtual Design Studio setup and participants

2

Collaborative Design Environment

A camel is a horse produced by a committee. (Old joke)

2.1 Introduction

In carrying out design tasks, design team members use a variety of tools and techniques to process the knowledge and the information that relates to the design project. As part of the creative construction of concepts and ideas, they exchange data, share opinions, and build arguments that help them establish proper methods to approach a design problem. Before the computer, they used paper and pencils, blackboards and postal system. Yet, after computers and communication systems became wide spread, they adapted these new resources to their collaborative needs- By taking turns editing the same file, by mailing diskettes to one another, and by exchanging files as well as a message through email. This simple model of collaboration can be extended in a more complicated way when the projects get more complicated and the design complexity increases. As a result of that, resource management will become an expensive subject which may result in frequent design compromises.

This chapter will focus on the collaborative design characteristics and components, trying to establish a way of dealing with its challenges by understanding its mechanism within team behaviour.

2.2 Definition

Collaboration can be defined as an implementation of joined forces and efforts that helps create a framework to bring, organize, manage, and produce common objectives. Collaboration provides a solution to the problem when the individualistic approach becomes insufficient in terms of timeliness and efficiency.

2.3 The Role of Collaboration in Design

As a social phenomenon, collaboration reflects the tendency of humans to cooperate with others to achieve some goals. In design, collaboration between designers, consultants and other people involved plays an important role in carrying out the tasks whether in solving spatial problems or fabricating structural elements. It is an inherent characteristic that any design task can hardly eliminate it from the process.

Members of design teams have traditionally clustered themselves closely together in offices, studios, and conference rooms to carry out their various tasks [Mitchell, McCullough, 1995]. This type of communal organization is effective in terms of the ease of communication and interaction. To a certain degree, designers have developed proper forms of communication in transferring ideas among them. Face-to-face interaction is probably the most common form of communication when the personal and social attributes need to be explicitly explained for immediate interaction. When communication becomes technical, other forms are used to transfer ideas or reviews to certain ideas. Whether in a written form, a sketch, a model, or a red circle surrounding part of a drawn façade, communication is still between humans. Processing of the information transferred between team members depends on the effectiveness of these forms. In the other hand, a combination of two or more of all the above is often required as part of the interactive process between team members during the design process. A drawing board in a design studio can accommodate few people to discuss specific design issues. A pin-up board can accommodate more people to review the project and interact with each other. A conference room would accommodate managers and designers to meet and discuss project issues. There is certain level of hierarchy from private to public to communicate design issues.

Clearly, physical presence of collaborators in this environment is essential in terms of the efficiency of communication and interaction. This type of collaboration becomes more expensive in terms of time, energy, and cost when collaborators are distributed over various geographical locations. Additionally, the design process becomes less integrated and more fragmented. That means more effort has to be invested in management and control over the project data to minimize the difficulties involved.

2.4 Collaborative Activities

Three important factors that influence the collaborative activities:

1. The information flow
2. The group behaviour
3. Creative problem solving

2.4.1 The Information Flow:

As part of the general process of collaboration, the information flow determines the fluency of communication and the control of the different stages of the process.

Based on the information flow model (Fig.12) by John Smith, Design team members develop three basic types of information: tangible, intangible, and ephemeral. The tangible knowledge can be divided into target products that

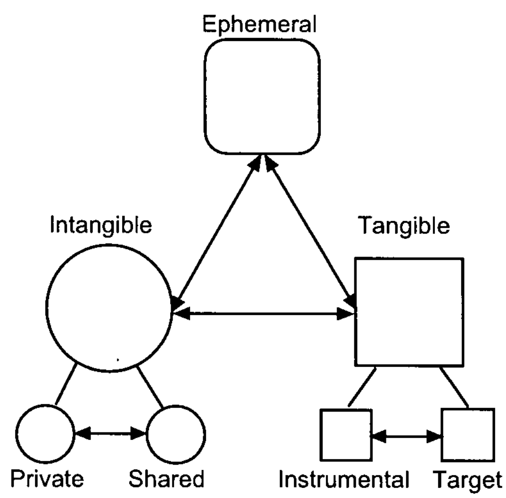


Fig. 12: Types of Data based on the information flow model

represent successful completion of the team's task and instrumental products that support the team's work on the target products but are not part of the product. Intangible knowledge does not take tangible form but, rather, remains within the heads of the team members. Some is shared by almost all team members; other is private with respect to an individual or a subset of the team. Ephemeral products lie somewhere between tangible and intangible knowledge. This information is given physical form for brief periods of time, but unlike the instrumental products that are included within the artifact, ephemeral products are destroyed or lost. These three types of information and their respective subtypes are shown in figure 13.

The collaborative process produces a flow of information, as information in one form is transformed into information in a different form. For example, during team discussions, private knowledge held by one member may become shared knowledge held by the group if that person explains a privately held concept to the team. If the individual with the private knowledge uses a

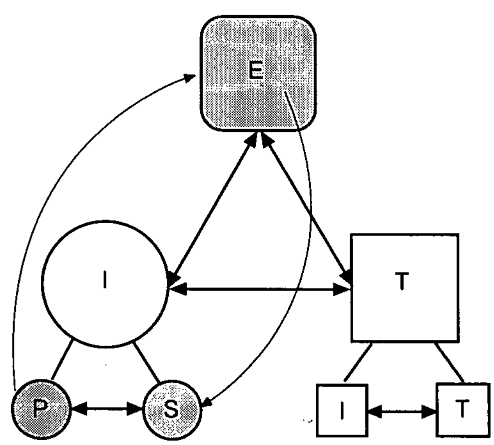


Fig. 13: Flow of information from private to ephemeral to shared

whiteboard to draw a diagram to help explain the concept, the information is transformed from private to ephemeral to shared knowledge.

As a result of multiple transformations for the information produced by the design team members, the design product becomes more of a collective nature or a composite outcome than an isolated one dimensional artifact.

It is necessary to illustrate the efficiency of the flow of information in collaborative design as a key component to successful collaboration.

Several patterns of the information flow and distribution can be extracted out of design teams, with respect to the source and the path of the information

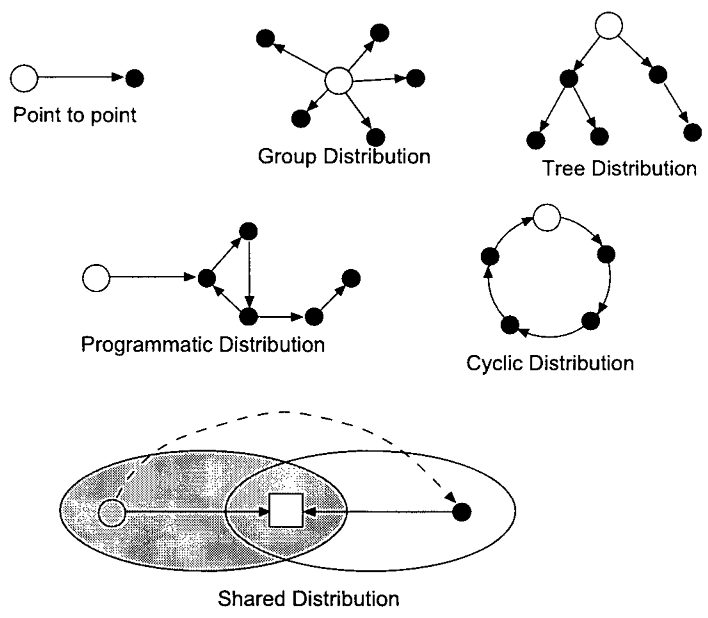


Fig. 14: Document Distribution paths

(i.e. document distribution). Figure 14 shows different possible patterns of document distribution:

2.4.2 Group Behaviour:

Collaborative design actions normally take place in sequences or phases rather than as isolated events. For example, a discussion normally includes a number of different statements by different members of the team, interspersed with individuals' drawing diagrams, referring to documents present or absent, showing transparencies, waving their arms in the air, and so on.

The fundamental problem faced by collaborative design teams, on the one hand, to divide their work into semiautonomous tasks so that they can take advantage of the parallel efforts and the individual expertise of its various members and, on the other hand, to synthesize their respective contributions to form a context form.

2.4.3 Creative Problem Solving

Architects as designers have to manipulate abstract representations of the site on paper as well as being self-conscious about how they manipulate these representations. They have to keep track of what is to be accomplished by their designs, how to accomplish them, which design standards to observe, and how to regulate their time and resources. Partitioning of the design process assists the effective and efficient conduct of work through teams of designers in the architect's office.

A design problem is typically specified in a brief. However, many documents, customs, and human experiences that are natural extensions of the brief cannot be completely specified. A well defined problem has possible representations and transformations. In contrast, a design problem often requires the discovery of new representations and rules, even though a large set of conventions is available as part of the culture of design. Each designer applies his or her own rules to determine whether or not a design is acceptable. Most designers are satisfied because of lack of time rather than anything else. Some designers tend to develop further their previous solutions or come up with entirely new solutions, rather than regenerating parts of an earlier solutions.

By all means, design is a very dynamic environment that should always be tolerable and flexible. Reflecting these characteristics in a new medium for architectural design requires a deep understanding of how designers work.

2.5 Distributed Collaboration

Under many circumstances, design resources and facilities are distributed over different geographical locations whether in the physical world or the virtual one. Under this type of collaboration, distributed management and communication technology, are key drivers to the performance level. At the same time, the need for collaboration cannot be satisfied by technology alone. A fundamental change in the behaviour of the teams is required. The increasing volume and velocity of information requires an environment where designers can identify, analyze, and represent the collage of knowledge responsively. If a large project is surrounded, first by a thin membrane of knowledge shared by the group as a whole and, second, by thick patches of more specialized knowledge, how can we characterize this knowledge? How do we piece fit together? Is it important for groups to share certain kinds of knowledge but not others?

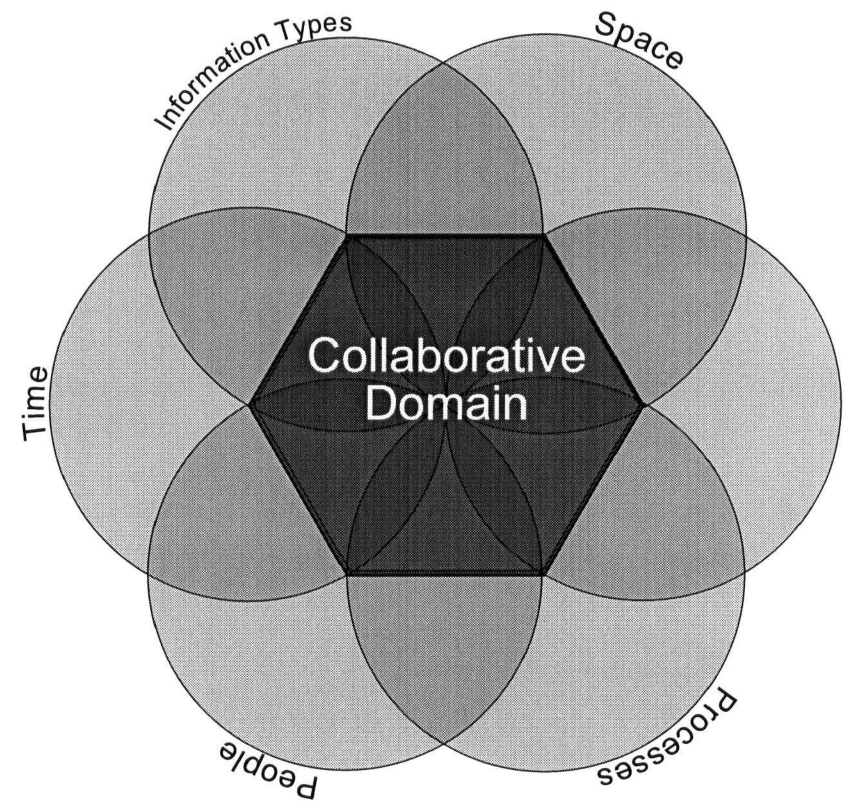


Fig. 15: Spectrum of collaborative domain

The spectrum of collaborative environment is neither illustrated by technological tools, nor by the information types only. Possible collaborative design environments involve, time, space, people, and processes as well. Figure 15

2.5.1 Space

As one of the components of collaboration, space can be physical as an office, a cluster, floor, building, site or as a virtual space as a web site, a server, VR space, or an information space.

2.5.2 People

As participants of any collaborative activity, people can be represented by an individual, a team, a collection of teams, or even an informal coalition. The size and the coherence of the group is another factor to consider in determining the effectiveness of collaboration and the efficiency in their communication.

2.5.3 Time

The duration over which the behaviour of the group is observed and characterized can be within seconds, minutes, hours, days, or even years. The synchronization of this will be either real-time (synchronous) or non real-time (asynchronous).

2.5.4 Processes

The various processes groups use to do their work; whether cognitive, social interaction, mediated, collective, distributed, or algorithmic; are part of the spectrum of collaboration.

2.5.5 Tools

With non computational tools, a pin up board, a whiteboard, TV, VCR, Fax, etc.; or computational ones, like computer applications, databases, distributed file system, internet, video conferencing or intelligent agents; all these tools are used in collaborative environments.

2.5.6 Information Type

We can classify the type of information with respect to its social character as intangible private, intangible shared, ephemeral, tangible instrumental, and tangible target; or we classify it according to its structure, as structured data like bills of materials, tables of specifications, and list of details; or as unstructured data, like a design concept in a sketch format or a conversation between team members to critic the spatial attribute of some project.

2.6 Knowledge Exchange and Distributed Teams

Part of the essence of any collaborative behaviour is to share and exchange knowledge and resources. Frequently, distributed teams lack homogeneity, consistent membership, and collocation. Other implications can be added responsibility for team members and increased workload for coordination.

Effective knowledge transfer requires an answer to three important questions:

1. How do we transfer raw data into useful information?
2. How do we collect/ collate/ organize the information?

3. How do we effectively transmit information to others?

The logistics of collaborative activities becomes and additional expense that should be handled with consistency and speed. Otherwise, if the process fails to have the proper mechanism of running, it will backfire expensive consequences to the collaborators.

3

The Information Space (iSpace)

3.1 Introduction

Jacques Derrida, explaining the privileged postal technology (the E-mail), said: "Electronic mail today, even more than the fax, is on the way to transforming the entire public and private space of humanity, and first of all the limit between the private, the secret (private or public), and the public or the phenomenal."

This type of transformation is affecting the social limits of perceived space. As collaborators communicate within certain boundaries of physical space, protocols and methods of communication have been developed to organize the human interaction. When the definition of the space changes, new methods of communication and protocols has to be introduced to accommodate the change to make collaboration possible. In this case where the information space is becoming another medium for collaboration, if designed properly, it will not just be inhabited, but will be able to support a wide range of activities that extend the design process to new prospects.

3.2 Definition:

The Information Space: It is a collective context that is defined by transmitters and receivers and serves as a medium to share subjects in a digital form. Transmitters and receivers can be humans, software agents, or digital data.

3.3 Components of iSpace

3.3.1 The E-space (Epistemological Space)

As one the three components of the iSpace, the E-space as it was put by *Boisot, is where the distribution of knowledge and information occur at a given instant.*

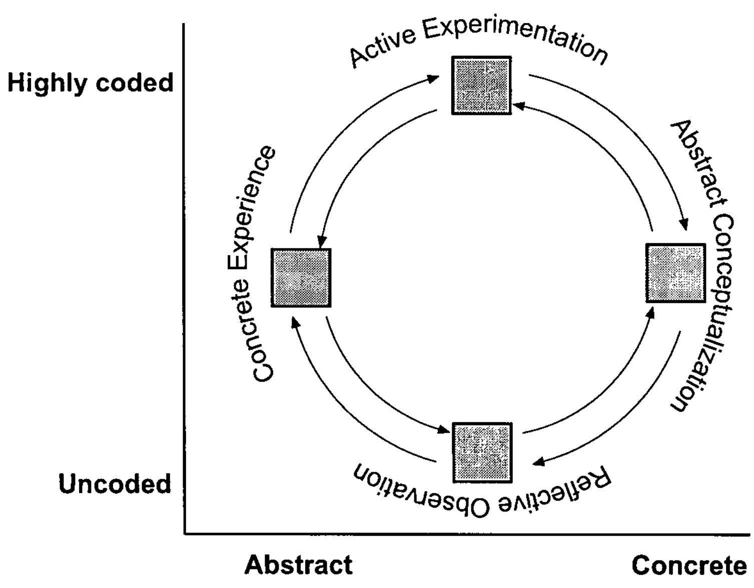


Fig. 16:

Learning cycle in the E-space

The E space ,unlike a closed system, exchanges information with its external environment. It is the space where learning is acquired, knowledge is processed, and cognition is developed (Fig.16).

Our physiological capacity for storing external data is limited to our daily information needs. The need to make room for fresh data requires that we clear out heads of information that can better be stored elsewhere [Boisot 95]. Effective learning thus requires selective forgetting.

The E-space is a personal space being confined to what is going on inside one individual's head. The way that the knowledge held by an individual is configured in the E-space is affected by the way he learns and by more general personality factors. The social learning and cognitive processing happen within the E-space.

3.3.2 The U-Space (Utility Space):

The E-space component addresses the semantic problem in communication within the iSpace. The precision of transferring knowledge and information to convey the desired meaning is what the U-space is about.

Communication, to be effective, must overcome technical, semantic, and pragmatic barriers to the transmission of information. Meaningful communication always requires some minimum sharing of context between sender and receiver. Where this is difficult one must resort to shared abstractions in order to be understood. Abstraction facilitates the diffusion of a message since it increases the number of particular situations in which a message can have utility and relevance.

The U-space explicitly links the diffusibility of a message to its degree of abstraction. Trajectories in the U-space towards well-diffused and abstract knowledge are affected by the prior distribution of knowledge in the space.

Effective communication requires the sharing of either abstract codes or contexts between sender and receiver. The choice is affected by the communication technologies available. The communicative component of data pro-

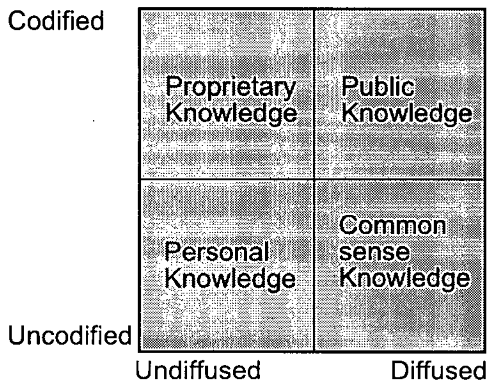


Fig. 17:

Typology of knowledge

cessing is a social activity in the U-space (Fig.17).

3.3.3 The C-space (Cultural Space)

The codification of knowledge has social and psychological implications. The relationship is fundamental. Uncodified knowledge cannot be captured in writing or stored without losing the essentials of the experience it relates to. A simple example, is sending a sketch of some architectural design project to someone else without explaining the idea verbally or textually. Codified knowledge can be stored or put down in writing without losses of information.

Another dimension of the cultural space "C-space" is the diffusion of knowledge. Undiffused knowledge stays locked inside one's head whether because it is hard to articulate or because one decides to keep it in there. While, diffused knowledge is shared with others.

In conclusion, sharing knowledge in *iSpace* is an inherent character of its mechanism. Helping seamless codification and diffusion of knowledge is a one of the tasks that has to be implemented in designing the iSpace.

3.4 Problematical Communication

Three level of communication problems arise :

Level A problem: How accurately can a given message be transmitted? (The technical problem)

Level B problem: How precisely does the message convey the desired meaning? (The semantic problem)

Level C problem: How effectively does the received meaning affect the conduct in the desired way? (The effectiveness problem)

** The switch from sensory to artificial channels will often be costly. New codes have to be learned by all parties to a communication process and these may not be readily mastered. Further more, a communication infra-structure may also have to be set up. The greater the resources that have to be devoted to the creation of a communication infrastructure, the more sen-sible it becomes to develop specialized codes that economize on its use. Thus, coding skills consists essentially in choosing that level of redundancy which minimizes transmission costs without sacrificing the clarity of a mes-sage.

3.5 The impact of iSpace on design as a social process

As a starting point of studying the impact of iSpace on design sociology, we have to consider the overwhelming transformation from the actual to the virtual. Pierre Lévy in his book: Becoming Virtual, has explained this phenomenon as the Moebius effect that is resulted from the virtualization: the transition from interior to exterior and from exterior to interior.

The traditional worker had his office. The participant in the virtual corporation, however shares a number of physical (buildings and furnishings) and software resources with other employees. The member of the conventional corporation travels from private space to the public space of the workplace. In contrast the telecommuter transforms his private space into public space and vice versa. Place and time blends together.

In describing the role of the internet in reshaping our lifestyle, Rawlins said:" This is a social gathering different in style, scope, and scale from anything we know. It is not a cocktail party, although it is a little like one. It is not an office meeting, although it can sometimes seem like one. It is not a picnic, a party, a riot, a face-to-face conversation, or a get-together around the water-cooler. Nor is it a bunch of notices thumbtaked to a bulletin board or graffiti scrawled on a toilet wall. It is all of the above and none of the above. It is a new thing— a groupmind.".

The term "Groupmind" has probably some social representation of a new process for synthetic thinking. It refers to the capability of linked minds to collectively synthesize intelligence. When data are accessible at any time and from anywhere, presence becomes an alternative that demands evaluation. The Groupmind becomes coherent perceptual state that influences design collaboration. The design objectives will be more transparent to the individual minds. The collective nature of this process has certain social advantages in reconnecting the physically absent collaborators. Absence becomes telepresence. The sense of grouping and belonging will give a better control over the collaborative design process. I could care less about the emailer of a CAD file. My sole concern will be the sent file itself. My assessment of the content of that file will be purely technical to some extents. While if I communicate in real time with the emailer, I would have to remember his or her name, and as any human being, I will construct first impressions about them if not attitudes. Interpretations of what they say or do will be affected. I will also manage to develop an understanding about the way they think. Efficient collaboration between team members demands healthy social environment.

Fluency of collaboration in the Information Space may also play an important role in getting its acceptance by collaborators as a medium to interact rather than a medium to get frustrated. Network speed and stability are not yet up to the expectations of most users who want to exercise their social experiences over the wires.

As discussed in the example above, the social change of the collaborative workspace can have a direct impact to the design process (i.e. evaluation, reviews, and production) as well as an indirect impact (i.e. collective intelligence, communication, and group objectives).

4

Paradigms and Conclusions

4.1 Application Profiles of iSpace

With respect to the communication model discussed earlier, number of interactive web based applications are developed to serve real-time collaboration between design team members. There are many advantages why they are done through the web. First, the amount of flexibility it offers in terms of the operating system compatibility. Second, these applications can be accesses from anywhere, internationally, without restrictions of time and space. Third, they all require minimum set up to perform, with minimum maintenance. Forth, the web is a widely accepted medium of communication that does not require a lot of learning from the side of users. And fifth, it offers an interesting integration with other facilities that are offered by the web (i.e. on line catalogues, references and web cameras attached to projects sites).

These applications will be discussed here by features and applicability in the collaborative design environments.

4.1.1 The "pinUpBoard"

Features: Generally, the pinUpBoard (Fig.18) is written to provide a real-time media browsing and discussion that allow collaborators to exchange critic on shared media, simulating the gathering on the pin-up board by the design team members or between the designer and the clients. Number of tools are also provided to facilitate that type of communication and interaction:

1. Selective approach for the presented media, rather than a linear slide show.
2. Area pointer to help identifying the area where the collaborator is referring to.
3. Status control over the presented media, in terms of location, scale and orientation.

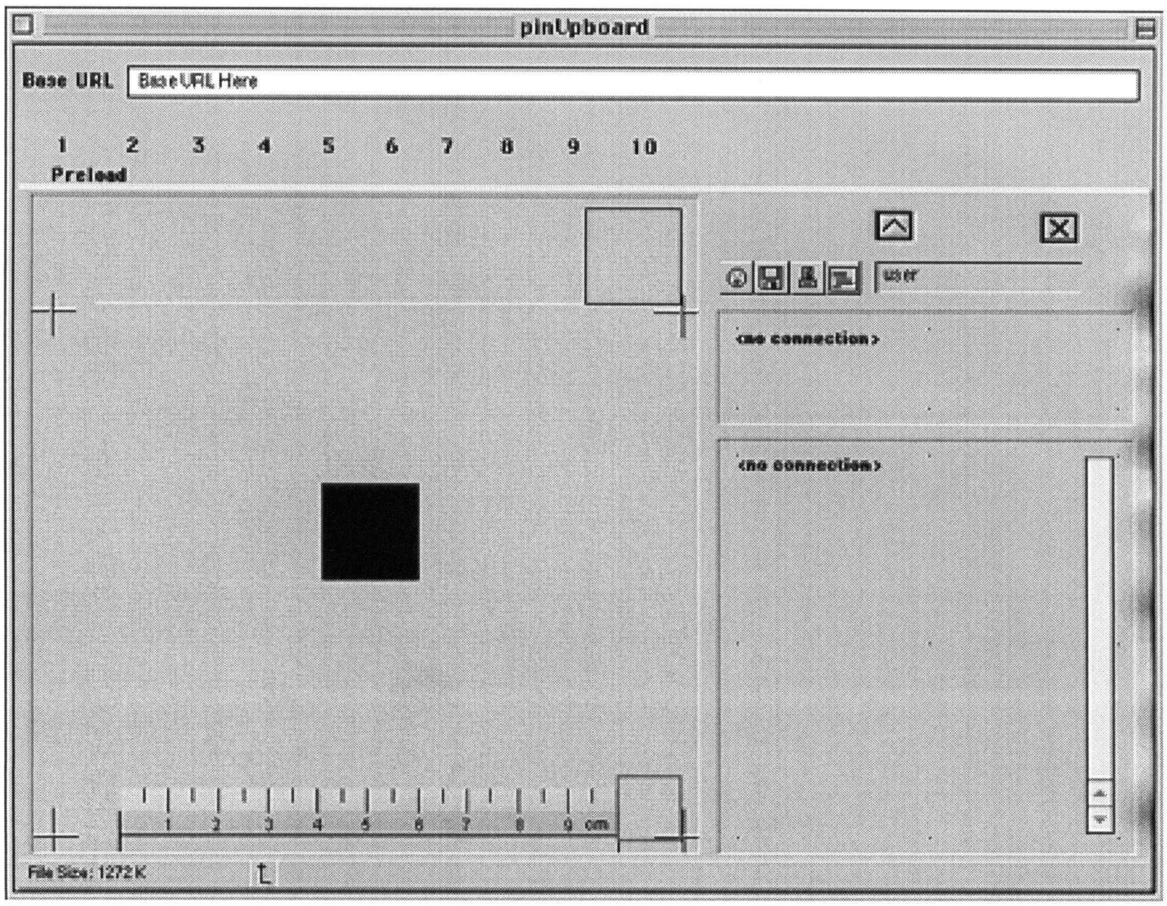


Fig. 18

The pinUpBoard interface

4. A scaling tool to measure

5. A limited talk space for the collaborators to transfer ideas in a written form.

Applicability: Although this application is written to be a web based one (Shockwave version), but it can run as a standalone application that rely on the "Multiuser Server" by Macromedia Inc. The limitation of the pinUpBoard is the way it is addressing the media download. It is basically using text format transfer to override the network speed which is intended to be so, because of the today's limitations for high bandwidth accessibility by most people. Yet, Binary media transfer can be accomplished here without technical barriers. The key thing to run the pinUpBoard is the pre-loading of the media before the collaborative session (Fig.19). That means, every user will have the same media on their ends and it will be called by the application upon the users' requests. The setup time for the session is minimal if compared to the frustrating waiting time for the real-time media download off the internet, while, this method allow the presenter to file transfer his or her media to the

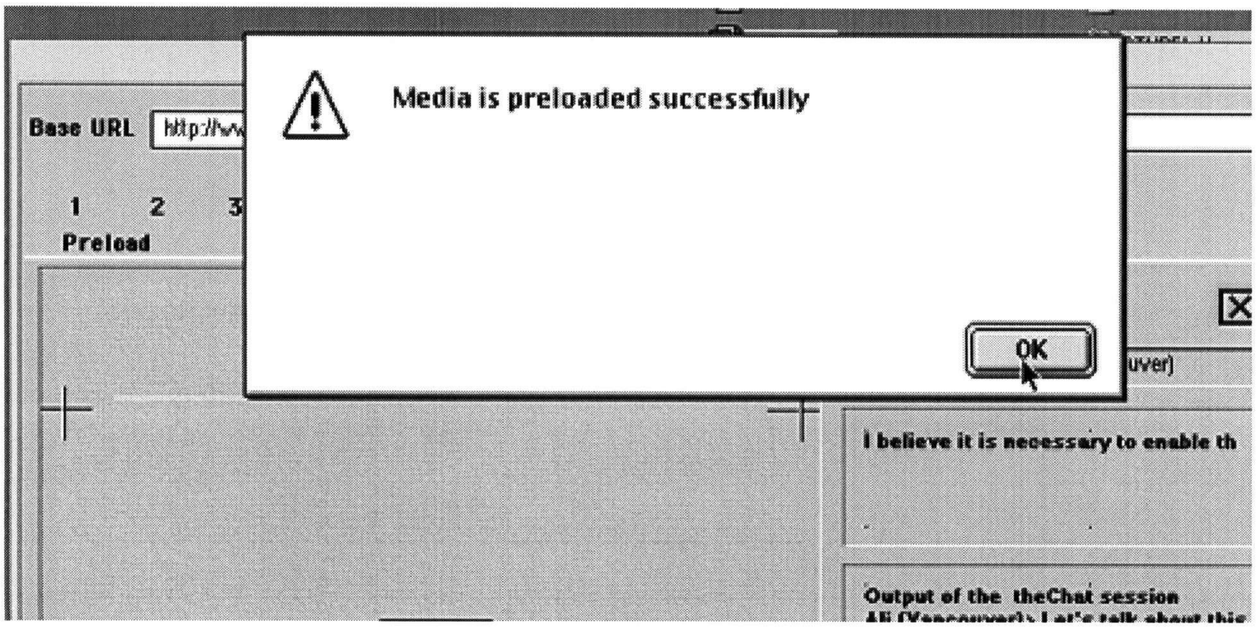


Fig. 19

Media is preloaded dynamically throughout the collaborative session servers from one location in a non-real-time mode.

4.1.2 The "sketchBoard"

Features: The sketchBoard (Fig.20) is a web-based (Shockwave version) whiteboarding application that allow collaborators to share the same sketch board on real-time mode, exchanging freehand sketches for design ideas with control over the brush's color, shape, size, and rotation, along with a talk space for real-time collaboration. Number of tools are provided in this application:

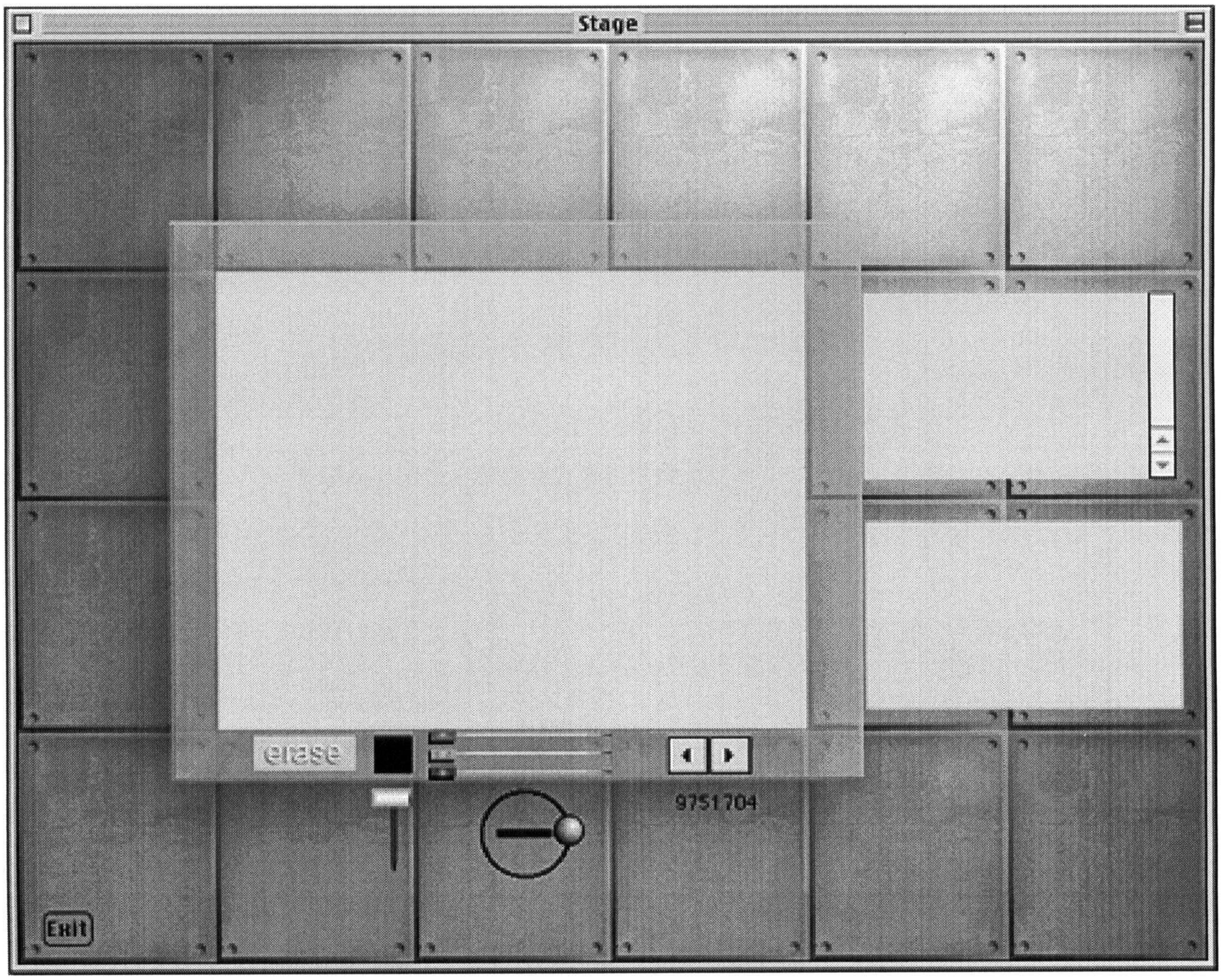


Fig. 20 : The sketchBoard interface

1. A sketch board to act as a background for the sketching.
2. A number of brush shapes
3. A control bar for the color of the brush
4. A control bar for the size of the brush
5. A tool for controlling the rotation of the brush strokes.
6. An eraser (non-selective)
7. A login screen
8. Eight sketch boards are offered to be shared by collaborators in different categories of design issues.

Applicability: Although this application is written to be a web based one (Shockwave version), but it can run as a standalone application that rely on the "Multiuser Server" by Macromedia Inc. This application is intended to allow for sketching in a shared real-time mode on a blank background or on top of other collaborators' sketching (The tracing paper effect) with the possibility to comment in written text and send the comments to others. This application is shared by the users through the "Multiuser Server" with multi-session capability. The main limitation of the sketchBoard is that it by no means can handle the skillful human hand abilities, and neither does any other application in the market today or even tomorrow.

4.1.3 mediaBase

Feature: This database management system is an application that is based on the adaptation of CGI scripts made available by Eric Raymond at www.opensource.com. It allows anyone who has been given password verified access to manipulate a specific database file on the web by adding, modifying, and deleting records. It also incorporate lock file routines so that no one can actually manipulate the same record while someone else is manipulating it. This is a non-real-time collaborative application that enable design team members to control a central media database for a project, or a client or other criteria. It has number of tools provided with it:

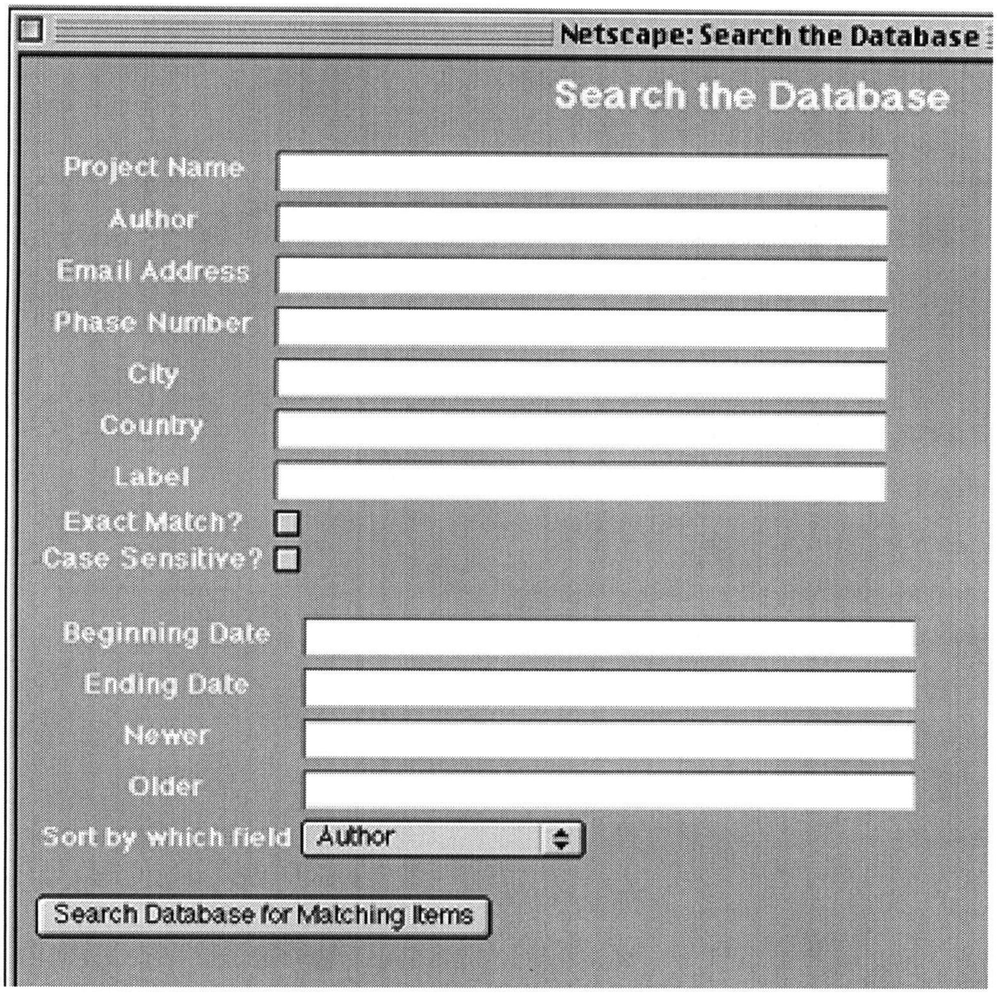


Fig. 21

mediaBase search interface

1. A login screen with possibility for new users to register for an account on the fly.
2. Password verification
3. A search engine with multiple search criteria as shown in figure 21
4. An interface for the media browser that is currently it accepts text and images only.

Applicability: As a web based application, the mediaBase is a useful component to the design collaboration for it provides team members a shared online database (Fig.22) that is accessible from anywhere and in any given time. It gives a good reference control of the load of files and information about projects, designers, dates, and work locations if applicable.

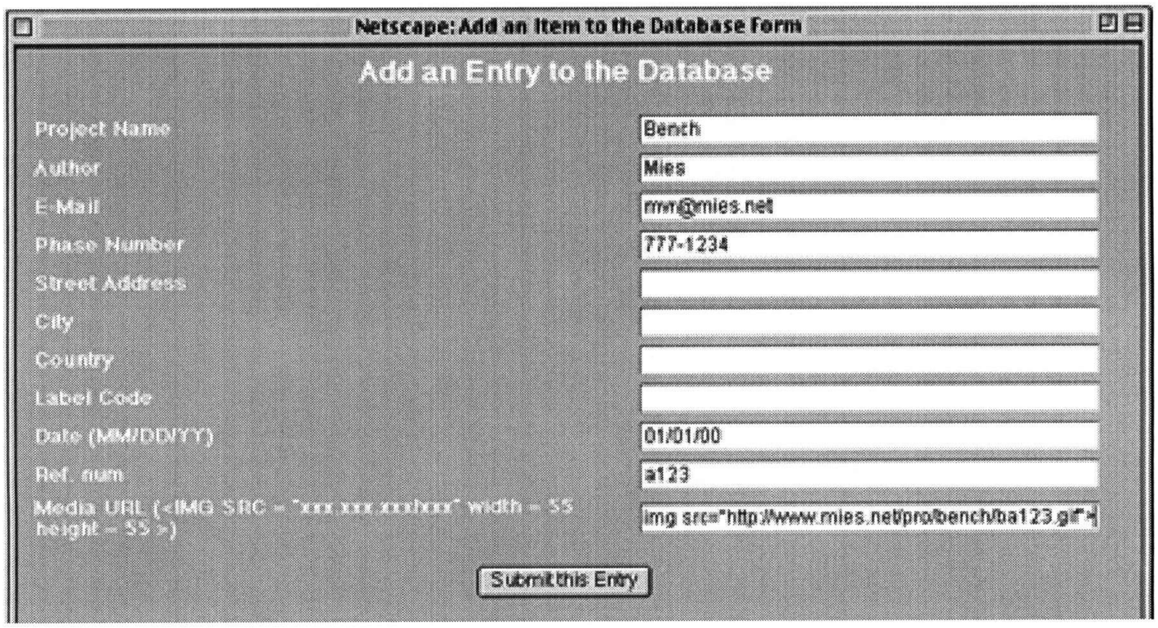


Fig. 22

Records within the mediaBase are editable

4.1.4 teamCalendar

Features: This is a web base calendar application that is based on the adaptation of CGI scripts made available by Eric Raymond at www.opensource.com. It allows collaborators to add, modify, and delete from a shared calendar. However, though team members can all see all of the scheduled events, only the poster of a message can modify that message (Fig.23)

Applicability: Time has always been an important factor in the design process. Team members have to meet deadline, schedule meeting for design reviews, and declaring phases throughout the design process (Fig.24). This application is a web based tool that can run in both realtime and non-realtime modes from any location.

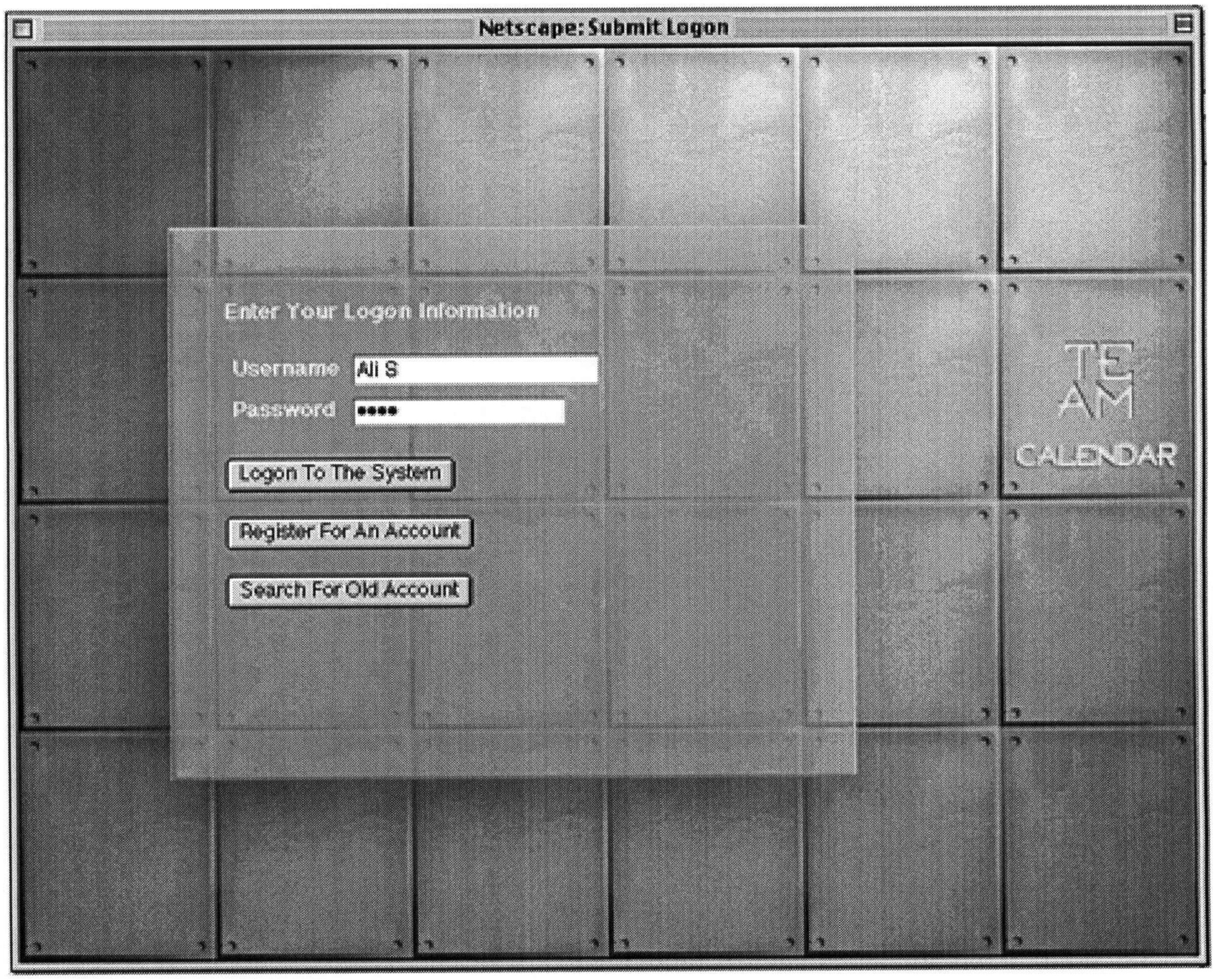


Fig. 23

teamCalendar Login screen

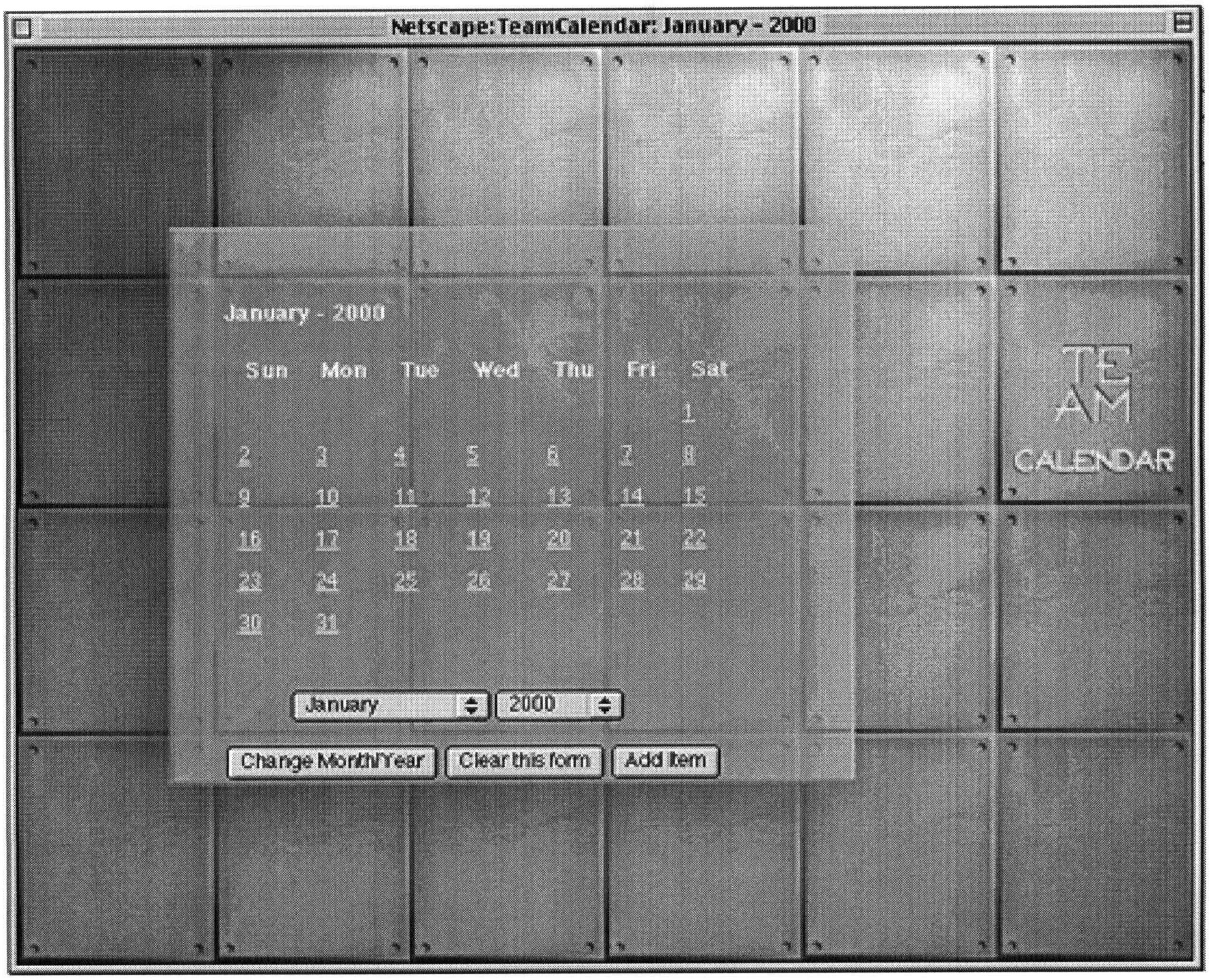


Fig. 24

teamCalendar interface

4.1.5 talkSpace

Features: This is an application built on CGI scripts made available by Eric Raymond at www.opensource.com. It is a useful CGI program that allows a number of people on the World Wide Web to talk to one another simultaneously. It differs from a BBS (bulletin board system), in which the messages are typically read hours or days after they are posted. The ability to chat on

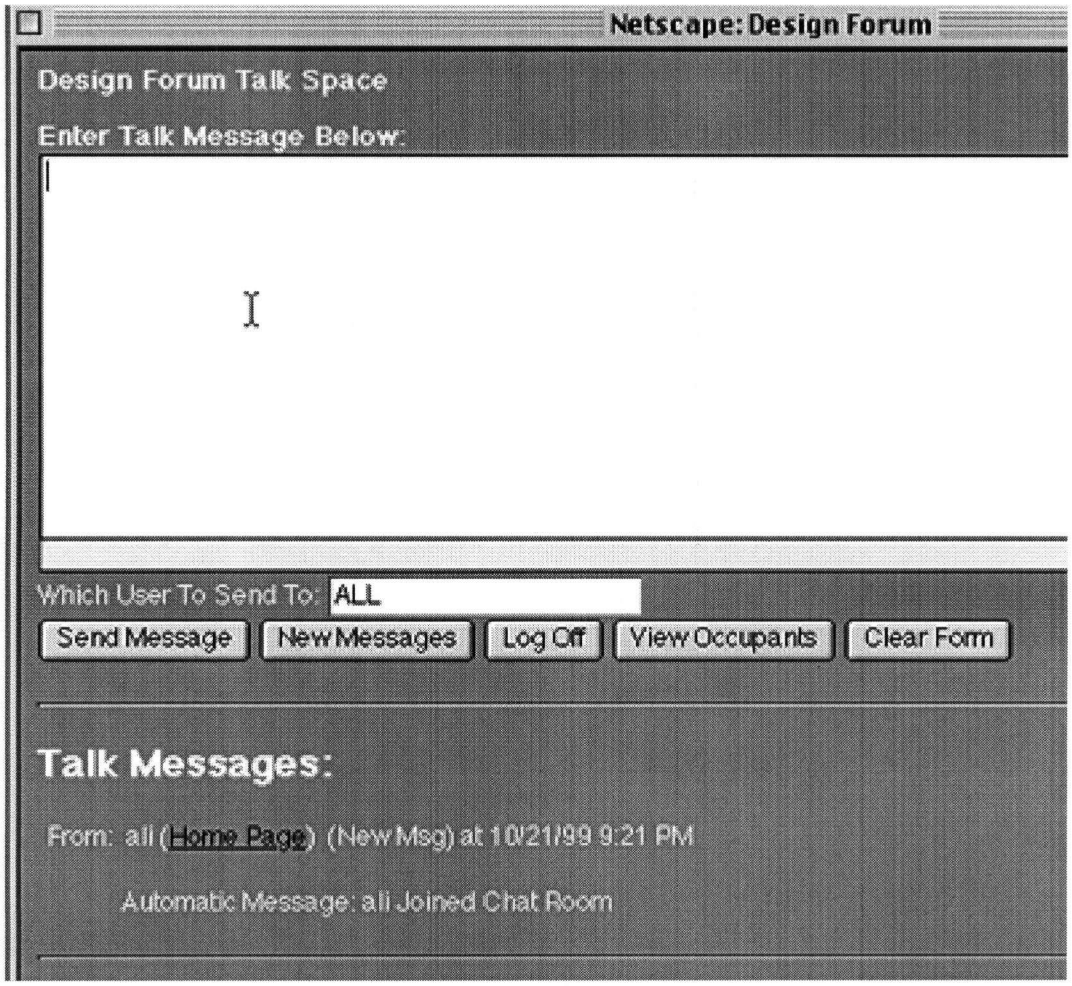


Fig. 25

talkSpace interface

the Web can be a quick way to hold a "virtual meeting" . Although both talkSpace and WebBBS store messages for other people to read, there is a major difference in how the user sees and posts messages. The BBS em phasizes long-term storage of messages, including statistical data such as the date and time the message is posted. The BBS also encourages users to branch out into different topics in "threads" of replies. On the other hand, talkSpace emphasizes the quick posting of small messages much like a conversation among a group of people. Dialogue is designed to flow swiftly in small, easily digested chunks. Additionally, because the topic is being discussed by everyone at the same time, there is little room for different people discussing many different things in the same chat session. Thus, there is no reason to keep track of different threads of conversation. Because people are discussing things simultaneously in real time, another feature of Web chat is the ability to refresh or display new messages as quickly as desired. This is done using the META HTML tag to force refreshes within a certain time frame. talkSpace includes many features designed to facilitate this kind of dialogue. In talkSpace, users can refresh messages using a button that is displayed in plain view. In addition, if the user is using a browser such as Netscape, that supports the META REFRESH HTML tag, the user can choose to have the chat messages refresh or redisplay themselves automatically at a user-defined interval. Messages are displayed in chronological order of posting from most recent to oldest so that users can quickly look through a list of statements. In addition, users can specify whether to see only new messages each time they refresh the screen or to include a user-defined number of previous messages. Viewing several of the previous posts along with new ones tends to provide the user with greater continuity (Fig.25).

By default, messages are posted to everyone, and the user's information is embedded as part of a posted message. This arrangement facilitates quick posting. By default, posted messages are seen by everyone. However, the user has a choice of entering a different username to specify whom the message should go to the message is then entered as a private message from one person to another. This is option analogous to someone whispering a comment to someone else in the middle of a larger meeting. Additionally, Netscape-style frames are supported; messages are refreshed in one frame while the user types messages in another frame. This feature allows a user to set a relatively high refresh rate for seeing new messages, while leaving the message submission form intact while the user is typing a message. talkSpace also has configurable options such as the automatic announcement of a user's entry into the chat area, allowing people to keep track of who is currently in the system. Also, when a person leaves, he or she is encouraged to announce the departure by pressing the Log Off button. Nothing is more disturbing than to find out the person you were chatting with has left the room! In addition, WebChat can be customized to remove old messages by age and by number of messages. For example, if WebChat is used for real-time conversations, it is generally not useful to keep the conversation messages for more than an hour. Additionally, you may want to make sure that not more than 10 or 20 messages stay around at any given point, because messages older than the first 10 may be irrelevant to the current course of conversation. On the other hand, on other chat areas, you may want to keep the messages around for a long time to keep a full transcript of the discussion or meeting.

4.2 Collaborative Design Scenario

4.2.1 Process

In an experiment ran between a number of students at the Computer Lab of the School of Architecture at UBC, a preset collaborative design scenario has been set for the collaborators to follow (Fig.26). They started initiating the type of project that they needed to do by discussing it over the internet (Fig.27), using talkSpace as a medium for the communication. They exchanged general information of the project. One team required the other

Suggested scenario of the different phases of design collaboration

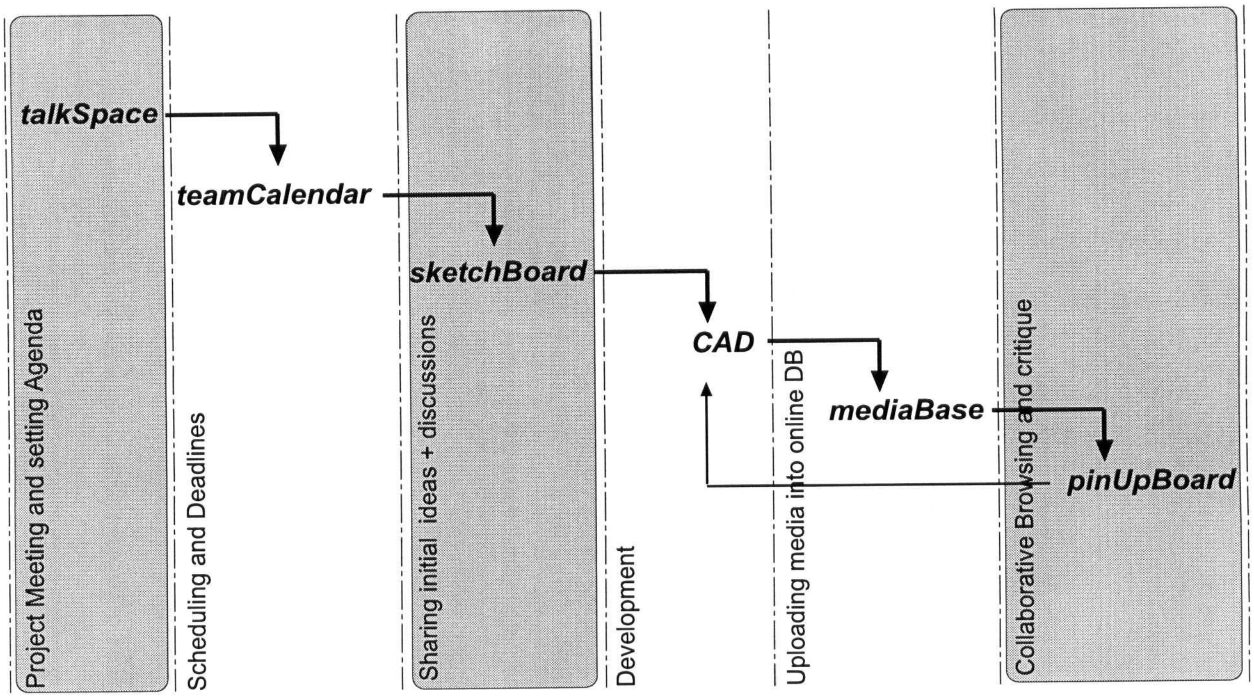


Fig. 26

Collaborative Design scenario using the iSpace applications

team to help in designing a simple bench. As they were discussing the project, they logged in into the teamCalendar where they could specify deadlines and meeting times for them on the net. Team 1 posted their deadlines and submission dates required from team 2, while team 2 responded to agree on these dates and times. The next step, they started a sketchBaord session (Fig.28), where team 1 sketched in a freehand mode on the shared screen what they needed in terms of form, jointry, materials, and colours. During the sketchBoarding, they where exchanging commentsabout what is on the sketchBoard and pointing out to some areas of concern.

At the end of the sketchboard session, team 2 took the data and compiled it into a CAD drawing (Fig.29,30). After they were done with the CAD drawings,

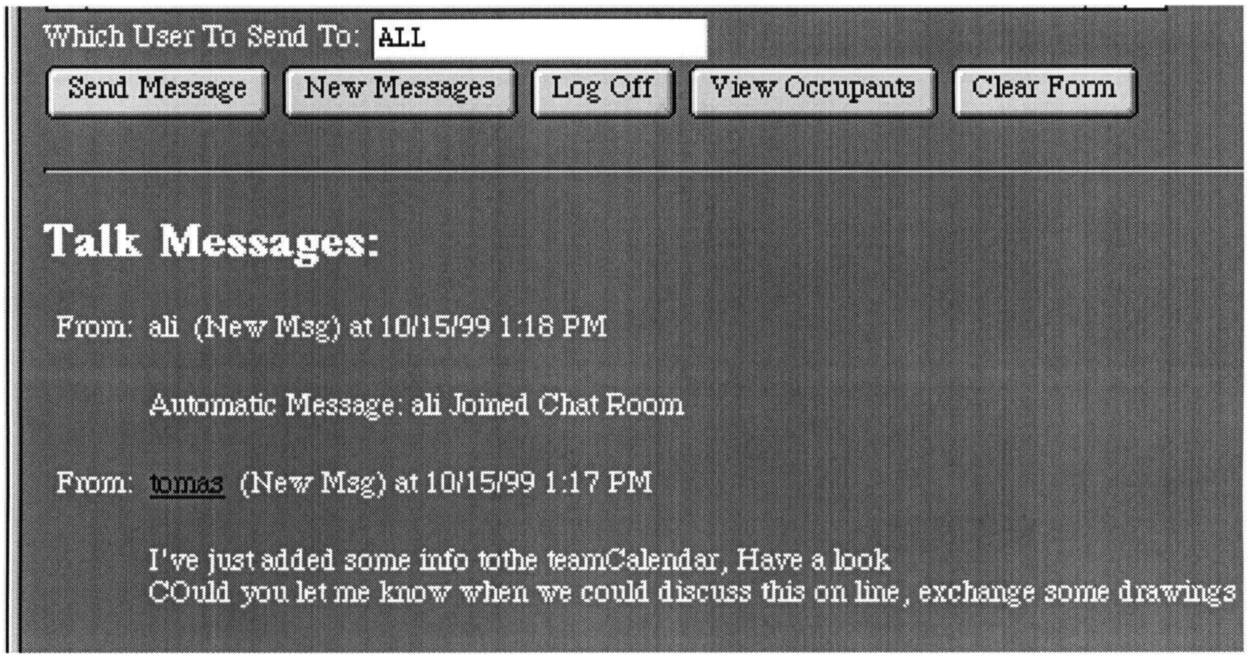


Fig. 27

Students at UBC exchanged messages as a first phase of project collaboration

they prepared some rendered images of the bench and published the rendered images into mediaBase and transferred the CAD files to the web server to make it available for team 1 to edit it.

As the images made available on the mediaBase, team 1 had the opportunity to look at the files and prepare their input for the pinUpBoard session that is scheduled to happen after. All the published data were organized and structured as records in a database, searchable, editable in realtime.

Before the two teams met on the pinUpBoard session, they have set an index of the media reference to be downloaded during the session.

The pinUpBoard session, is a realtime collaborative application that has to rely on some stable and fast network data transfer even under low bandwidth

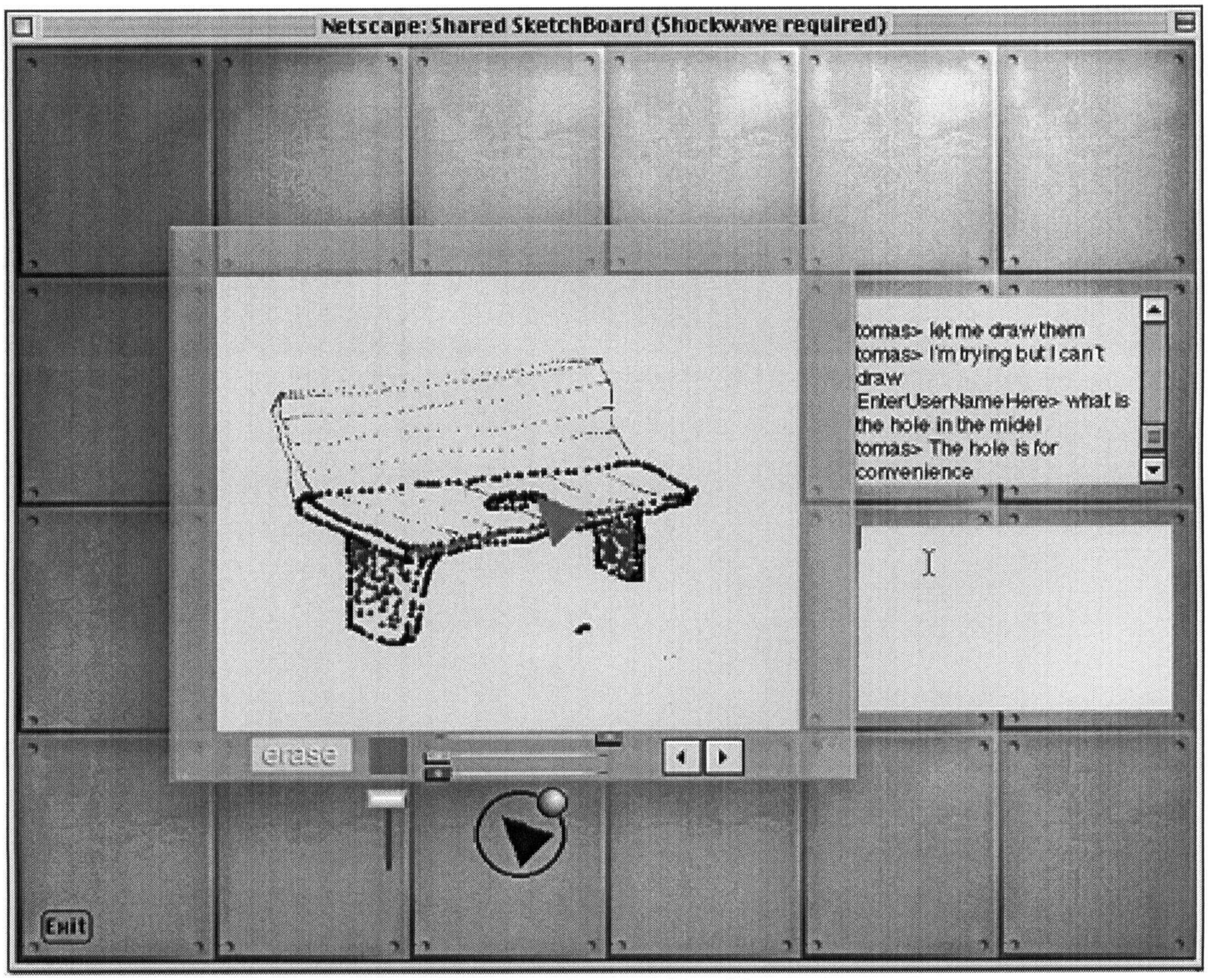


Fig. 28

The 2 teams shared live sketching over the sketchBoard

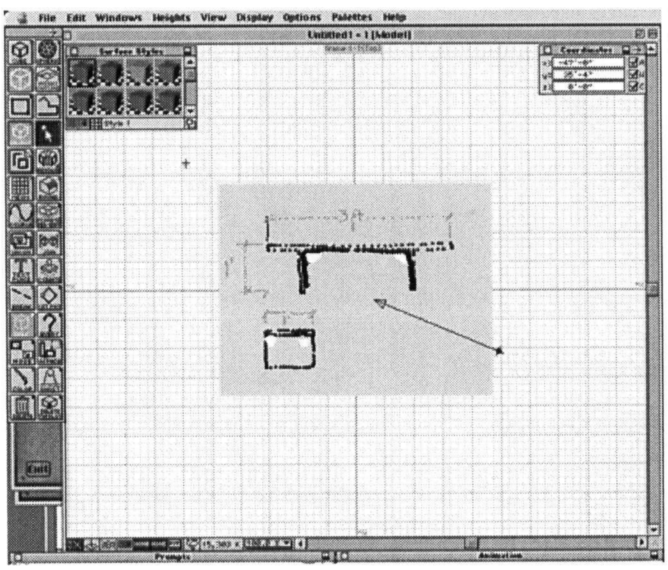


Fig. 29

Team2 took the sketch produced in sketchBoard into a CAD program

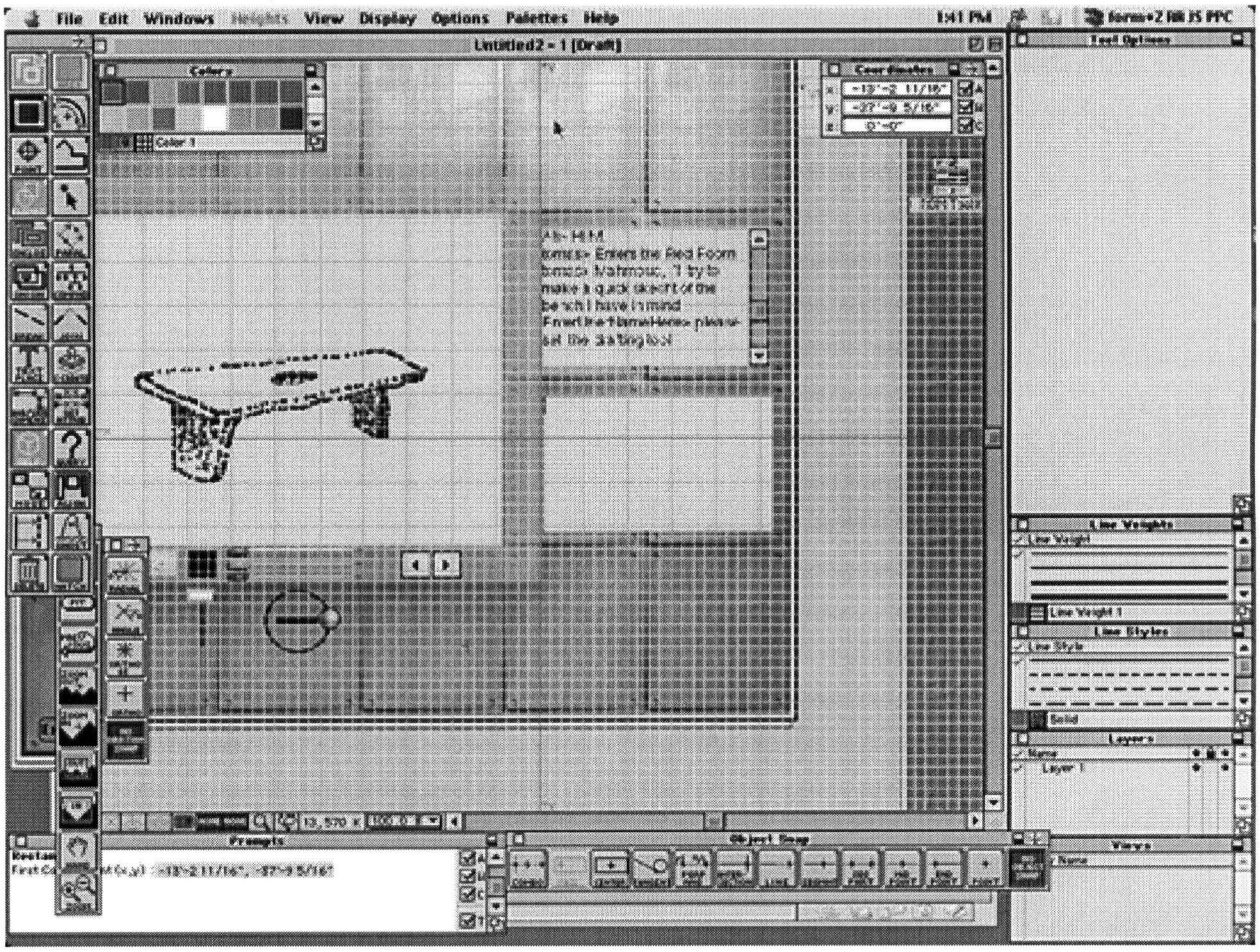


Fig. 30

Building the 3D model in CAD (FormZ 3.0)

connections.

After they both logged in for the pinUpBoard application, they were able to share the media in realtime, taking terms in controlling the browsing of the session (Fig.31). The two teams were able to exchange comments, red circle areas on the drawings, measuring, zooming, and panning the media on the screen.

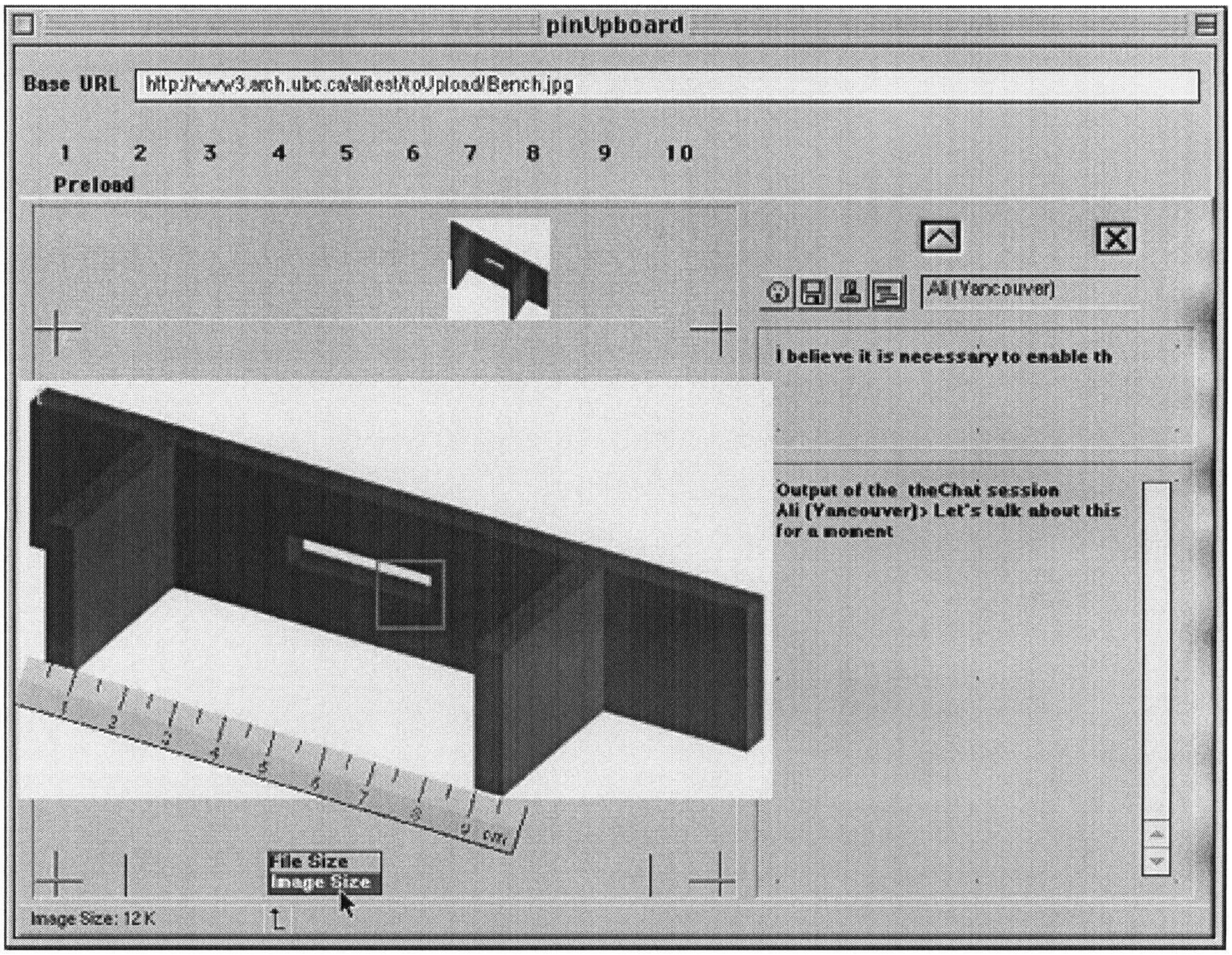


Fig. 31

Both teams shared the pinUpBoard to display the media and exchange comments on them

The last collaborative session was meant to be the first pin-up meeting of many subsequest sessions that represent the review cycles of the design process.

4.2.2 Evaluation

The first issue that came to surface when collaboration started was concerned with the level of interaction. People usually expect to practice their social skills in the virtual space the same way they are used to it in the physical space. One of the collaborators asked for a video camera and voice transmission among all collaborators. As this sounds to be a simple idea to implement, infact it is possible when the bandwidth is quite high. Yet, this collaboration experiment has defined the goals from the start that it will use a low bandwidth connectivity to set a benchmark for the least cost and best quality that design team members could get. If we talk about fully immersive environment where collaborators are sharing in realtime the virtual space, transferring back and forth binary media, working on the same model, sharing the same cursor, and conversing with each other through video conferencing screens, while others are rendering the model somewhere else, importing different textures in realtime from many sources to experience the visualization of the architectural product in full length, then we will be dealing with an expensive technology that can hardly return its investment with low profile projects and limited budget work.

Some other technical issues were raised during collaboration, such as the speed of the freehand tool on the sketchBoard does not really catch up with the speed of the human hand. People also expect the application interface to have some standard look that resembles interfaces found in products they are used to. Infact, standardization of the information flow can result in predictable pattern of behaviour of the groups during collaboration rather than wondering around to find the right tool for they want to do next.

One of the observations that we have made, is the way designers solve a design problem over the net. Mapping ideas of each other, and collectively dissiminating the knowledge required to solve the design problem. To a certain extent, collaborators could brainstorm simple ideas about the project, making quick decisions, and implementing it in realtime. Considering the traditional processes of similar nature, we think that it is very possible to enhance the production environment by giving the designers more of the tools they are used too in addition to the new tools originated by the technology itself.

Since this prototype is designed to accommodate 50 users, it is really difficult to have common protocols of communications between that number of users. Controlling the collaborative sessions needs mediators that will filter out messages, establish the right channeling of information flow and protocols as well as administering the process in general. The role of a mediator is crucial in collaboration, whether it is merely a software agent or a human, or even both, is open to further studies and tests.

4.3 Conclusions

As of the time this research is written, the architectural profession is still in a period of transition between the analogue and the digital format. Crafting a design concept is still a manual process. Vectorizing sketches is not yet feasible, sharing a digital project in full length over the network is cumbersome enough to waste time that was gained by other factors. The digital technology and after 30 years in the architectural field has not reached the desired scope and performance. Best questions are asked by novice technology users. Expectations are high, and anticipations are higher.

One way to reach the seamless integration between the information technology and architecture (the researcher's point of view) is to contribute to it. Architects, as much as they are developers of better spaces to inhabit, they must add the information space as another design problem on the list.

They will also be the first to talk about Green Digital Spaces, Ergonomics of Virtual Space, and most importantly, the styles and typologies of the Neo-virtualism. Desire is the inspiration of the new need.

Drawing conclusions off this research has two dialectic sides:

on the one hand, it appears that setting up an environment that can have inexpensive solutions for distributed design collaboration can result in a very effective communication as well as a solution for designers dispersed on different geographical locations and time zones to work together, share their knowledge and solve design problems in a limited scale of project size.

While on the other hand, the type of a collaborative experience may vary according to the context of the design process and its different phases. As a result, applications that provide limited tools can be hard to adapt to the different needs of designers and designs. By allowing designers to customize their own tools and use their intelligence to use creative techniques is probably the most important issue that should be considered when developing applications for design collaboration.

In many ways, designers are not typical users as the term is used. They need more freedom in the medium of creativity and flexible tools that enable

Bibliography

AKIN, OMER; Psychology of Architectural Design; Pion, London. 1986

BOISOT, MAX H.; Information Space: A Framework for Learning in Organizations, Institutions and Culture; Routledge, New York. 1995

BOYD, LANE; Collaborative Efforts, Computer Graphics World, Vol. 21, Number 9. September 1998

BUSH, VANNEVAR; As We May Think; The Atlantic Monthly, July 1945

DERRIDA, JACQUES; Archive Fever: A Freudian Impression; The University of Chicago Press, Translated by Prenowitz, Eric. 1996

FISHER, K & FISHER, M. D.; The Distributed Mind: Achieving High Performance Through the Collective Intelligence of Knowledge Work Teams; AMACOM, New York. 1998

GUNDAVARAM, SHISHIR; CGI Programming on the World Wide Web, O'Reilly, California. 1996

KOLAREVIC, B. & SCHMITT, G. & HIRSCHEBERG, U & KURMANN, D. & JOHNSON, B.; An Experiment in Design Collaboration; Proceedings of Acadia 98; Quebec, 1998

LÉVY, PIERRE; Becoming Virtual: Reality in the Digital Age; Plenum, New York. 1998

MEYROWITZ, JOSHUA; No Sense of Place: The Impact of Electronic Media on Social Behavior; Oxford University Press, New York. 1985

MILNE, MURRAY; Computer Graphics in Architecture and Design; Proceedings of the Yale Conference on Computer Graphics in Architecture, Connecticut. 1968

MITCHELL, WILLIAM J.; City of Bits: Space, Place, and the Infobahn; MIT Press, MIT. 1996

MITCHELL, WILLIAM J. & McCULLOUGH, MALCOLM; Digital Design Media; Van Nostrand Reinhold, New York. 1995

RAWLINS, GREGORY J.E.; Moths to the Flame: The Seductions of Computer Technology; MIT Press, MIT. 1996

SMITH, JOHN B.; Collective Intelligence in Computer-Based Collaboration; Lawrence Erlbaum, New Jersey. 1994

STANNY, K.M. & MOURANT, R. & KENNEDY, R.; Human Factorsin Virtual Environments: A Review of the Literature; Presence Vol.7, No. 4, August 1998, p327-351

WINOGRAD, TERRY; The Design of Interaction; Beyond Claculation: The Next Fifty Years of Computing; Copernicus, New York. 1998

WOJTOWICZ, J., DAVIDSON, J., MITCHELL, W.J.; "Design as Digital Correspondence", Computer Supported Design in Architecture ,Kensek, K., Noble, D. (ED), ACADIA 1992

WOJTOWICZ, J., (ED.) "Virtual Design Studio", Hong Kong University Press. 1995

Web Links

www.adaptivemedia.com

www3.arch.ubc.ca/ali

www3.arch.ubc.ca/jerzy/vds_research/

www.bentley.com

www.extropia.com

www.macromedia.com

www.opensource.com

www.yahoo.com

Appendix

Included with this book, a CD ROM that contains the compiled applications developed for this research. It runs on both Mac and PC platforms.

A description of the content is as follows:

pinUpBoard: A standalone version of the application for both mac and pc

sketchBoard: A standalone and a shockwave version of the application

cgi-bin: This directory include the cgi scripts that need to be installed on a http server . To run them you will need to change the path for the server directories.

<u>calendar:</u> teamCalendar application

<u>chat:</u> talkSpace application

<u>DB_Manager:</u> mediaBase application

webSite: A copy of the published web site for the research at:

<http://www3.arch.ubc.ca/ali>