4 Architectural Virtual Space in Design Education

Sungho Woo, Yoshihide Takenaka, Tsuyoshi Sasada

Depatment of Environmental Engineering, Osaka University

INTRODUCTION

Our research in recent years has included the subject of providing collaborative work space in the field of architectural design. We propose to improve the quality of architectural design education by extending the physical space of the architectural laboratory into the virtual space of the network (i.e. Internet). In this paper, this extension is called the Architectural Virtual Space (AVS) system. The aim of this paper is to provide the AVS system with reality, interaction and real time, and to popularize architectural design education by providing the applications and power whenever needed for collaboration on the Internet in conjunction with the growth of various browsers of hypermedia.

When it comes to the process of collaborative design projects related to Architecture and Urban Design in a university setting, a few conditions are needed in order to collaborate smoothly using computers and networks. Students located elsewhere (and if needed, the professionals) can review designs and exchange views immediately in a seamless environment on the network. Furthermore, if required, users can review designs, operate an authoring tool at once, and record the results of the design review and the contents of modification using agent tools. The record of examination will be saved automatically.

The established design system used in our university laboratory is a single-user application (not shared) by nature. It was developed to assist designers as a tool of design review and recording while solving various specialized problems. Therefore, there is a functional discordance between the design tool for design review and the groupware for communication from a distance.

This study emphasize the AVS system which extends the established design system. The AVS system is comprised of the authoring room which has tools for the creation and modification of objects in virtual space, the browsing room which has tools for automatically saving the review process and its result, and the communication room which has tools for the various forms of communication (Figure1). It is operated componently using middleware. We investigate its applicability through case studies when the AVS system is applied to design projects. We examine the problems when computer graphics is applied to architecture and urban design and try to find new solutions. Therefore, we suggest the AVS system for a solution to those problems.

1.0 A MODEL OF COLLABORATIVE DESIGN FOR EDUCATION

The group-oriented AVS system is a model of design environment where the collaboration progresses smoothly between the university and students, or between the university and the social organization in architecture design process. If needed, the AVS system has synchronous and asynchronous functions.

The synchronous function allows many kinds of tools in the AVS system to be shared,

and changes in the AVS system such as motion, data modification and sound is transmitted to the multi-users immediately. In this case, the problem of having a seamless environment in time and space is solved.

The asynchronous function is a function in private space (not shared) in the AVS-system. The design process needs to set limits to the public, and needs to progress in private space until the design is partially completed. Thereafter, the shared AVS system accommodates changes. In addition, the people concerned in designing are free from the restraints of being president at same time and same place. This can be compared to using a bulletin board for communication. The asynchronous function improves the quality of communication or design.

The AVS system is categorized as follows regarding the collaborative design environment:

1.1 Virtual Space

Virtual space is a main work space of the AVS system and has an interface with an authoring room, browsing room and communication room. It consists of shared virtual space and private virtual space. Shared virtual space allows multi-users to interact on the Internet.

The mechanism of the shared virtual space adopts a peer to peer method using the IP multicast which does not need a centralized server. Participants communicate with each other using the multicast in virtual space. The shared state is considered to be a shared memory on the network where processes interact through simultaneous access on the memory. The peer to peer method does not need a centralized server which means the world where an object is being added is alive while an arbitrary peer is active. After the object is completely replicated in another node, the object exists independently from the author and process.

The data in shared virtual space consists of Virtual Reality Modeling Language (VRML) data and Object data (Dive's data format) on the World Wide Web (WWW). VRML data is linked with other VRML data on the web, and is connected by virtual space anywhere in the world. In addition, it is possible to use text, image, movie and sound data on the WWW browser as a result of assigning the Uniformed Resource Locator (URL).

Object data appears as a result of reliable multicast protocol and active response by operating consistently and simultaneously. The object is replicated in numerous nodes which are coherent to changes in the replica. In order to carry on the design process simultaneously, every node takes a changed message from the multicast.

The dynamic movement of the object is defined as an interpretative script in Dive/Tcl. Dive/Tcl is effective on nodes in which an object is replicated. An event on the system (for example, interaction of users) such as a signal, timer or collision produces a script.

Users can navigate in 3-dimensional space, meet another user, utilize applications, and collaborate with another user. In shared virtual space, the participant is called an actor. It may be a human user or an application process. AnAvatar is used as a prototype which is modeled graphically by an input device of an actor in 3-dimensional space.

1.2 Authoring Room

The authoring room is equipped with tools which manipulate various objects, produce executable macro, and then modify it.

The authoring tool which is used for making Object data or VRML object-oriented data utilizes free software on the Internet. In order to decide on the design of virtual space, attribute data such as color, texture and shape, data is edited visually consulting the database.

The list server draws up a list of distributed data periodically during the first stage, and then integrates, arranges and makes an icon of it. Each piece of linked address information data can be downloaded by clicking on the list at anytime. When needed, the list server represents the data as an icon using a keyword search. The icon palette is called the parts box.

In the parts box, amacro which defines the movement of objects in virtual space as well as object data can be arranged. It is made of Dive/Tcl, and has its own interface window.

The design team can select the proper application which is designed componently for work in this room. In the collaborative environment, commercial applications as well as custom-built applications can be accessed theoretically.

1.3 Browsing Room

The browsing room is equipped with tools which edit and produce the processes of the design review, and give the results as a format of a variety of hypermedia in virtual space.

New types of design review use the concept of a time axis in virtual space. It is possible to reconsider the design contents after recording and reviewing the contents. The renovated presentation which contains a wide variety of data such as still images, animation and walkthroughs becomes prominent. To produce an animation which has been made using traditional recordings, one needs to integrate the previewer (tool of making the motion script), walkthrough and recorder.

It analyzes the data of virtual space on various conditions and suggests an application which saves the results of the analysis. On the WWW browser, if you input some data such as the position of the sun, its color and texture, Radiance which calculates a shadow of the object displays the input result. Radiance is connected with the WWW using the Common Gateway Interface (CGI).

GI is an interface for running external programs under the Hyper Text Transfer Protocol (HTTP) server on the WWW. CGI is a gateway which handles information requested from the client, and converts the result to the Hyper Text Markup Language (HTML) document, and sends the HTML results to the client (Figure2). CGI is linked with various resources in the world, and can use machine power and applications from a distance. It connects between applications and is operated componently to exchange an application if required.

1.4 Communication Room

The communication room is equipped with tools which enable a variety of communication between students who participate in the design project for smooth collaboration in virtual space. There are communication tools (i.e. the chat between multi-users or between single-users based text). The Nevot enables sound transfer. The

project participants state his or her opinion on the WWW and exchange it using bulletin board, which record a still image and text. The bulletin board is connected under the concept of CGI.

2.0 CASE STUDY-THE PROJECT OF THE FISH MARKET

2.1 Introduction

On the Island of Awaji in Osaka Bay Japan, the Maruyama fishery harbor is located. We made a ten-year total renewal scheme of the harbor on the request of local governments of the the Hyogo Prefecture and Seidan Town in 1992.

In accordance with the master plan, we designed facilities of the harbor one by one. The construction of two of these facilities has been completed. The fishing platform will be completed in 1993, and the fish market in 1995. Furthermore, we are proceeding to design two facilities: the fish market park and the sports field.

2.2 Design review

The AVS system is opened when a part of the fishing platform and the fish market in Seidan Town is completed. First of all, we opened the homepage of the fish market and explain how the design process works (http://www.env.eng.osaka-u.ac.jp/DesignP/Maruyama_F_H/ Maruyama_F_H.html) (Figure3). We made a design review using 3-D models and computer-generated images. Sketches which try to match the design with the environment is opened, including the process of volume study where a soft membrane covers a forum over reinforced concrete, and the process of shadow study where a membrane casts its shadow on flat surfaces, and the color and texture of rubber and metal.

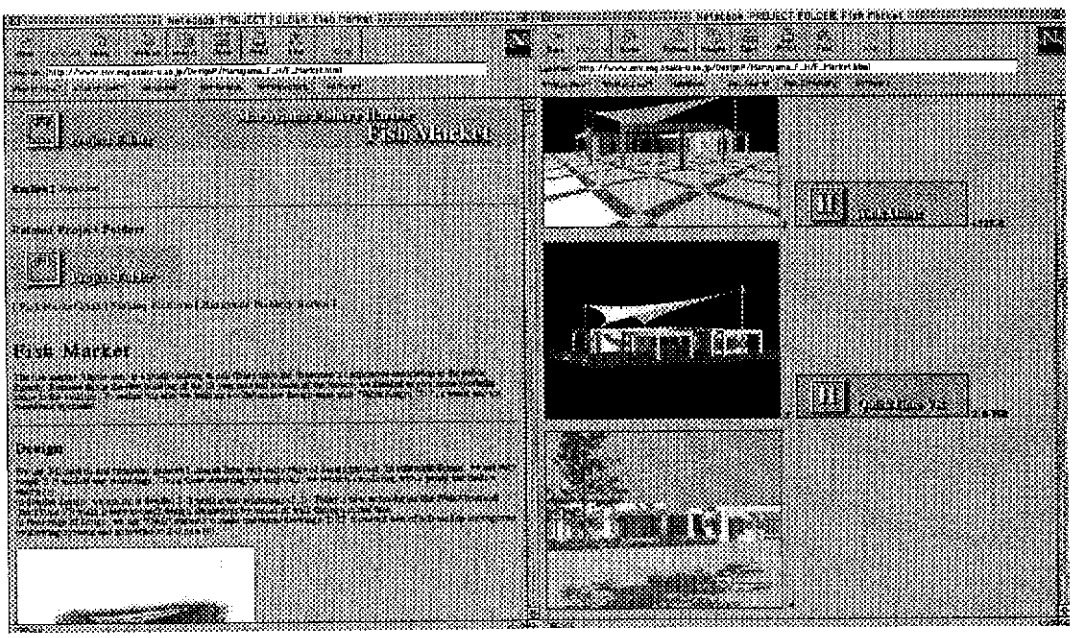

Figure1: Composition of the Architectural Virtual Space (AVS)

The students who have a shared window in their machines review the design in the virtual space of Seidan Town (Figure4). The student is on board and sees a facade of the fish market or fish market park in Seidan Town. The student also walks around the fish market and looks at the scenery of Narutou bridge from the fish market. Then, he or she reviews the details of the flame joints on the membrane and the interior layout of the fish market. In addition to the design process, there is in progress simultaneously in the private virtual space, and completed sections are put into the shared virtual space. Participants in virtual space can discuss information with each other.

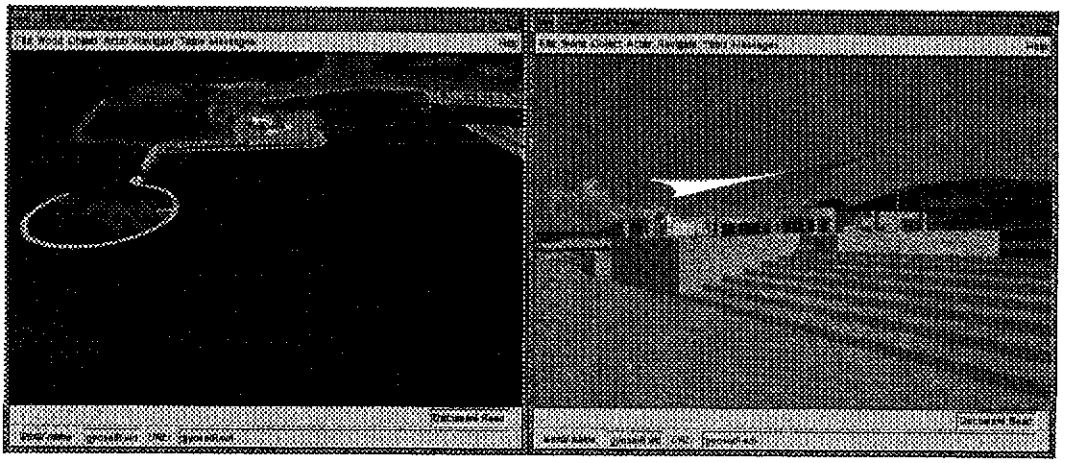

Figure 2: The Concept of the Common Gateway Interface (CGI) *Figure 3: HomePage of the Fish Market*

2.3 Design Modification

In the authoring room it is possible to modify shape data or attribute data using the edit mode and authoring tools on the VRML browser (Figure5 right). In other words, the design review, as well as design modification (such as the facade of the building, color and texture), is in progress in accordance with the circumstance.

In the application group, there is Radiance on the Web in order to review shade renderings of the fish market (Figure5 left). Radiance executes a rendering on the basis of setting (such as the position of sun, eyepoint and lighting) which is decided in virtual space, and rendering result are displayed on the homepage. One can modify the design of virtual space, and analyze it.

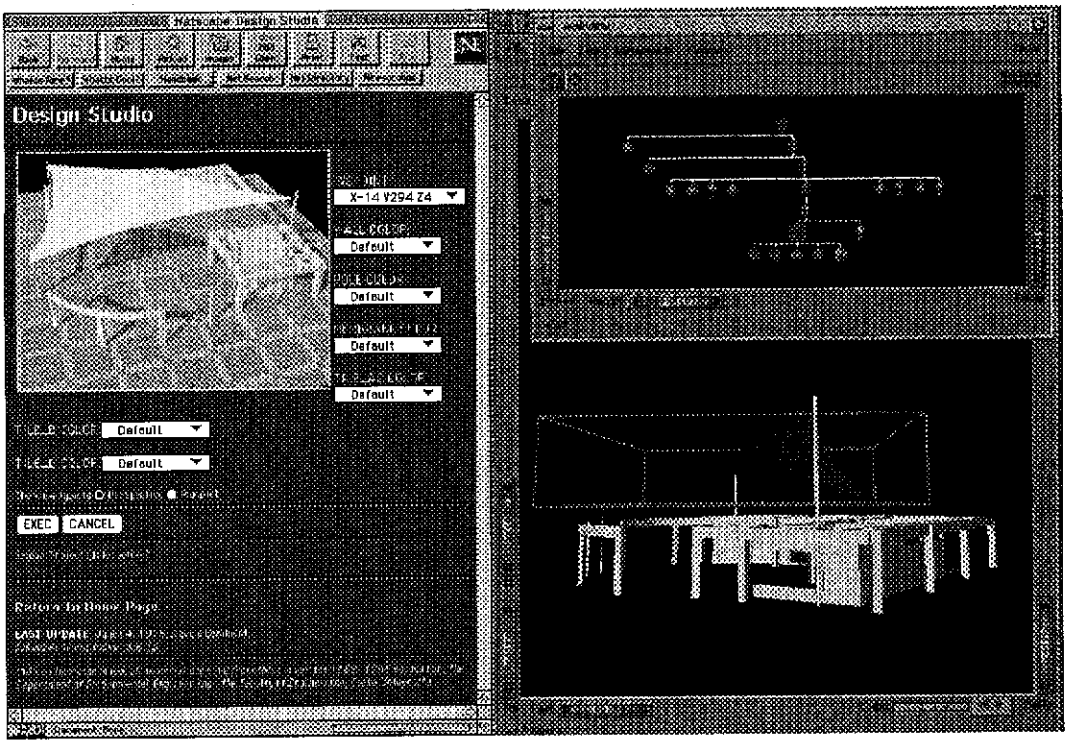

Figure 5: Webview's edit window (right) for modification and Design Studio (left) for analysis of shadow

2.4 Communication

The students who reviewed the design in virtual space can use various communication tools. They can use the chat in virtual space simultaneously. We can find that communication using the bulletin board is an effective method. Using this method, a student uses a bulletin board of a homepage for discussion about the design. The student inputs the text and image data in the bulletin board on the homepage of the fish market. If he or she inputs the title, comments and contents in an assigned form of the homepage, that information is automatically added to the bulletin board of the homepage. Server match image data with text and add it to the bulletin board. The bulletin board of the fish market homepage has a list of comments which is recorded automatically in the design process.

CONCLUSIONS

Urban and architecture design is the result of the teamwork of multi-disciplinary groups including designer, client and committee. The design process includes the exchange of information between individuas and organizations, and discussions among professionals of the team.

We have been using computer graphics in thedesign project process as a means of communication in the presentation, design, design review stages and confirmed that computer graphics is a effective and powerful communication medium for consents for all participants.

However, there are problems when computer graphics is applied in the design project. For example, initiative and timing are needed for the new types of system environment

and the motive of the development of the AVS system.

The application of the AVS system as a tool of education for projects in university makes collaboration smooth between professor and student, between students, between student and professionals (if required).

In this study, professor and students enter into a shared virtual space which they made, and review the design interactively (such as in case study of the fish market project). This system is an available environment for participants to access data made by collaboration on the web at anytime. Each participant can see what he and she wants using the interactive function, such as walkthroughs and examiners (review tool of rotating the object) and non-interactive functions, such as still images and animation, while he communicates with another participant.

Each student can review the design in the architectural virtual space made by the professor and students. It is easy to use an authoring tool for making data, gathering opinions of participants on the bulletin board, VRML viewing and application analysis of the shadows from a distributed area. All of them is composed componently. This design environment makes the design review possible at any stage of design in the architectural virtual space on the web.

In this study, the AVS system makes it clear that there is the possibility of open architecture education with progressive communication between professor and students in various locations, with the fish market project as example.

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