The Internet as Communication Medium and Online Laboratory For Architecture Research

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This case study documents the experiences of two courses recently conducted on the Internet. The courses are a sequence of core methods courses offered to post-professional degree architecture students studying in a Computer Aided Design concentration in a Master of Science program. In these courses the students use the Internet as a communication medium and as a research tool using the Virtual Reality Modeling Language (VRML). The VRML interface in the Web browser serves as an online laboratory and presents new opportunities for communication and for studying distributed computing in a multimedia and multidimensional environment.

Introduction

This paper is a case study documenting the experiences of two courses recently conducted on the Internet. The courses, Architectural Information Systems and Computer Aided Design Methods, are part of the sequence of core courses offered in a Computer Aided Design Concentration in a Master of Science Program. In the past both courses had been conducted as seminars, and both used the Internet in a way similar to the way that library and other sources of literature were used. Over the past year both courses were converted to include use of the Internet as a major component of the course experience. The Internet was used as a medium of communication and as an online laboratory.

The purpose of the course sequence, conducted over two semesters, is to provide students an introduction to research in computer aided architectural design. Most students are recent graduates of five year professional programs and most have no previous research experience. More than half have one or two years of professional experience between their professional program and their return to graduate school. All of the students are computer literate and have prior experience on the Internet and with many of the kinds of computing software used by architects.

This study describes the goals of the courses, the curriculum and the Internet component, and gives the scenario for each course as it unfolded over the semester. It assesses the impact of the Internet on the courses, both as communication medium and online laboratory. The paper concludes with identification of a set of issues arising from the Internet experiences and identifies potential areas for research.

Motivation for the Case Documentation

For the pre-Internet version of both of the courses described in this paper the computer was not brought into the classroom, though the content of both courses is totally computational. Previous experience over several years had shown that it was difficult to carry on a focused discussion when the computer was present and that a lot of time was consumed tending to the computer's needs. In fact, these classroom sessions were some of the few times that

the group was out of contact with computers. Both students and instructor typically spent much outside of class time on the computer.

The decision to increase the Web component of the courses was made for several reasons. While revising the syllabus for the fall semester of the Architectural Information Systems course I was unable to decide either on an appropriate textbook, or the appropriate software to demonstrate information system concepts. In the past, in addition to using 3-dimensional geometric modeling software, I used a desktop GIS (Geographic Information System) system that had a relational database attached to the geometry generator. For this I used MapInfo, among other desktop GIS systems, because of ease of use and built-in spatial analysis features. Since distributed computing was becoming of increasing importance in the course, it appeared that the World Wide Web itself would make a good tool. The accessibility and the low cost of using the Web make it a near perfect computing situation: no struggles with software acquisition, limited seat licenses, software bugs or training. The prospect emerged of an online laboratory: the class would no longer be isolated from the action and excitement out in industry. What I hadn't expected was how many resources would be available on the Internet.

Architectural Information Systems Course

The goals of the Architectural Information Systems Course are twofold: to give an introduction to major concepts in information systems in computing in general and to architecture in particular. The objectives are to familiarize the students with the theoretical and conceptual underpinnings of information systems, to demonstrate how these concepts are used in practice, to identify problems arising from their use, and to identify outstanding research questions.

The pre-Internet version of the course was held as a traditional class. A small group of graduate students and the instructor assembled in a seminar room once a week. The class was a combination of discussion and lectures. The reading list was pre-selected by the instructor. Occasional computing demonstrations were held for the class as a whole. Individuals worked on the computing exercises outside of class time. Most of the information about the course was distributed or exchanged in the classroom.

- physical setting
    - seminar room with four large tables grouped together around which people sat
    - blackboard
    - wall pin-up space
- syllabus
    - class format - discussion and some lectures
    - schedule of weekly discussion topics
    - preselected textbooks and readings
    - assignments
        - weekly reading assignments
        - set of exercises with an information system
        - term project - topic chosen by student
            - product was a paper

Pre-Internet Observations and Perceptions (Architectural Information Systems Course)

Students' academic background lacked discussion experience since most came from five year professional programs in architecture that were predominantly studio and lecture. Previous years' experience had shown that discussion, with the variety of cognitive exercises that accompany it, was at least as important as content in preparing students to write a thesis. The computer was not brought into the room, nor was a computer classroom used, because the mechanics of its use in previous courses had interfered with having focused discussions. The class learned to use software by moving into a computer room for one or two class sessions. If the students needed to demonstrate their projects the class would temporarily move to a place where there was a computer. The class size was too small, eight to 12 students, to fill a computer laboratory for class sessions. Frequently the class found

itself in laboratories where other students were working on projects at the same time, and these settings tended to be noisy and distracting.

Internet Scenario (Architectural Information Systems Course)

The Internet scenario for the Information Systems course was the same as for the pre-Internet version of the course - it was even held in the same seminar room - except for the addition of the computer.

- physical setting
    - seminar room with four large tables grouped together around which people sat
    - blackboard
    - wall pin-up space
    - desktop Pentium computer whose display was projected onto a wall with a Proxima projector
        - graphics accelerator
        - sound with full size computer speakers
        - Zip drive
        - color printer
        - ethernet connection to the University computing network
            - access to the Internet (including the students' home pages and e-mail)
            - access to students disk storage on the University file servers
- syllabus
    - class format - discussion
    - schedule of semester themes, each discussed for two to three weeks
        - internets and intranets
        - distributed and enterprise computing
        - intelligent agents
        - virtual reality
    - no textbook (I couldn't find a suitable set of already published books that was sufficiently up to date and, exciting to read and relevant to architecture.)
    - readings were not preselected (The class participated in the generation of the readings - this included interesting sites and relevant software as well as articles.)
    - assignments
        - weekly Internet literature search assignment (Each student gave a weekly report that might be a paper handout accompanied by a verbal presentation, or an Internet report accompanied by a verbal presentation. The Internet report was done on the computer present in the seminar room. The literature searches included scholarly articles, sites and demonstration software. Students put their URLs on their home pages, send them to others by e-mail or distributed handouts in class.)
        - two papers
            - first paper - the students were required to choose from one of the first four topic themes and cover the subject comprehensively
            - second paper - students chose a topic from any one of the themes and were required to identify a subtopic within the theme on which to do an in-depth investigation

Internet Observations and Perceptions (Architectural Information Systems Course)

I began the semester using a loaned notebook computer from the media center. I would check the computer out the night previous to the class to load the software for the class and to set the ethernet settings to connect to the campus-computing network. For all of the sessions for which I tried this arrangement something major would fail to work. After a few sessions I resorted to wheeling the computer (after purchasing a computer cart) from my office into the seminar room. Though this was cumbersome, I could count on the computer and the software behaving predictably.

For this class I didn't have a substantial amount of material about the class on the Internet. The Internet was used as an online laboratory: as an information resource, for e-mail, as a source of software to test and demonstrate, and for viewing 3-dimensional spatial models using the VRML plug-in in Netscape Navigator.

One of the most interesting aspects of this course was how the students identified major issues in the area given a start of just the six topic themes. When they began the course everyone was already an Internet user. At the beginning of the course they spoke a lot about their anxiety about ever understanding or making sense of all of the information on the Internet. They were skeptical about the value of the material on the Internet and seemed to believe that the material was not the substantial stuff of which courses were made.

Their major question was how do you know what is real, legitimate knowledge? My response was to turn the question back to them to discuss how they decided the value of information in other situations. This led to a semester long discussion of who, or what, was an authoritative source. The "What is real?" question was more than just a question at the beginning. It was frustrating for the students to begin their first Internet searches, because they didn't believe that any sense could be made of what was on the Web, and they didn't have any confidence that they would be able to decide what was valuable, important and real. They also did not expect to find substantial material, because their previous experience was that when you got close to the real thing there was just a pointer, such as a book or article title, or there was a cost to get access to the material.

There was an unexpected amount of material related to the course themes on the Internet, not just pointers to books and articles, but the real thing. The material came from many sources. There were many university sites that had tutorials, reading lists and URL lists and online journals (Maher 1998, Akers et al. 1998). Organizations were a good source; particularly the ones that already had accessible digital libraries of some kind (ACM 1998, IEEE Computer Society 1998). Some books were completely online (Carey and Bell 1997) as well as available in print from the publisher. Vendor sites were particularly interesting. Previous to the Internet, access to industry material was a matter of reading advertisements in trade magazines and journals and sending for information by checking boxes in the reader information postcard at the back of the magazine. Since most software cost money, especially for site licenses, acquiring new software was a lengthy process.

In the first assignment the students used material mainly from the Internet. In the second paper, they were encouraged to include non-Internet material from the library (the library catalog is on the Internet) and other sources. The students in the class were able to identify major issues relating to the themes. Because they had found the material themselves they seemed able to identify and discuss issues more easily than I had seen other classes do with material selected for them by someone else. They knew where the material had come from and remembered what connections had led them to it, although someone occasionally would comment that they had followed so many links that they sometimes lost track of the initial question.

Computer Aided Design Methods Course

The Computer Aided Design Methods course builds on the previous course which introduced students to concepts of computer aided information systems. The goal of the course is to study methods to enable people to specify, design, and build computational systems with which to design buildings. The objectives are to give students the methodological tools to solve problems relating to these systems and to design research studies to investigate them. The task is not to design buildings, but to design the computer tools with which buildings can be designed.

The pre-Internet version of the course was held as a traditional seminar. A small group of graduate students and the instructor assembled in a seminar room once a week for approximately three hours. The syllabus consisted of weekly readings, literature searches and two major papers. Most of the information about the course was distributed or exchanged in the class.

- physical setting

    - four large tables grouped together around which people sat
    - blackboard
- syllabus
    - class format - discussion
    - textbook
    - reader of book chapters and journal articles
    - assignments
        - literature search - annotated bibliography
        - minor and major papers

Pre-Internet Observations and Perceptions (Computer Aided Design Methods Class)

The goals and experiences for this class are much the same as the Information Systems class, and the observations and perceptions parallel the previous class also. One difference between the two classes is that by the second class the students have considerably more computing, discussion and writing experience. They have begun to develop their own interests and the experience and knowledge of the entire class contributes to lively discussion and the introduction of many student generated discussion topics.

Internet Scenario (Computer Aided Design Methods Class)

The circumstances leading to this course being given on the Internet were unusual. The instructor was unable to be on campus for the first part of the semester. The decision to give the course on the Internet and the first Internet meeting of the course happened in an interval of less than one week.

- physical setting - students were spatially distributed on the Internet - there were no class (face-to-face) meetings for the first half of the semester
- syllabus
    - class format - all of the class information including readings, assignments, content explanation and examples was on the instructor's home page on the Internet (McIntosh 1998). The students submitted assignments by putting them on their home pages. Grades were sent to the students by e-mail. All consultation with students was done by e-mail.
    - a set of textbooks
    - assignments
        - weekly reading
        - weekly programming problem and a written report of the problem
        - e-mail discussion - one or two questions per week

Internet Observations and Perceptions (Computer Aided Design Methods Course)

The students followed the course instructions, issued weekly on the Internet. They did the readings, responded to the e-mail discussion, did the programming assignments in VRML (Ames, Nadeau, and Moreland 1997) and wrote their reports. When they had a programming problem they couldn't solve themselves they would e-mail the problem code to the instructor. I would find the bug, make a comment in the code to indicate where the problem was, comment out the non-working code, replace it with the substitute code that worked, add a few paragraphs of explanation of what the problem was, and e-mail the now working program back to the student.

From an instructor's point of view, the assignments were easier to grade because of the detachment from the students. As a result it was easier to be critical. The comments about an assignment had to be communicated as clearly and succinctly as possible in an e-mail message, and this seemed to encourage a direct and focused response. Also, my written comments for the assignments were lengthier than formerly to try to ensure that the

message would be understood. For their part, the students written reports improved considerably compared to reports I had seen in previous years.

All of the content information and explanation was on the Web page, rather than presented in a lecture or through discussion. The amount of formal written explanation was more and different than had been used when the class met face-to-face. In the in-class case, an outline of the session was available to the class. Depending on the nature of the material, it would be discussed by the class on the basis of readings or clarified for the class by distribution of examples or by writing on the blackboard. In the Internet case, all kinds of questions had to be anticipated, and a logical and formal sequence of presentation was followed.

The Internet as Online Laboratory

Use of the Internet as an online laboratory was a direction I had pursued initially in the Information Systems course. In Computer Aided Design Methods course I used the VRML 2.0 (Virtual Reality Modeling Language) plug-in in the Internet browser (Netscape or Internet Explorer) as a three dimensional spatial modeling and simulation tool. The purpose of the course is to learn how to design computer tools for constructing models of buildings, and the VRML browser is a natural prototyping tool for this purpose. VRML is a scripting language similar in some respects to HTML. VRML models are created in a text editor or by an authoring tool; the model is embedded in an HTML Web page. Anyone on the Web who has the plug-in installed in the browser can navigate the VRML model in much the same way that an ordinary Web page is browsed. The VRML browser used in the class is free and downloadable from the Web (Intervista 1998).

The metaphor of an HTML script is the scrolling page, while for the VRML browser it is a three dimensional space rendered in perspective. The user does not scroll to navigate as with a page, but navigates using the mouse and the effect is like walking or flying through space. This motion gives the sense of the passage of time as well as movement in space. In addition to the representation of three-dimensional shapes, the shapes can be animated to simulate the behavior of real or designed objects. The Intervista VRML 2.0 browser has a JavaScript and a Java API (Application Programming Interface) as well. The mouse is used to interact with the shapes, for example, to touch and move objects, deform them, or to cause other actions to happen, such as to summon an elevator or start an automobile moving.

The VRML browser turned out to be a versatile software component when used in conjunction with other prototyping methods and techniques. Its real-time 3-dimensional modeling capabilities, along with its interactive and dynamic aspects, allowed students to progress through entire system prototyping cycles. They could specify the conceptual model of the system using an object-oriented modeling notation (Muller 1997), then implement a small prototype in VRML.

Conclusions

Converting to an Internet course is probably more manageable when done one, or a few, steps at a time. The Internet version of the Computer Aided Design Methods course initially required a lot of time just to put the material on the Web page. This was not a problem with HTML authoring, but one of course design (or, re-design).

A course given totally on the Internet, without any face-to-face contact, has a different temporal dimension than one that meets at some physical location. In many ways it is less constrained than a class that has physical meetings. The possibilities for exploiting this difference are infinite. One of the problems I encountered, as a first-timer, was having assignments due (and students asking for debugging assistance and sending drafts of reports) at the same time that I was trying to get the next week's material onto the Web page, though I did develop strategies for distributing the work load. This would be less of a problem if material were being reused from a previous course offering.

The kind of material needed on the Internet-only course was different from what I had used in the face-to-face class setting. The major difference was that it had to be complete and more logically presented than if it was being presented in the classroom setting. In the classroom setting there would have been opportunities for clarification and reordering of material if the material, as presented, didn't make sense to the students. Over a period of time an FAQ (Frequently Asked Questions) component would be helpful.

The response time in the Internet setting, from when the material was presented on the Web until the first feedback was received gave a sense of time passing in slow motion. It was difficult to determine whether the message had been received until an assignment was turned in, the online discussion occurred, or a student sent an e-mail message asking for clarification.

The establishment of community (Akers et al. 1998) was difficult to do through just e-mail and the weekly online e-mail discussion. The students required encouragement to respond to what others had said in previous discussion comments. It seemed as though they didn't have a sense of belonging to a group. However, I had observed similar behavior in face-to-face discussion groups composed of inexperienced discussants. The students also had to be encouraged to bring to the discussion what they had learned in the readings.

The Internet as communication medium and online laboratory is a powerful combination. While the Internet has been in existence for only a few years, there is already a large body of literature on the pedagogy of its use. The concept of the Internet as an online laboratory is an alternative way of viewing the role of Internet browsers and their plug-ins. Since the status of educational institution makes the software available at no cost, the accessibility to computing is leveraged for students. The significance of this combination will undoubtedly unfold, as things tend to do on the Internet, at a break-neck pace.

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