Network Based Group Work CAD for UNIX Workstation

Mitsuo Morozumi
Yuji Murakami
Kazuhisa Iki

Department of Architecture,
Faculty of Engineering, Kumamoto University
2-39-1, Kurokami
Kumamoto City
JAPAN 860

This paper discusses a model of collaborative process of architectural design and a network based group work CAD to support them. In the first part, the authors introduce a prototype system they developed to improve the environment for synchronous (interactive) design communication. Reviewing the process of students' collaborative work that used the system, the authors point out that the frequent and timely exchange of CAD data with the system could not only stimulate designer's' imagination but accelerate the process of design development.

Keywords: collaboration, group-work, CAD, design process, network

1 Introduction

With the development of high-band width communication technology, the idea of a network based group-work design system start attracting designers interests..

"The Virtual Design Studio," Professor W. J. Mitchell's writing, gives us many impressive suggestions on the future direction of such design environment [1]. It is possible to say that the file-transfers through computer networks have already opened up the possibility of a hands-on collaborative design process, so long as one regards that the architectural design activity develops only in a concurrent, but asynchronous fashions. A video teleconference system also could supplement necessary face to face communication, even among designers who work in distant places [2].

It is not seldom that designers desire to exchange design information among team members to get critical feedback and achieve fast problem solving. How about the development of systems that could support the synchronous collaboration? There are several group-ware systems that have utilities for exchanging, over-laying, and editing raster data in an interactive fashion, such as the collage exchanging, or the cola (Xerox PARC), but few systems could handle CAD models or vector data that became quite common and most important media of design communication [3].

It is the goal of this study to develop a model of network based group work CAD systems for UNIX workstations that could provide the seamless design environment both for the synchronous (interactive) and the asynchronous (independent and concurrent) activities. This paper mainly discusses the collaborative design system for one place. This is partly because the speed of public communication on a network still remains slow, and partly because the model of synchronous collaborative design process had not been well defined yet, This paper discusses the following topics:

(a) a model of collaborative process of architectural design, and examples of technical barriers that exist in the conventional method.

(b) a model of G-W CAD as a solutions to the barriers pointed out.

(c) analysis of student collaborative design work that used the prototype system.

(d) evaluation of the system and the tasks left for future studies.

2 Analysis of the collaborative design process

2.1. A model of collaborative design

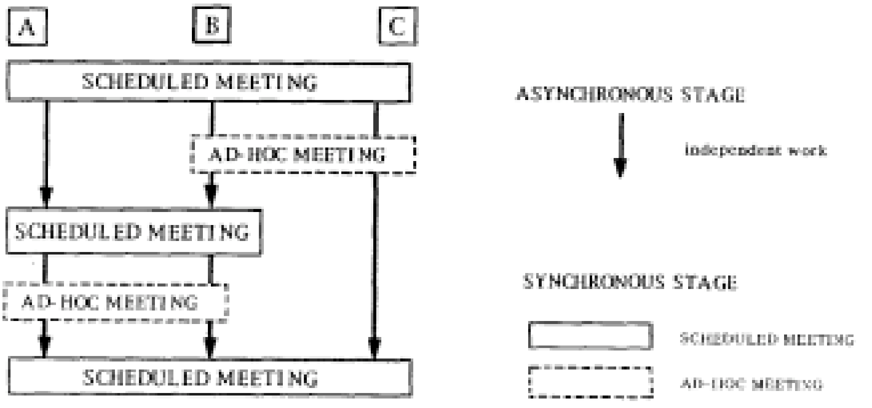

Figure 1 A model of collaborative design process

The authors, reviewing how students communicated and acted to develop their proposal in several group design projects, assumed a basic model of collaborative design process. It is possible to regard that their works correspond to the schematic and the design development stage of design work in a professional team.

(a) A total process of collaborative design will be carried out as a chain of asynchronous (independent) and synchronous (interactive) activity stages (Figure 1). In the former, group members work independently to complete the assigned tasks by the designated time. In the latter, they assemble, review, and exchange the results of independent works, and then achieve some agreements in each step.

(b) The synchronous activity stage generally starts in two different ways: scheduled meeting and ad-hoc meeting. The former generally takes the style of presentation and discussion, or sometimes, brain storming with all group members, while the latter usually takes the style of spontaneous information exchange among the part of group members, such as to get critical feedback and achieve fast problem solving.

(c) There are two different cases in assigning tasks for the asynchronous stages: assign the same task on a competitive basis, and assign differing but inter-related tasks. Divide responsible parts of a building to produce a model of large complex will be the latter case.

(d) A group member uses various media of communication. When they develop conceptual models, in other words, clarifying requirements, establishing design guide lines, establishing formal image, the verbal expression, manual sketch, graphic image data, or rough scale model become the major media of communication. When they define a physical configuration of the proposal, the drawings or the three dimensional models play important roles.

2.2. Technical barriers of the conventional communication method

The network based CAD system that supports file transfer has already improved the environment of communication required for asynchronous collaboration, a good deal, but few systems have not yet provided convenient utilities for the synchronous collaboration. Only some of those group-ware systems support communication through texts and raster image data [4]. Some of barriers usually faced in the synchronous collaboration are the following:

(a) It is a common scene of a design meeting that team members sit around a CAD terminal or a video projection screen to see some members presentation. Such a style could allow only the system operator to hold the privilege of manipulating models or viewing conditions. Any other member would be allowed only to make verbal expression. It would be ideal if all members could have an equal chance to manipulate the models or to change the viewing conditions and if they could share and review the records of discussion later [5].

(b) It frequently occurs in the asynchronous stage, especially when the team members split their tasks, that some member needs to refer to another members design or even want to quote a part of his or her models as the author described in the 2.1 (b), but most CAD systems require a complicated process of data exchange for designers [6]. Communication sitting around hard copies, besides, sometimes after the request will be the common result of these barriers. Complicated procedure of data exchange will never promote but only to degrade interactive design development process.

3 Functional framework of the GW-CAD for UNIX workstation

3.1 Configuration of the prototype system

The authors have developed a basic model of group work CAD system for UNIX workstations: the GW-CAD. The prototype system has uses two workstations networked with LAN. Designers exchange all necessary communications through the system except the image data are captured and sent to the system through a Mac system that is linked to the same LAN. Hardware and software configurations of the system are the followings:

Hardware:	HP9000 model 735 and 710
OS:	HP Shared-X
Software:	AutoCAD R12J, Alied Telesys Center;
	NET PC/TCP, ver. 4.0: White Board (free-ware)
Programming Language:	Autolisp, HP CADS (Aut0CAD Development System)

Because the authors could not find a video communication system that works on HP workstations, the prototype system did not deal with the audio and video communication by that moment.

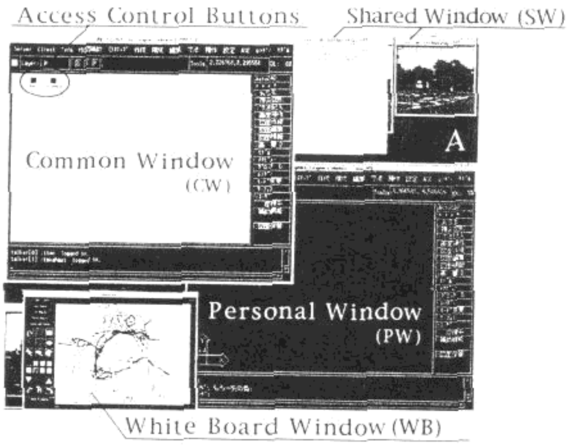

Figure 2 Standard window configuration

3.2 Window configuration

Figure 2 represents standard window configuration. The author put character A or B in each graphics so that the readers will be able to identify which terminal it represents.

(a) Each workstation has at least two CAD windows. Personal CAD Window (PW) allows designers a personal modeling space to develop and test each idea without being interfered by others. All utilities of AutoCAD R12J can be used in it.

(b) Common CAD Window (CW) provides a space in which to broadcast a model to others, to assemble those models of different members, and to quote a part of those models to develop variations in the PW. In the prototype system, both members can manipulate viewing conditions and layer controls of the CW from each terminal by just hitting the access control buttons displayed on each CW. A red lamp indicates who holds the right to access the CW. Shared-X always controls the CW on each workstation so that each member (two members, in this case) will be able to observe the same image

(c) Image data and text data can be retrieved from the database and presented on the shared windows (SW). Each member can also share the SW with the simple menu operation. To draw rough sketches and exchange them, the system uses the White Board (WB) in the SW.

3.3 Method of communication among the members

(a) The system requires some of the members to install site models or other common modeling data to the CW using the INSERT command of the AutoCAD in the beginning.

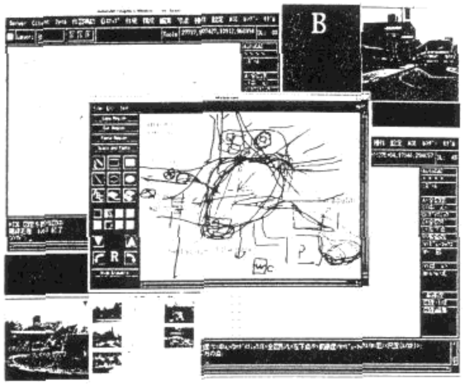

Figure 3 White Board that support communication with sketches

(b) When designers want to discuss design requirements, design guidelines, formal image, they can use the SW and the WB to exchange visual information (Figure 3). c) To present sections of models (objects) developed in the PW to others, the send-out command copies the selected objects in the PW and places them at the corresponding location in the CW (Figure 4). In selecting objects, he or she can follow the normal procedure of the AutoCAD. The system automatically displays the image of those objects sent and creates a back up file of the model stored in the CW, attaching a special label so that he or she can trace the process of design development.

(d) When a designer wants to quote sections of models proposed by others as the seed of the new element design, he or she can copy sections of the model (objects) displayed on the CW into the PW (Figure 5). For simplification, the authors call objects selected as targets of copying action Mother Objects, and the objects generated in the PW as a result of a copy operation Copied Objects.

(e) It is also possible to send back the Copied Objects to the CW (Figure 7), after adding some objects, or removing or transforming some part of the Copied Objects (Figure 6). It is possible to select whether the Copied Object should replace the Mother Objects or simply add them as the new objects [7].

(f) The present version system does not allow editing of any models on the CW directly.

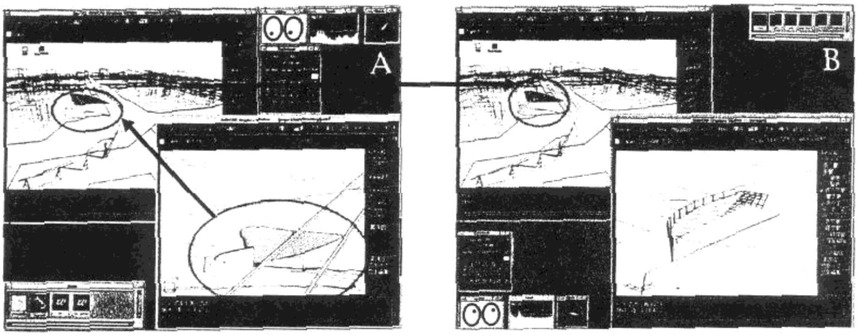

Figure 4 Display image of operation to exchange models between terminals: first step

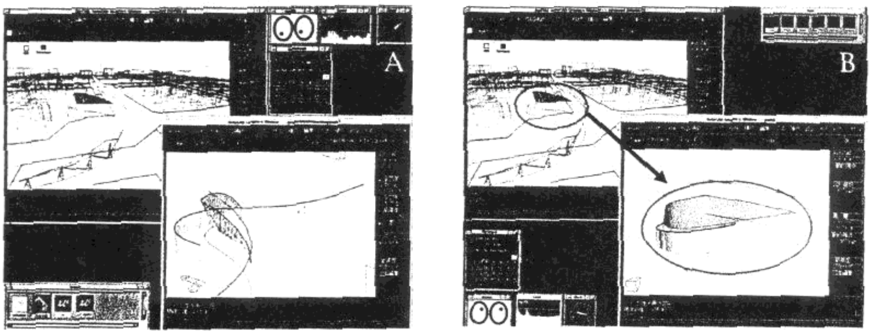

Figure 5 Display image of operation to exchange models between terminals: second step

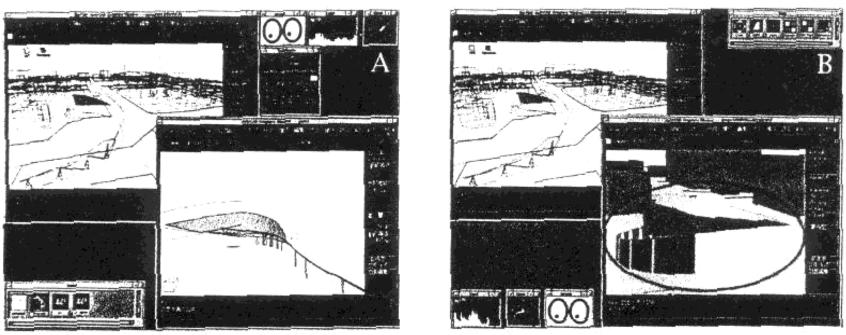

Figure 6 Display image of operation to exchange models between terminals: third step

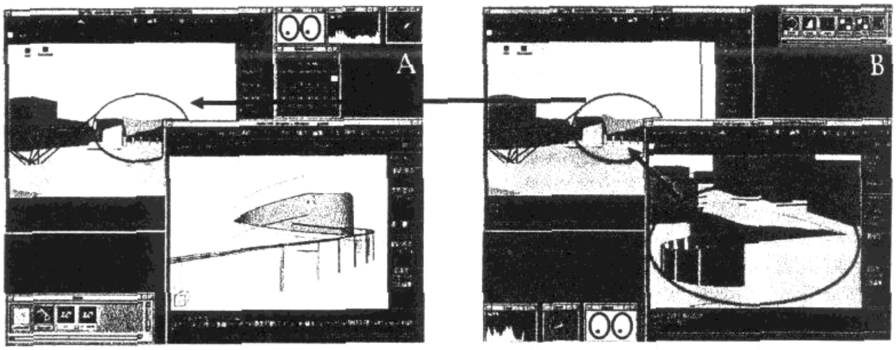

Figure 7 Display image of operation to exchange models between terminals: fourth step

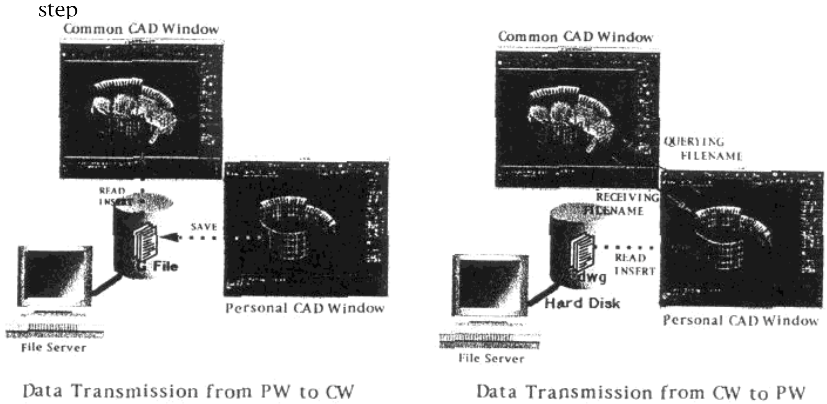

Figure 8 Mechanism of CAD data transmission between the CW and the PW

3.4. Technical considerations

The host machine operates all windows. HP Shared-X controls all necessary procedure for window sharing, and NFS allows to use the AutoCAD in each CAD window. To present sections of objects developed in the PW to CW, the system stores selected objects as a new file and sends out a prompt message with files name to the AutoCAD system that works as the CW (Figure 8). On receiving the message, that AutoCAD system starts commands designated in the message. The copy back operation from the CW to the PW follows similar procedures described above. The authors have written data-gram type utility to make the AutoCAD system watch the receipt of message and to activate commands needed to exchange data between the CW and the PWs.

4 Case study

The authors have asked students to use the prototype system in their group design rect. The case study was taken from the latest work of students in a design competition: design shelters for the two bus-stops in the small local city: Yatsushiro. As Figure 9 shows, the site for each bus-stop location on the opposite side of large streets-crossing has a distorted shape. The site is located in the old section of the downtown area, a 10 minutes walk to the major shopping arcade. Figure 10 and Figure 11 - 12 respectively presents their final out put and the process of design development in about two weeks study.

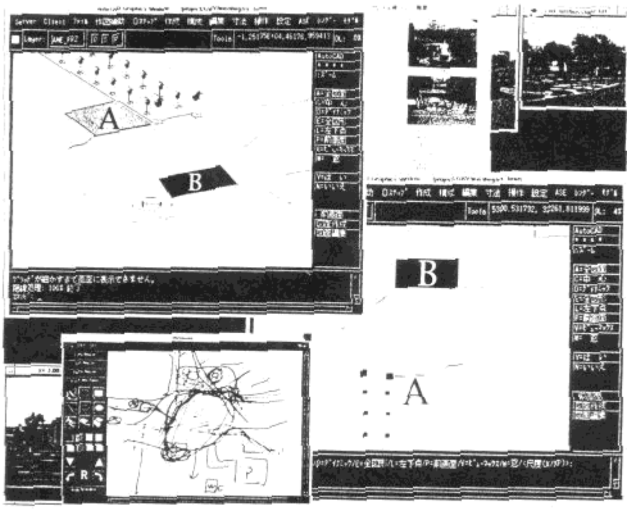

Figure 9

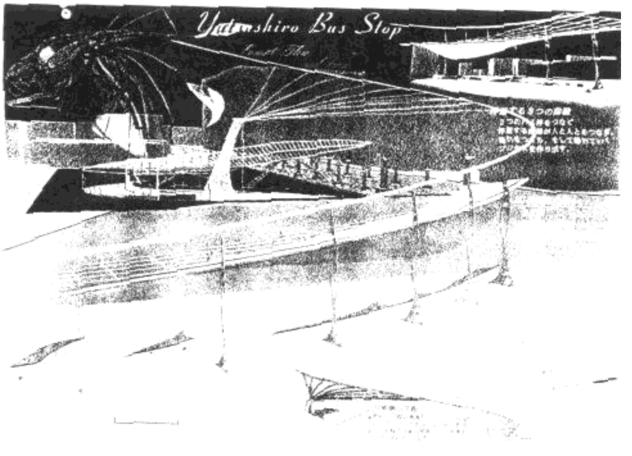

Figure 10 Final presentaion made by the student

In the beginning, students expressed that it was strange to each display while they were sitting side by side, but after two or three days, such anxiety seemed to have disappeared. Though the authors asked them not to use any materials in the form of hard copy to communicate with each other, they did not seem to have any special difficulty in their communication. The Figure 11 shows that they exchanged their data frequently to ask for advises on design schemes, or to make proposals to others. An effective example of the system use is that, on the 8th day, student B reviewed and advised student A's proposal in the CW, selecting viewing condition that could observe the A's bus-stop from the view of the B's bus-stop user. Observing the shape of the roof and the silhouette of the surrounding buildings, student B proposed a revised model. Without the easy data exchange utility, student B would neither test student A's proposal in CW from his site nor even revises other student's proposals.

On the 12th day, student A gave the student B an idea to use the shape of his wall design by as a guide to design benches of B´s bus-stop. This could be another interesting case of communication that the system had stimulated.

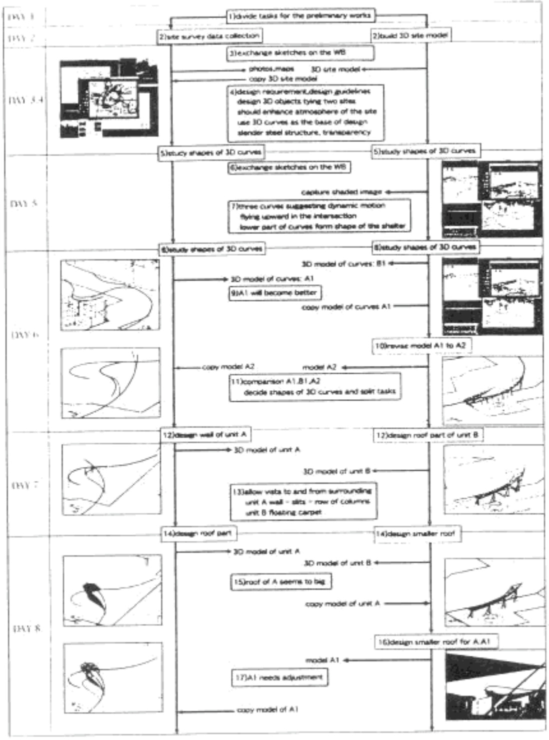

Figure *11* The process of design development and some of their graphic

Though the period for the project was short, and various works and exercises assigned to them had prevented them from concentrating on the project, they succeeded in submitting attractive proposals as shown in Figure 10. Compared to the work previously done by those students, the author has the impression that the proposed project has a higher quality of design and presentation than those other works.

5 Conclusion

It is difficult to prove whether the system enhanced students ability or not. It is also difficult to estimate whether the system can be used for synchronous collaboration among designers who work in distant places, at this moment. Reviewing the process of the case study, it is possible to conclude at least that the proposed system will be able to support quite active collaborative design work in one place. The case study has given us a clear example that frequent and timely exchange of CAD data with the system could not only stimulate students imagination but also accelerate the process of design development.

Some of the advantages of the system found during the experiment are the followings:

(a) The case study showed that the proposed model of collaborative design process has represented a real case well. It became clear that ad-hoc meetings have important roles in the group design. How to support such information exchange without interfering independent works has become quite an important subject for a group-ware design.

(b) A working environment that has both the CW and the PW seems to fit well to a collaborative design process. It usually takes less than ten seconds to exchange three dimensional models between the PW and the CW. The data exchange through the CW or other SW succeeded in providing sufficient communication interface among members.

(c) The utilities to record design process both raster data and vector data appeared very convenient to review and trace the process. This paper was written using materials recorded by this utility.

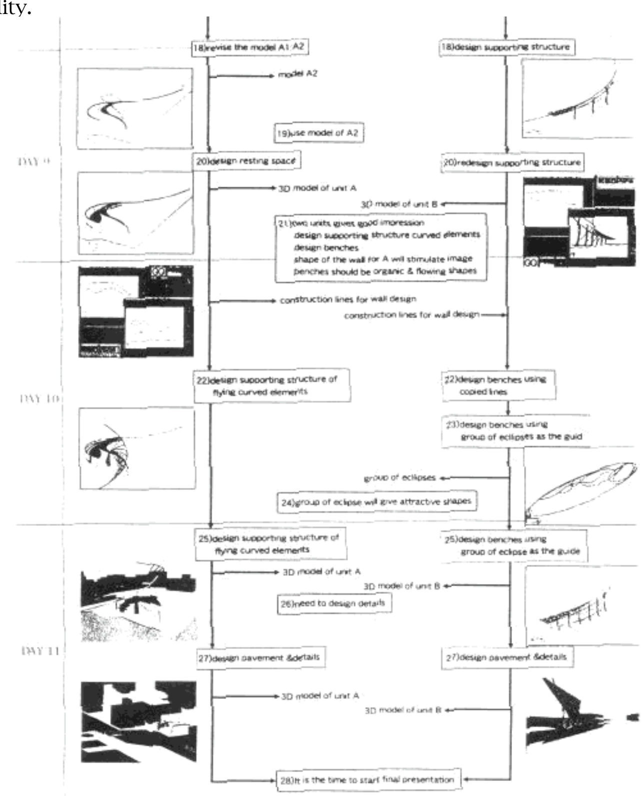

Figure 12 The Process of design development and some of their graphic out put: second half

Some of the subjects for the future studies found through the case studies are the followings:

(a) The CPU loads of the host machine become quite heavy because it has to control all windows. To increase the number of terminals in the system, it seems essential to find a way to distribute CPU loads among workstations.

(b) To keep a record of design development process, the prototype system did not allow any member directly to manipulating CAD models in the CW windows. The students requested strongly to allow interactive modeling in the CW.

(c) It would be convenient if the designer could select objects to be replaced and ones to replace them in the future system.

6 Acknowledgments

This study was supported by the Grant-in-Aid for Scientific Research from the Ministry of Education, Culture and Science. The authors gratefully acknowledge the contribution of Mr. Sin-ich Setoguchi and Mr. Tadashi Yano, former graduate student, for developing the system, and Mr. Katsunori lino and Mr. Masayuki Takahashi for producing graphic materials for the paper as well as participating the case study.

7 Endnotes

[1] See 3).

[2] See 1). Waseda University in Tokyo and Kumamoto University in Kyushu Island conducted a similar experiment in August 1994. There were two teams. Each consisted of two students, one of which lives in Tokyo and the other in Kumamoto. The digital team used FTP and e-mail through Internet, while the analog team was allowed to use Fax and telephone to communicate with the partner. 2) compared how the level of communication that took place within each team was different during the process of design development.

[3] Chen et al. 1) used collage (version 1.2.1, an interactive white board and image sharing program). 4) (Written in Japanese) introduced major studies on group ware system.

[4] Chen et al. pointed out the need to extend the technology between sites so that it could help synchronous design development. Mitchell also discusses in 3) as: "Some of the most interesting and important research issues that might be immediately tackled relate to the interface. What metaphor should structure interactions in the virtual design studio? How can teleconferencing effectively integrate continual reference to the CAD geometric model?"

[5] Yamaguchi developed the Mac based group ware system, in which switching system allows to connect multiple keyboard to a single CPU. See 7) for detail.

[6] GDS allows to share models among terminals only for "viewing'. It also requires several steps of file operation to quote a part of models some other member is editing.

[7] When a designer selects adding operation, the system insert the Copied Objects to the different layers from those for the Mother Objects.

8 References

(1) Chen, N, T Kvan et al., "Place, Time and Virtual Design Studio", Proceedings ACADIA Conference, (St. Louis: ACADIA, 1994); pp 115-132

(2) Hayashida, K, S Watanabe et al., Advanced Design Education Using Information and Network Technology", Proceedings of the Seventeenth Symposium on Computer Technology of Information, Systems and Applications, (Tokyo: AIJ.,1994); pp. 252-257.

(3) Mitchell, W J., "The Virtual Design Studio", Proceedings of the Seventeenth Symposium on Computer Technology of Information, Systems and Applications, (Tokyo: AIJ.,1994); pp. 497-502.

(4J Sakata, 5, Multimedia and Network Technology for Realizing Group-ware, (Tokyo: Software Research Center Inc.,1992, Written in Japanese).

(5) Setoguchi, 5, M Morozumi et al., "A Study on the System that Supports Group Works in Early Stages of Architectural Design", Proceedings of the Seventeenth Symposium on Computer Technology of Information, Systems and Applications, (Tokyo: AIJ.,1994); pp. 246-251.

(6) Wojtwicz, J & W. J. Mitchell, "Design as Digital Correspondence", Proceedings ACADIA Conference, (ACADIA, 1992); pp. 89-101.

(7) Yamaguchi, Set al.,"Architectural Design Environment of the Next Generation", AT magazine, (Tokyo: Delphi Research Institute,1994.12); pp.26-27.