TEACHING STEEL DESIGN ON THE WEB: THE BLACKBOARD EXPERIENCE

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ABSTRACT

The World Wide Web has become one of the major hubs for communicating and delivering information. From an educational point of view, it can be used as a platform for centralizing information pertaining to a given subject. If planned and carried out adequately, this centralization can be very helpful and useful to students. This is especially true when one is dealing with a structural design oriented course in which students are trying to learn new design concepts and fairly complicated analysis techniques while familiarizing themselves with the new terminology and products of the trade.

This paper describes an effort to complement classroom instruction in a steel design course with the web-based educational tool called Blackboard. In its traditional format, this course is quite challenging to students because of the huge amount of information, other than design and analysis procedures and methods, which they get exposed to. The author demonstrates how the steel design learning experience can greatly be enhanced when information, in the form of animations, illustrations, computational tools, and case studies, is made available to the students through a web educational system such as Blackboard. The author's findings are corroborated by the results of a survey that was administered to the students through the Blackboard system itself.

1. INTRODUCTION

Learning the basics of structural steel design can be one of the most challenging educational experiences for a senior civil-engineering student. From a teacher's point of view, introducing structural design concepts to students does present its fair share of challenges. This is because structural design, a task that adds an artistic dimension to engineering work, is an open-ended and multifaceted process that cannot be taught in one class or even any specific number of years. Design requires 1) a sound understanding of the basic concepts of engineering mechanics and structural systems and materials behavior, 2) an understanding and familiarity with the building and design codes that may be in force in a given jurisdiction, 3) sound engineering judgment, 4) sufficient knowledge of fabrication and construction processes, and 5) experience. Although structural design courses that are offered at most accredited engineering schools may address these requirements to a certain degree, adequate coverage is usually limited to the basic concepts associated with structural member behavior and design. The other components of the design process are usually left for the student to pick up during the course of his/her design career. In a report prepared for the American Institute of Steel Construction (AISC) by the Ducker Research Company (2000), surveyed structural engineering firms indicated that it takes an average of 14 months- including 13 months of costly in-house training- before a new hire is considered productive.

Given the limited time allowed for design instruction in most engineering programs, instructors have been looking for ways to enable their students to acquire knowledge about their subjects outside of scheduled class time. One of the approaches that has been gaining popularity in recent years is the use of the World Wide Web. In the field of steel design instruction, Adeli and Kim (2000) used Java to develop interactive and platform independent steel member analysis and design tools that were accessible through the World Wide Web. Using these tutorial tools, students could find answers to many what-if scenarios in structural steel design. This boosted their learning experience in the design course significantly while making it a lot more interesting.

Wilkins and Barrett (2000) developed a web site to support student learning in building construction technology. They cited scheduling and site access difficulties, in addition to concerns for student safety, as some of the main reasons against performing actual real time site visits. Such visits usually form an important component of learning in the field of civil engineering. Their web site, which they refer to as the Virtual Building & Construction Environment, has a multimedia database of buildings that are under construction. This well structured site, which is one of a collection of similar websites developed by a consortium of four universities, allows students to perform virtual tours of the construction sites to learn more about construction methods and technology.

These examples took advantage of the ease of accessibility and the flexibility with respect to the type of information that the World Wide Web can make available to its users to develop very useful learning tools. This paper describes how the author took advantage of a commercial web learning environment called Blackboard to complement class instruction in steel design.

2. STEEL DESIGN INSTRUCTION AT BRADLEY UNIVERSITY

The department of Civil Engineering and Construction at Bradley University provides its students with opportunities to gain knowledge and competence in the design of steel structures in three different courses: two at the undergraduate level and one at the graduate level. The undergraduate level courses are CE442-Design of Steel Structures and CE498-Civil Engineering Design Project. The graduate level course is CE562-Advanced Steel Design. CE442 is designed to introduce students to the basics of analysis and design of structural steel members with a brief introduction to connection design. Students meet with their instructor for class three times per week for fourteen weeks during which they are introduced to issues pertaining to the behavior and design of tension members, compression members, beams, beam-columns, and simple bolted and welded connections. In important objective of the course is also to familiarize students with the AISC Manual of Steel Construction (2001). Students who wish to learn more about the subject can then select a project that involves the design of a steel structure when they take their capstone design course (CE498). In this latter course, students get to learn more, through hands-on application, about overall structural behavior, building codes and their applicability to structural design, the structural design process, structural steel fabrication and construction details, and documentation and reporting of design results. For more advanced steel design education, undergraduate students have the option of taking the Advanced Steel Design course, CE562, as a technical elective. This course covers advanced topics in steel design including the analysis and design of slender compression members, plate-girders, and designing for torsion.

Although students have ample opportunities to develop their steel design skills in this program, time constraints dictate that required material be covered at a rate that is too fast for many of them to comfortably keep-up with. The use of the Blackboard system came in handy in this situation to allow students to catch-up with important concepts and even learn more about the subject at their own pace. A description of how the system was used is provided in the next section, followed by an analysis of student perception of the benefits of the approach in the following section. Conclusions and recommendations are then provided in the last section of this paper.

3. WEB DELIVERY SOLUTION

The web delivery solution that was adopted to complement steel design instruction in this program was to use the web learning environment Blackboard. The system was chosen over a stand-alone web site because of all the tools that it makes available to the instructor and also the students. Blackboard is an online Course Management System consisting of sets of course contents management tools, communication and collaboration tools, assessment tools, personal information management tools, virtual chat and whiteboard tools, in addition to access to other academic web resources. Figure 1 shows a snap shot of a typical control panel of a course site.

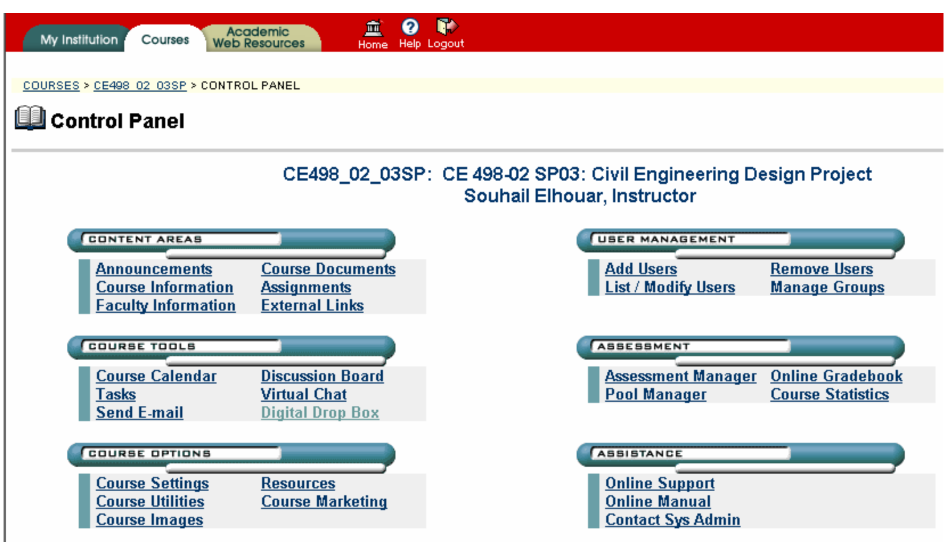

Figure 1: Typical control panel of a course Blackboard web site.

Using the control panel, a faculty member can post information about the course and course documents in a variety of formats including text, pictures, movies, animations, and slide shows. There is a special area for posting assignments, a course calendar where exams and assignment and project due-dates can be specified, many communication tools including a virtual classroom with instant chat and chalkboard functions, and an assessment manager for creating online tests and surveys. The system also has an online grade book where students can monitor their progress in the class.

The system was used in the two undergraduate courses that deal with steel design. In CE442, Design of Steel Structures, the system was used to post visual aids, design aids, and assignments, and to communicate with the students. The visual aids were animations to help students visualize some important concepts in steel design that students have traditionally had problems grasping just from class instruction. One of the animations was to help students visualize block shear failure. It showed a rotating 3-dimensional rendering of a plate as it was failing in block shear and identified the different elements of the plate that were providing resistance. Other animations showed the sources of lateral loads and their effects on buildings, how to identify the tributary areas of beams and columns, and the usefulness of lateral bracing. All of these animations were made available by the American Institute of Steel Construction through a program called Web Enhanced Teaching of Steel Design.

The design aids were mainly spreadsheet applications that were developed by this author. They consisted of one application for the design of tension members, one application for the design of columns, another application for beam design, a fourth application for beam-column design, and one last application for the design of column base-plates under simple axial loading.

In CE498, Civil Engineering Design Project, the Blackboard system was used to post project information, class presentations, a steel building design case study, and links to relevant web sites. It was also used to setup individual group areas for the different teams and to communicate with the students. Figure 2 shows what a student would be able to access once logged into the documents area of the course.

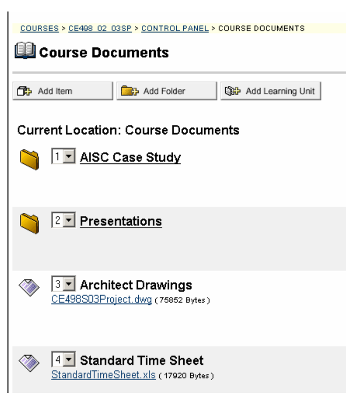

Figure 2: Course documents area of the civil engineering design project course.

Of special interest in this posting is the AISC Case Study folder. This case study was developed for AISC by faculty at the University of Kansas, and it has a wealth of information about the practice of structural steel design that students can explore at their leisure and gain tremendous insight into the material.

Some of the useful features of the Blackboard system are those that keep track of site activity. Blackboard can actually provide detailed information about access to the site by individual users or all the users. The pie chart in Figure 3 below for example, provides an idea about the number of hits per area of the system about two months after the start of the semester. This figure clearly shows that all the areas of the system are being accessed by students, but more importantly, it shows that students are visiting the course documents area at a much higher rate than the other areas, which suggests that they are accessing and learning from the information that is posted there.

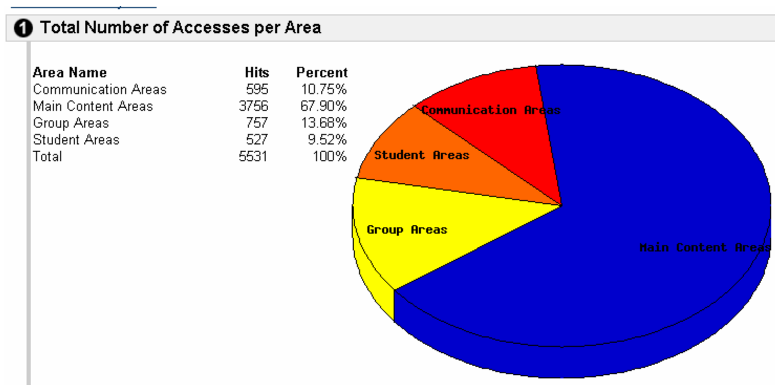

Figure 3: Course access statistics.

4. THE STUDENTS' PERSPECTIVE

To better assess the effectiveness of the use of the World Wide Web, and more specifically Blackboard, to complement class instruction in steel design, this author has developed a survey that he administered to 22 students who were enrolled in CE498-Civil Engineering Design Project. All of these students had to design a steel structure as a major part of their project, and many of them had taken their steel design course with the author. Students were able to participate in the survey from within the Blackboard system by answering sets of questions dealing with their prior experiences with web-based-education (WBE), their prior experience with the Blackboard system, and their experience with the system in the current course.

Although only 18 of the 22 students ended-up participating in the survey, this author believes that the results were quite revealing. Out of the 18 participating students, three people had no prior experience with the web as a learning environment supplement, five people had limited experience with the web as a learning environment supplement (used in only one course before), 9 described their prior experience as moderate (two or three courses), and only one described the experience as frequent. However, eleven of the students (61%) agreed that the web can be a very effective teaching tool. On the other hand, when students were asked if Web Based Education (WBE) could be more effective than the traditional class lecture format for engineering design courses, only one person (6%) tended to agree with that statement.

An insightful set of answers is the one dealing with the mostly liked feature of WBE as illustrated in Figure 4. Six students (33%) cited the 24/24 availability of information as their most liked feature, four students (22%) preferred the ease of access to information, and five students (28%) liked the numerous examples and case studies that were posted on the site.

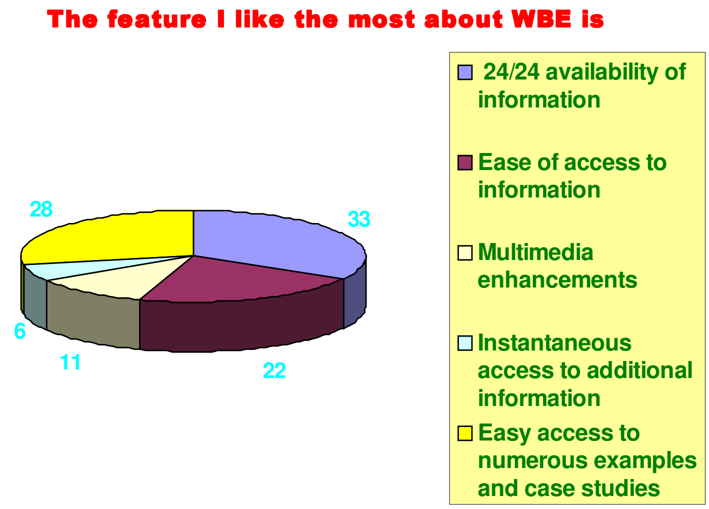

Figure 4: Best liked feature about WBE.

Perhaps the most telling sets of answers are the ones dealing with the usefulness of the animations that were posted on the web site. When asked about the benefits of viewing the block shear animations, three of the students (17%) said that viewing the animations did not improve their prior understanding of the concept, 14 students (78%) said that it had strengthened their understanding of the concept, and one student (6%) said that the experience corrected a prior misunderstanding of the concept. These results are summarized in Figure 5 below. Previewing the lateral bracing animation did not affect three of the students, but the remaining 15 students (83%) said that the animation strengthened their understanding of the concept.

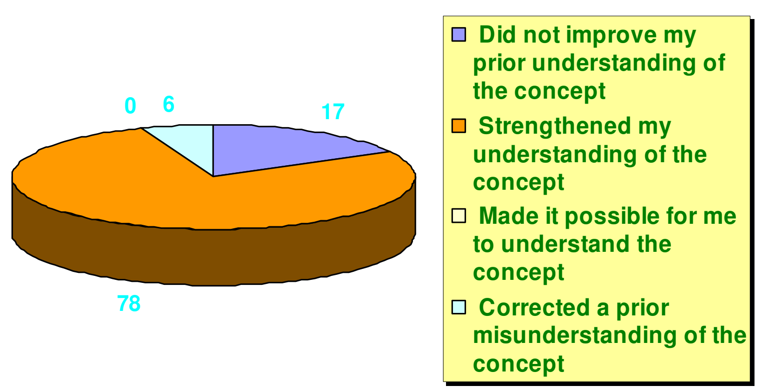

Figure 5: Effect of previewing the block shear animation.

5. CONCLUSIONS AND RECOMMENDATIONS

Although this study is preliminary in nature, the findings were very helpful in setting a direction for integrating web based learning into steel design courses. Students who participated in the class survey all agreed that the Blackboard system should be used to complement class instruction. However, they did not seem to be ready to take their full instruction in steel design from the web. It made sense that some of the material that was most beneficial to the students consisted of animations, design examples, and case studies. This is exactly the material that instructors need to use more of but may not have enough time for in the classroom. Posting it on the web was an effective measure that benefited students without placing undue stress on them or the instructor by trying to squeeze additional material into already overloaded lectures.

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