Representing and distributing 3d-content in web-based architectural design education

Evaluating 3d-presentation methods for e-learning

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As information telecommunication technology develops, teaching at universities changes. E-learning and working on-line create new challenges for the development of architectural education. Education of architecture contains special challenges. With new presentation technologies ideas and objects can be presented graphically in 3-dimensions on the e-learning environment. In a research project the Architectural Media Laboratory (AML) at the Tampere University of Technology (TUT) has studied the use of different techniques utilizing computer modelling and photography-based methods in presenting and teaching architecture.

Keywords: 3d-modelling, e-learning, virtual model

Background
Teaching at universities is changing. The development of computers, telecommunication technology and computer networks has caused and enabled this change. The development is moving towards a shared e-learning environment. The goal is for the student to be able to take the courses he or she wants in the order he or she wants irrespective of time and place. This will simultaneously create an all-data-saving expanding database, which will work as a reference source for future students.

With the changes Computer Aided Architectural Design (CAAD) has brought also the teaching methods of architecture have changed. Computers have reached a level of maturity where content can again be viewed separate from the technology which created it. In addition to pretty pictures the focus is once more on the design and its content. In working life design is changing into a shared process where information is electronically exchanged. At the Universities the line between a design teacher and a computer teacher is fading. CAAD is becoming a part of architectural education.

In Finland telecommunication networks are already quite effectively utilized for architectural design and building. Actually, architectural computer education may even have fallen behind the situation in working life. The role of e-learning architecture as a new pedagogic method can thus also be seen as preparatory for the working life.

Introduction
Together with the universities Finland’s Ministry of Education is developing a national education service, the Finnish Virtual University (http://www.virtuaaliyliopisto.fi).
As a part of the virtual university’s project the Architectural Media Laboratory (AML) of Tampere University of Technology (TUT) studies the presentation of 3-d objects and spaces in an e-learning environment. The study is focused on the special needs of architectural education but the results will also be applied for the needs of other educational institutes of TUT.

In this first phase (presented here) the project focuses more on mapping out the technology and methods rather than utilizing the e-learning environment and studying or using the pedagogic possibilities of the new presentation methods. However, the pilot courses shall link the methods directly to teaching. In addition, the attitudes of the teaching staff and students towards e-learning and, specifically, on the implementation of the pilot courses were studied during the project.

This paper will shortly summarize the presentation methods studied in the project focusing on techniques based on computer modelling. The paper will also present the pilot course and its plans for future development. The final report of the project will be completed in fall 2002.

E-learning architecture – possibilities and special requirements

The meaning and usage of e-learning architecture can be presumed to follow the general guidelines of e-learning. The possibilities are extensive but implementation is limited both by the quick technical development that changes the software as well as the opposition from the teaching staff to changing the teaching curricula. E-learning does not only mean distributing course material and information on-line, it can and it should influence the structure of teaching deeper.

E-learning architecture has its own special features. Architecture and teaching it are based very much on the visual. Teaching is often performed with examples such as pictures and graphics. The students also often produce pictures and scale models as a result of their training exercises. Teaching basically contains a vast amount of pictorial material.

The basic quality of architecture, 3-dimensionality, becomes emphasized in the pictorial material. Presenting 3-dimensional qualities by using 2-dimensional presentation equipment is one of the greatest challenges of learning. Even with studies and work training, it often takes years to develop the skill to read 2-dimensional design documents 3-dimensionally.

Things that previously were difficult or even impossible to describe can now be presented with 3-d modelling. With the new presentation techniques utilizing 3-dimensionality and modelling it is possible from the very beginning of learning. Using the new techniques it is much faster and more illustrative to present the relationship between a space and 2-dimensional design documents describing it than with traditional methods. This in turn has led to a larger amount of design alternatives and variations in design studios. New presentation techniques can increase the birth of ideas and plans.

The abovementioned techniques also have a down side in e-learning. There are high technical standards to the pictorial material and the processed data often builds up in size. Producing, presenting and saving this data needs its own technical solutions.

Goals set for presentation methods

Special attention was paid to visual and aesthetic quality when the presentation methods for teaching were tested and selected. Previously, the inadequacy of visual quality was considered to be one of the biggest problems of presentation techniques based on real-time 3-d graphics. The distribution technology for the presentations and the technology’s suitability for e-learning was the second important criteria. The third criteria was availability and price.
The methods were divided into techniques based on photography, techniques based on computer-aided modelling and the combination of the two, hybrid methods. After a study period, photography-based methods became a part of Ilkka Alavalkama’s Still Media course and the methods based on computer-aided modelling a part of Jani Lahti’s Visualizing Architecture course. This paper will concentrate on the methods based on computer-aided modelling. Techniques based on computer modelling can be divided into two categories: firstly applications using real-time 3-d graphics and secondly applications using still images and animations based on pre-calculated cube and panorama projections.

Special attention was paid to the following details:

- Integration to the design process and design software
- Intelligence (programmability), adding information to the model
- Visual and technical quality
- On-line distribution

Integration into CAAD systems – production
Integration with existing and generally used CAAD systems was a prerequisite for a working 3-d presentation system. In order for the 3-d presentation techniques to be able to be utilized in a sensible way in teaching and in design the user (producer of the presentation) cannot be burdened with excessive extra work. On the other hand CAAD programs and the information they produce have become established standards where as 3-d presentation techniques are going through an intense phase of development. Linking closely with the CAAD systems ensured a clear data transfer interface for the future, even if it at the same time meant that the interesting and unconventional approaches had to be renounced.

Linking information to a model – simulation
On the other hand, there was a desire to study a process where information from a CAD model was used in a more advanced way than only for a visual presentation. The selected case studied lighting simulation and adding simple functionality into a model.

Figure 1. Process chart: Producing a 3-d presentation
Visual quality

Visual demands for quality are set by what the presentation is used for. Visual demands for quality are quite different for a preliminary presentation than for presenting a ready design. The goal was to find a system that can produce raw 3-d
content (preferably directly from a CAAD program) quite fast and, when necessary, utilize e.g. the abovementioned lighting simulation.

**Network distribution**

One of the biggest problems turned out to be network distribution. The file size of the produced 3-d models easily grew so large that it was impossible to distribute them except in LAN or with a computer that had an extremely fast Internet connection. The studied data transfer technologies included traditional techniques that transferred the whole model from the server to the client as well as more advanced applications that used streaming techniques. In the future the latter techniques will most likely make it easier to transfer large 3-d models on-line.

The technical qualities of the end-user's hardware are another factor limiting the 3-d presentation on-line. The study project was based on the presumption that the outlines of the end-user's hardware correspond to the producer’s hardware.

**Evaluation and implementation**

After evaluation it was decided that a few alternatives should have operating instructions and be implemented. The selected methods were the open VRML standard for its’ almost de facto status and the commercial Eon Reality technology. The latter was selected for its’ excellent CAAD compatibility and programmability. Another important factor was also Eon Reality’s scalability from desk top VR to immersive virtual environments.

### Table 1. A table presenting tested, documented and implemented technologies.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Manufacturer</th>
<th>url</th>
<th>Tested</th>
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<th>In use</th>
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Figure 4. The same model as in the pictures on the previous page imported into EON-Reality. In this format, the model can be published for example on the Internet. The realistic lighting is imported from Lightscape as textures.

Figure 5. Imaginary site and prototype huts distributed on the site.
Figure 6. Prototype huts in the accuracy they were presented to the students.

Figure 7. A virtual model in the EON program of Alvar Aalto’s contest proposal (not realized) for the Tallinn museum of fine art.
Implementing the methods on pilot courses

The technologies selected during the project have been tested during the Visualizing Architecture and Still Media pilot courses. These courses can be characterized as normal www-aided courses and not actual e-learning courses in the broad sense of the word. However, these pilot courses have served as an important media when the future application of the used techniques and teaching methods were evaluated.

Visualizing Architecture, spring 2002

The theme for the Visualizing Architecture course was a virtual village. The course took place during the spring semester 2002 ending in May. Students were given a pre-made simple 3d-model of a small (~55 m²) vacation time cottage or hut. The model contained only bearing walls, floors and ceilings. Students were free to modify the model by rotating or mirroring it on the site. Adding or removing parts of the model was also strongly encouraged.

There were three basic types of huts and each student was randomly given one type to start to work with. The virtual construction area of the project was divided into virtual sites that were also randomly assigned to each student. This arrangement was meant to expedite the beginning of the course. The teaching process could be quickly started when the basic factors were limited, so, after the equipment and software were dealt out the students has time to study the changes they wanted to make.

Each student modeled and visualized his or her hut and produced the required documents. During the work the models were at certain points joined up to produce the simulation of the whole virtual village. In the end the village was published as a virtual model on the Internet.

Feedback and plans for the future

As the course was a part of the virtual university project, the course was implemented on-line by placing all the teaching material and information available on a website. The course participants returned the weekly training work and actual training exercises on-line to a shared folder on the server.

When the course is over in June 2002 the actual meaning the 3-dimensional presentation methods had for taking the course will become clear, but already it is evident that due to the experimental nature of the studio, too much effort was put to setting up the working environment. This left the students without enough guidance to implement the new methods. On the first pilot course the 3-d presentation techniques took the role of passive presentation equipment and using them as a design aid suffered from the unfinished technical arrangements. Despite of the initial difficulties, feedback from the students has been encouraging. Limiting the design problem in the beginning and leaving time for learning new methods was thought to be a good approach.

The course has also served as a conclusive and eye-opening example for the other teaching staff of what can already be done.

On the basis of student feedback from the visualization course and the active participation of the students taking the course it is easy to conclude that mere studio information and on-line distribution of material makes learning more efficient. The project continues in summer 2002 with a visualization summer course. With a smaller group and a more intensive schedule the possibilities of the new techniques can be taken under a closer view. The summer course shall also try out presenting and criticizing the training exercises on web pages.

The exhibit of Alvar Aalto’s unrealized works arranged by the Museum of Finnish Architecture and the Alvar Aalto Museum is a natural follow-up
for applying the modelling methods studied during the project. This also presents valuable data about digitally reconstructing historical buildings.

Further plans for the future include using the studied desktop virtual environment techniques in the Cave environment of the Tampere Virtual Reality Center.

References