VIRTUAL CLASSROOM FOR ARCHITECTURE

CHRIS YEUNG, LESLEY CHEUNG
Department of Electrical and Electronic Engineering
The University of Hong Kong

AND

JEROME YEN, CHARLES CHENG
Department of Computer Science
The University of Hong Kong

Abstract. Over the past few years, we have seen that the evolution of the Internet and World Wide Web technologies have significantly enhanced the global communication and collaboration. People, no matter where they are, are virtually getting closer and closer. The barriers that came from time and distance have been partially removed by the use of such technologies. Internet and WWW are not just technology, they are an environment or space. With such breakthrough in technologies, a new paradigm in education is there. The education very differently from what we have now.

This paper presents an Internet-based environment to support teaching and learning in architecture education. We will discuss the design concept and how to integrate the technology and knowledge-based techniques to implement the learning environment for architecture students. Architecture is a very specific discipline which consists of the knowledge from arts, sciences, engineering, and more. One of the focuses in architecture education is to teach how to express and communicate design ideas with the multimedia or other technologies, such as, virtual reality (VR). A case study presented in this paper is about how to deliver and present the ancient Chinese temples and its bracket set systems from the server to the browsers to support distance teaching. That is, students and teachers may not be in the same location, but they are able to watch the same objects and to exchange ideas. We will discuss how to use multimedia technologies to illustrate how a temple and its bracket set differ from dynasties to dynasties and introduce its basic properties to the viewers. Moreover, we will discuss how we organize and handle 3-dimensional objects with such system.

Many people are still arguing about whether Internet-based teaching or a real classroom setting is better. We are not implying that Internet-based teaching is superior or predicting that it will dominate the teaching in the near future. However, we strongly believe that it is just another alternative to express and represent architectural thinking to over some of the barriers that come from time and distance. We believe, that it is always true, that the Internet-based teaching may provide both teachers and learners greater flexibility and to support more International collaboration. That is, regardless where the students or teachers are, they can always participate in learning or teaching and make teaching and learning much more rich and interesting.

CAADRIA '98 : Proceedings of The Third Conference on Computer Aided Architectural Design Research in Asia.
eds. T. Sasada, S. Yamaguchi, M. Morozumi, A. Kaga, and R. Homma
April 22-24, 1998. Osaka University, Osaka, Japan. Pp. 93-102

1. Introduction

Over the past two decades, researchers have used computer and communication technologies, such as, virtual reality (VR) and multimedia, to construct teaching and learning environments. Some results are promising. For example, through the use of a virtual classroom, researchers at New Jersey Institute of Technology have shown that computer communication is a possible way of delivering effective teaching. In particular, the results of their empirical studies have pointed out the superiority of the virtual classroom for well-motivated and well-prepared students provided that they have access to the necessary equipment (Hiltz, 1995). Similarly, Leidner and Jarvenpas (1995) suggested that technology can influence the pace and content of learning, as well as the purpose of instruction. In this context, they pointed out that technology could be used to transform education and to re-examine the efficacy of the traditional modes of delivery of educational materials, which are bounded by temporal and spatial constraints. Alavi et al. (1995), in the same line of thought, also suggested that computer-mediated collaborative learning is superior to the traditional modes of learning, because it facilitates active learning and construction of knowledge. The results of their empirical study of a group of MBA students show that desktop video conferencing is a viable medium for collaborative distance learning. In sum the emerging research shows that computer-mediated learning environment has great potential in facilitation of collaborative learning, in promotion of the learners' autonomy in controlling their own learning pace, and in enhancement of the instruction design.

In this decade, the increasing usage of Internet and WWW technologies have brought us not only a new way of information assimilation but also a change in the social structure of mankind. How to apply these technologies to support teaching and learning is one of the most frequently and widely discussed topics. In the human history, besides the paper and printing technology, information technologies (IT) might have created the most significant impact to the education (Frick, 1991; Berger, 1995). Among all the information technologies, Internet and WWW probably have the highest potential in pushing the paradigm shift in education (Oonnell, 1995).

The traditional education in architecture was more rely on the use of physical models or sketches. But development of such models or sketches is very time-consuming and under high pressure. That is, if you made a mistake, you have to start over again. But, with the computer and multimedia technologies, transfer from ideas into pictures or 3D objects takes much less time. Therefore, architecture students are often required to design and model buildings with 3D technologies before the implementation of the physical models. Such on-screen 3D objects made communication and exchange of ideas much easier and more efficient. However, the other challenge that face the

current architecture education is that how to support the distance collaboration. Distance collaboration has become very important in the current architecture education. How to integrate the expertise, knowledge and talents around the world to make create better design is the challenge and it is recommended to be placed in the architecture curriculum.

In a traditional computer-supported architecture education, students could only present their works, the models, on computer platforms. For audiences without appropriate computer equipment, only 2D images of those 3D models can be presented. Sometimes they used animations of their 3D models to demonstrate different parts of their design. However, these animations were limited the audiences to pre-rendered views of the 3D models. They are also required to work long hours to generate large files.

Virtual reality (VR) generates different views of 3D models according to the inputs from the users in real time. It allows the users to navigate to any part the 3D world with larger degree of freedom. VR systems are powerful tools for architecture students, but they are very expensive and may not be easy to learn and to use. Most students could not afford such expensive systems, unless they were purchased by the schools. Therefore education or learning could not be fully facilitated by the powerful features of the VR systems. From our experience and the lessons that we learned over the past, most architecture students still have problems in using such systems. They spent more time and energy in learning how to use such systems than in converting their ideas into 3D images. Neither 3D animations nor VR systems support collaborative works. This is the major drawback of such systems because collaborative works or collaborative learning has become more and more important.

An event called Virtual Design Studio (VDS) has been held every year by the architecture programs at different universities. Architecture students who have anticipated have been divided into groups. Each group consisted of students from different universities or even from different parts of the world. They had to do design based on a specific topic. In order to accomplish the tasks, they had to work collaboratively. However, due to lack of efficient collaborative tools or systems, they usually resulted in 2D sketches to present 3D models.

In order to solve such problem, we have developed a system to allow people from different places to collaborate together as long as they have Internet connections. Since people may use different computers and operation systems, our system must be platform-independent. That is, it can be run in any hardware platform and in any software environment. This system has to allow several users to use it simultaneously. In order to develop such system, we have selected VRML (Virtual Reality Modeling Language), Java, and Javascript.

VRML is the industrial standard of non-proprietary file format for displaying scenes consist of 3D objects on the web browsers. Such scenes are called VRML worlds. It has an interface with Java, which is a general purpose programming language developed by SUN Microsystems, and Javascript, a scripting language built in web browser Netscape. Java creates applications, called applets, which can be run in a web browser. Applets provide interactivity between users and the VRML worlds. They also allow users to manipulate VRML worlds. Javascript acts as a bridge between applets and VRML worlds. It transfers control signals from Java applets to VRML worlds so that tusers can manipulate the VRML worlds through Java applets. It also transfers messages from the VRML worlds to Java applets so that the later can obtain status of them. Sometime, Javascript can also be used to perform some simple jobs. By using these tools, we can build a very powerful system to enhance collaborative design processes.

In section 2, we will introduce some example Internet-based learning systems and discuss the functionality that required to support collaborative learning. Section 3 will be used to discuss the system design of the Virtual Learning Environment (VLE). A short example will be provided in Section 4. This paper is concluded with some discussions and recommendation for future research.

2. Web-based Collaborative Design Tools

The rapid development of the Internet and WWW technologies do not simply enable us to build a Web-page for task-specific activities (e.g. Frequently asked questions (FAQ), news group discussion, teleconferencing). On the contrary, they make it possible to build integrated learning and teaching environment which supports various modes of learning activities: self-paced learning, collaborative project team, teleconferencing, etc. Furthermore, the penetrating power of the Internet is great enough to enable the on-line learning systems to deliver education to special learning sites where the academic can hardly reach. For instance, the adult education centers, company training rooms, the Internet cafes, special schools for students with learning or physical disabilities, public libraries, prisons, selected homes (Hutchison, 1996). It is worth noting that the tremendous technological developments in Internet technology have brought us an unprecedented excitement and opportunity in education.

A recent news report released by Cnet [Href1], one of the leading on-line publishing companies, suggested that an Internet-based learning system:

> "use a wide range of technology to make learning as easy and collaborative as possible. While the level of sophistication varies, standard to most Web courses are communication systems, such as email, real-time chat rooms, and threaded discussion groups that let students interact with instructors and each other online."

More specifically, this kind of Internet-based learning system should have the following learning and teaching features:

Table 1. The features of On-line Education

Electronic lecture notes	- providing with student-customized learning materials
Message system	- connecting the course participants so as to achieve communication and collaboration purposes
Discussion	- enabling real-time chat or threaded discussions
Interactive quizzes and self-assessment	- generating on-line quizzes which are marked by the server
Course creation	- allowing the instructors to construct or modify their materials
Course management	- having a database management system which helps to organize the course materials
Student management	- having a database management system which helps to organize the student information and to track the individual user so that customized services can be provided.

Currently, some of these web-based learning systems have been developed to deliver real training or academic courses over the Internet. They range from grass-roots volunteer efforts, for example, Blue Web'n Library [Href2], Netday [Href3], and academic institutions, such as SUNY Virtual Classroom [Href4], the CORAL system of the National Chiao Tung University in Taiwan [Href5], to the commercial sector, such as, Zdnet University [Href6] and the Spectrum University [Href7]. Some generic system products are also available, for example, the FirstClass [Href8], Topclass [Href9], WebCT [Href10], which claim to provide easy to set-up program for creating on-line training courses.

Many of these systems place much emphasis on the courseware production and the Graphical User Interface (GUI). Although these systems do provide fancy interface and abundant course materials in multimedia format for the on-line learners, we could not agree with their educational view. Their focus is more on re-creating the usual classroom practice on the net, rather than

transforming the existing learning system to a more **pedagogical sound learning environment** on the Internet.

3. System Design of VLE

The Virtual Learning Environment (VLE) was designed with the general instruction design and constructive learning environment in mind, aiming to provide a simple-to-use interface to support the development of web-based lecture resource materials, question and answer facilities between teachers and students as well as video and asynchronous conferencing among students and staff.

Using the system, staff members can develop web-based multimedia resources without learning to master any programming language. Conveniently, it provides access to several powerful Internet search agents as well as a well-designed system of bookmarks that provides a good infrastructure and framework for the sharing of resources and collaboration.

3.1 Design Model

A VLE shell is a web which is designed to provide the guided navigation and communicative infra-structure to the users. Following the instruction and the guidance, the learners can access their favorite learning activities. The learning activities can be lecture notes, lecture video archives, simulation program, queries, self-tests or quiz. Based on the content and the presentation of the learning activities, they are categorized into four learning zones as shown in Figure 1.

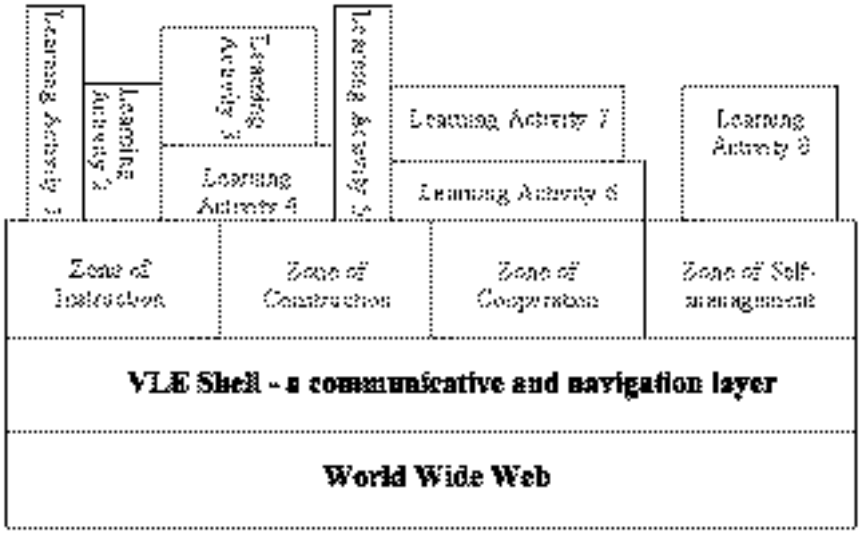

Figure 1. The VLE system model

Zone of Instruction -

The learning materials and activities in this zone are:

a. Organized learning material with detail guideline, e.g., an on-line course-book.
b. Clear and distinctive presentation of materials
c. Stimulation to gain attention to ensure reception of stimuli; e.g. using meaningful images, sound, and animation.
d. Allow learners to ask and to get feed back in an organized manner within a very short period of time.
e. With assessment instruments such as test or quiz to reinforce the learning outcome.

Zone of construction -

The learning materials and activities in this zone can be:

a. Discussion forum which foster sharing atmosphere within the learning community, e.g. chat room or bulletin board.
b. Construction tools so that the learners can construct their own learning environment, e.g. a note book or scrap book for them to collate and to organize their findings after studying the course materials or surfing the WWW.
c. Reflexivity tools which enable the learners to reflect on their own learning process. A reflection report which the course tutor can give remark or comment may be a good instrument to serve this purpose.

Zone of Cooperation -

The learning materials and activities in this zone can be:

a. Collaborative work with common objectives and same assessment criteria set for the learners so that the group learners can take up their individual responsibilities to share, to work together and to negotiate.
b. Project based so that the learning outcome can be substantiated to be something real for example, to produce a project web.

Zone of self-management -

The activities in this zone are not necessarily related to the designed principals we have discussed. This is made mainly for the learners to organize their learning activities and to administer their personal information. For example, to enroll or drop a subject course, to update their personal information so that they can be kept in touch with the VLE community.

Teachers and students can play different roles in different learning activities via the Internet. For instance, in the case of course instruction, the teacher can

present his or her instruction material by using the authoring tool of our system where the students can read using the book' function of our system.

3.2 Technology Employed

VLE system consists of a web server to provide the HTTP, FTP services, a SQL Server to provide the database management and a set of small server programs to provide the multimedia, interactive and teleconferencing functionality. In our system, we adopt the Information Server (IIS) 3.0 as our Web server, MSSQL 6.5 as our Database server and Active Server Pages (ASP), a server-side scripting environment, to create and run dynamic, interactive Web server architecture of our system is illustrated in Figure 2.

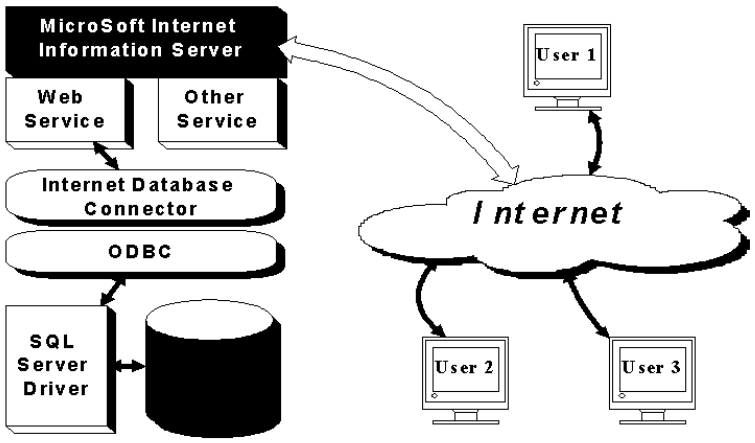

Figure 2. The VLE system architecture

There are three types of users supported by VLE: students, lecturers and administrators. Once a user log on into the system, system automatically identifies which group the user belongs to and provides the appropriate front page. For each group of users, VLE provides a set of functionality to support their possible activities. For example, for student, VLE provides eBook, FAQ, Test, Project, Web-Link, Reflection, Netmeeting, Mail and Bulletin. In the next section, we will use a simple example to illustrate how to use the system to support collaborative learning over the Internet.

4. An Example

Figure 3 shows that a teacher is using the eBook editor to insert a three-dimension image of a temple made by VRML into the contents of Chapter 3. Contents of the eBook can be texts, animation, and any multimedia files that can be supported by our system. Design of the eBook was based on the idea that an organized format like the content outline of a book will be a familiar device to help the readers to easily locate his/her interesting subjects, so our electronic book is designed by using a similar format quickly. The left-top frame of the presentation panel shows the course outline whereas the bottom frame shows the content of the respective selected reading section, and the right-top frame is a presentation windows that allow the animation or media clips to be shown. Unlike ordinary textbooks, the electronic book we devised can be composed of multimedia and interactive simulation program as well as text. The multimedia components can really stimulate the readers' interest while the simulation program allows the readers to test their understanding by doing experiment virtually.

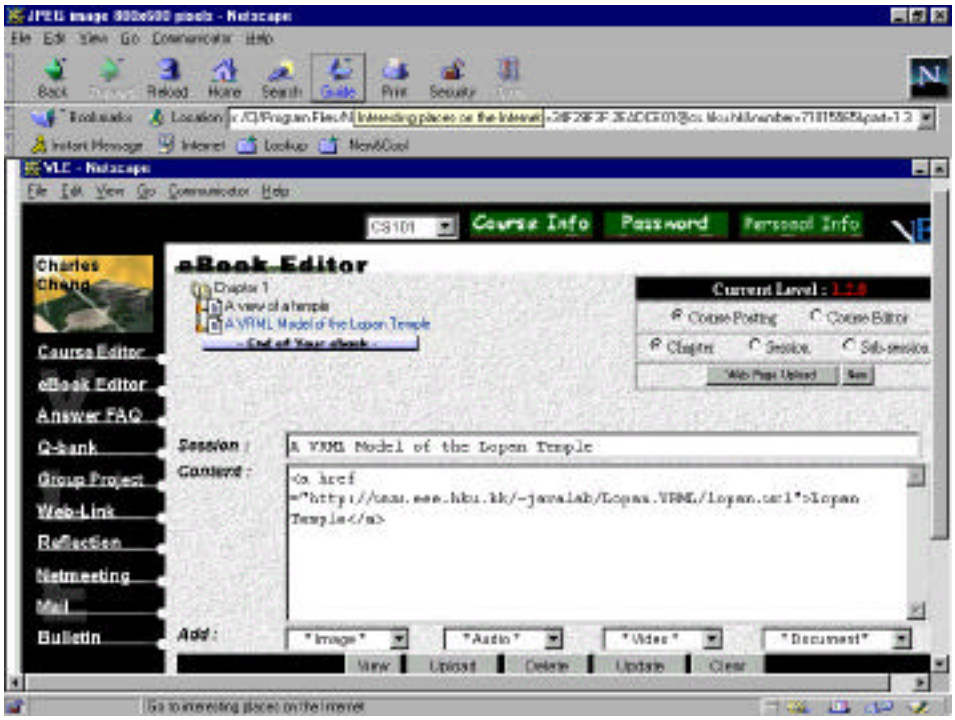

Figure 3. eBook editor and the insertion of a VRML Model of the Lopan Temple

After the URL address of the home page for Lopan Temple has been inserted, then the contents of Chapter 1 has been modified with the URL that connects to the VRML program and the 3D objects of the temple. Then student can use the

eBook viewer to view the image of the Lopan Temple as shown in Figure 4. Notice here that both students and teachers or instructors do have eBook. However, teachers have both editor and viewer functions inside the eBook, and students have viewer function only. The VLE system allows the use of any plug-in system to support other collaborative activities. For example, Netmeeing provide tools to support shared-sketching or shared-annotation for people who cannot meet face-to-face to discuss or make comments about the design over the Internet.

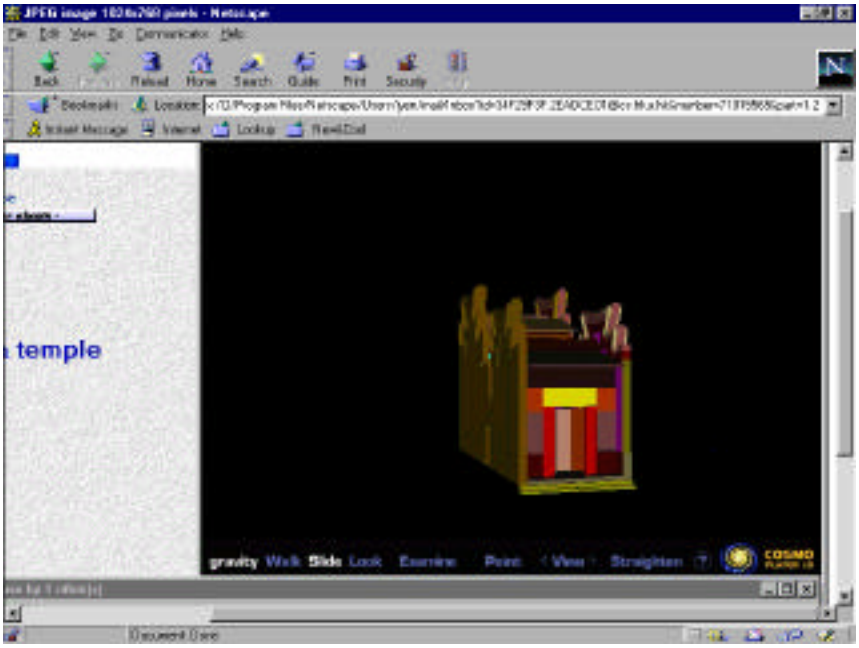

Figure 4. eBook and the VRML Model of the Lopan Temple

5. Conclusion

By making the use of the web-based technology, VRML, Java and JavaScript, we have developed the Virtual Learning Environment (VLE) to support the collaborative or distance learning in architecture education. With such system, architecture students can use a low cost, yet platform independent and easy-to-use, system to do 3D designing work collaboratively with other people from all over the world. This kind of collaborative work can empower the students in learning. That is, it makes learning more interesting, it improves their skills and designing power, and it allows them to gain experiences that can hardly be obtained when using traditional modeling tools. We are currently conducting some experiments to measure the performance gain. Results of such studies will be reported in our future manuscripts.