Using the World Wide Web in an Architectural Engineering Design Course

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Introduction

For more than a year Drexel University's Architectural Engineering Program has made extensive use of the World Wide Web (WWW) in a junior-level Architectural Engineering Design course. Both instructors and students have prepared virtually all their materials for presentation on the web. As with any new tool, there have been both difficulties and rewards. The intent of this paper is to communicate what we have learned.

Background

All Junior Architectural Engineering students take a pair of courses, Architectural Engineering Design I & II(ArchEng 390, 391) which are their introduction to the design of engineering building systems. As course prerequisites they have taken at least two Architectural design studios. They have also had as pre- or co-requisites: introductions to structural engineering, HVAC fundamentals and electrical/lighting systems. Virtually all students are also experienced EMail users and are accustomed to using personal computers for word processing and analysis in their courses.

Drexel has full ethernet/appletalk wiring of all buildings including most laboratories as well and all dormitories. In addition we have several multi-media rooms which are readily scheduled for student presentations. The campus network has an internet connection and all laboratory computers used by the students taking ArchEng 390 are equipped with the necessary software described in this article.

Prior to the course revision of AY1995-96 described here the courses were taught as a series of design projects using both manual drawing and CAD drawings for presentation purposes as well as a variety of computer-based calculation tools (Excel, FrameMac, E-20 etc.) The essence of the course was, and still is, to develop an understanding buildings as a group of interconnected "systems" that may be designed in a fairly logical manner. The pedagogical approach has always been to build from examining examples of existing systems, to designing individual systems (architecture, structure, HVAC, electrical), ending in a complete, relatively complex, building incorporating all systems. Students have always found the course both challenging and rewarding.

What We Changed

Beginning in AY95 we required use of the WWW as the primary presentation tool for documents prepared by students and professors in the class. All assignment information is now presented via web page and almost all student and faculty presentations are prepared and given using the web page as the primary organizing and presenting tool.[1] EMail is used extensively to announce changes to assignments and to answer questions of general interest, and a collaborative writing tool is used within the class for brainstorming activities.[2]

More specifically. In AY95 students were introduced to generating web pages using HTML editors. Approximately 2 hours were spent teaching the concepts of the Internet, HTML creation and responding to questions. In AY96 the existence of *Claris HomePage* has reduced that time to approximately 45 minutes because of it's hiding of the complexities of HTML. Students, with few exceptions, found little difficulty with learning the concepts - in each class a few became fascinated and quickly became informal resources to the rest of the class.
Using the same HTML editors the professors provide the traditional syllabus information, grading criteria, etc. as well as detailed assignment information on the class Home Page, which is maintained on the College of Engineering server. The work to prepare these in web-format vs. traditional paper format has become approximately equal with the minor additional effort of "posting" the pages and formatting them balanced by the reduced paper copying and distribution time. The total words in these documents are now probably 50% greater than before because of the ease of producing them. In addition, changes are made more regularly, again because of the ease.

Instead of written submission students are provided "folders" (directories) on a fileserver, with each student having their personal folder as well as shared folders for group projects, a folder for templates, and a "drop folder" for submitting work. The professor devotes approximately 1 hour per term to set up and maintain these folders.

In addition to traditional class discussion we have used a collaborative writing tool (Aspects) to perform brainstorming exercises within the class. After a 10 minute introduction[3] students settle down to use the tool effectively to generate a set of group ideas on such topics as "What are the questions to ask when starting design of a structural system". They are able to see each other's ideas as they are generated and comment on them. Each student can save a copy of the document and use it in the project that follows.

The Effects of the change
The effects of the change can be considered in four categories - document changes; class conduct changes; student skills/knowledge; knowledge dissemination.

Document Changes
The most visible change is in the format of the documents created by the students and professors. Because they are created for the web the criteria used to create them are different. A few years ago the standard presentation format was 24"x36" boards supplemented by written 8-1/2"x11" boards. Now most information is contained in a single multi-layered, interlinked set of web-based documents. This new form of document is not intended to be put on paper and, generally, never is. Instead, it is viewed on computer screens, individually by those developing the project and then in a projection facility when the results are presented to an audience.

The advantages lie in the ability to integrate images and text more easily and to link between information allowing overviews to be presented first and then relevant detail to be viewed only when necessary. Similarly, connections between different systems are readily made through cross-linking. An advantage to students during production is that it allows individuals to work separately and then to integrate their work rapidly by means of "links".

The disadvantages of this new format lie primarily in the (currently) limited visual resolution that

the computer provides. In past students could present very high densities of information (e.g. building sections or framing plans) so that the entire object could be seen at one scale as well as details examined by moving physically closer. Similarly, many aspects of a design could be seen simultaneously through different images mounted on the same board. Now, the computer screen limits the detail available to the fairly coarse resolution of about 72dpi. This forces students to present information in different screens which cannot be viewed simultaneously.

A second disadvantage is the current difficulty in using the web itself to perform and present the mathematical analysis which is usually an important part of AE Design projects. Students must use Excel and similar tools separately, summarizing the results tables in tables and words on their web pages. As Java and other tools develop this difficulty should disappear, but for the moment it causes us to jump in and out of web use in an unfortunate manner.

Class Conduct Changes

For both students and professors several changes in the class's conduct are associated with the revision.

- Most obvious is the increased reliance on the computer, both in the classroom and out. While discussion is still essential to the learning process, much of the time is spent before a computer or a display screen. The advantages of this approach are the increased capabilities, and the disadvantages lie in the dependence on limited numbers of fallible machines.

- The web-based nature of the course means that students find it "normal" to access resources from around the world by means of the many search engines available. Here the advantages lie in the increased pool of information available: the disadvantages stem from the decreased ability to use only "valid" information, which may lead to errors.

- The collaborative-writing tool produces a reusable document that is an enhanced form of discussion. Its advantages are in the record of the conversation and the ability of the entire class to participate simultaneously. Its disadvantages arise from the technical limitations of the current software and potentially the handicapping of those who do not type as well (although this has not seemed to be a problem).

- There is less time spent discussing the details of assignments because the instructor can assume that students will access the detailed descriptions available, and that answers to questions asked will be disseminated via EMail. (Note that this change doesn't seem as certain a consequence of the course revisions as some of the other effects mentioned. It may well arise as much from the instructor's commitment to the concept of criteria based learning.)

- Students find it much more "natural" to prepare a template for their presentation pages, work independently and then join the results into a professional-appearing product using the hyperlink capability. The advantages of this approach are that it promotes effective teamwork. It is possible that it will promote less integrated project results, although that does not seem to have been the case to date.[4]

- The instructors have an incentive to be more thorough in their preparation since the materials are presented on the web and are generally visible. This potentially allows

exchange with other colleagues as well as ready development of teaching portfolios, although this has not yet occurred to any major extent for this course.

Student Skills/Knowledge

Students enrolled in this revised course still achieve the fundamental knowledge for which the course was created - understanding of and ability to engage in the Architectural Engineering design process. It is extremely difficult to quantify design ability, so comparisons between the prior state of the course and the current state are somewhat subjective. With that caveat, the grades achieved have generally been at the same or higher level compared to those in prior years. It is my strong impression that we are doing a better job of imparting that knowledge because the clear, presentations allow us to look at the process more clearly than in past. There is also a reasonable possibility that act of "outlining", which is inherent to HTML use, helps structure their knowledge.

In addition we are teaching skills that will serve them well during their professional careers. These include:

- Information searching using the web
- Understanding of the World Wide Web / Internet
- Web page creation and alteration including graphics conversion.
- Use of a Cooperative writing tool

The total class time devoted to teaching these skills is approximately 1 class period out of 20 (5%). The trade-off or loss is the deemphasis of traditional paper-oriented presentation skills.

Knowledge Dissemination

A somewhat unexpected result of this use of technology is the increased ability to share knowledge generated during the course with succeeding generations of students. The most striking instance of this new knowledge is the analysis of existing buildings.[5] The final project of the term is an Architectural Engineering analysis of a local building of some complexity. These analyses are placed on a web page where they can be seen both by students and anyone else with web access. They have been very helpful for succeeding classes as they address their own building analysis and design projects. The effort required to accomplish this is about 1/2 hour at the end of the term.

Overall Conclusions

Both the instructors who share the teaching of this course are content with the changes made, while wishing for further capabilities such as analysis capabilities and higher graphic resolution. The time required of both students and professors is not significantly changed. The computing infrastructure must exist and must be well maintained for the approach to be successful, but the necessary equipment is becoming standard in all engineering schools. Most importantly, we believe that the quality of the fundamental work is at the same level or higher and that students have additional significant skills.

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[1] For a access to the latest version of these materials see the author's home page: http://mitchell.coe.drexel.edu

[2] The two instructors who have taught AE-Design for the last two years, James Mitchell & John Morris, have shared in its revision. In trading the course back and forth we have learned from what the others does.

[3] And another 10 minutes for students to play, during which laughter bursts from the computers around the classroom as they see often salacious comments appearing on their screen as soon as they've typed them.

[4] It is worth noting using WWW pages as a presentation tool to an audience is not yet as "smooth" as using a dedicated tool such as PowerPoint.
[5] http://www.coe.drexel.edu/CAE/AE.Reference/Bldg.analysis/Bldg.Analysis.home.html

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