INTEGRATING ENGINEERING THEORY AND PRACTICUM WITHIN INTERACTIVE ASYNCHRONOUS COURSES

C. Greg Jensen, ASME Member
Associate Professor
Mechanical Engineering
Brigham Young University, Provo, UT 84602
cjensen@byu.edu

E. Max Raisor, ASME Member
Professor
Mechanical Engineering
Brigham Young University, Provo, UT 84602
raisor@byu.edu

Maintaining ABET-accredited engineering programs requires hands-on laboratory experiences in addition to course instruction and theory. Web courses that satisfy both required elements have not been available in the past. During the past year educators and academicians have openly debated the educational benefits of on-line instruction. Some have argued the foundational principles underwriting the "virtual university" while others have questioned whether or not such innovative developments can meet the high standards of traditional college and university curricula.

In a global context, the need exists to reach beyond the confines of the university campus to share both learning and practical experience with students in remote locations.The work of professors Jensen and Raisor

addresses the conversion of a computer-aided engineering graphics course (ME 172) to an interactive asynchronous course where both theory and hands-on CAD training are emphasized. This course was taught to students enrolled at Brigham Young University (BYU) in Provo, Utah and

simultaneously taught over the Internet to students enrolled in a comparable class at Ricks College (recently renamed BYU-Idaho) in Rexburg, Idaho. ME 172 is a complex course that incorporates materials from several classes previously taught in the College of Engineering at BYU.

Jensen and Raisor define Interactive Distance-Learning (IDL) as: *Any live, Web-based sharing of courseware, hardware, or software resources, point-to-point or multipoint conferencing, text-based chat-rooms, team collaboration, etc., which allows students at remote or distant locations to link, via the Web, to campus laboratory equipment for on-line instruction, individual student practice, and model creation.* If a course is to be an integral part of an accredited engineering program, on-campus and remotely located student experiences must be equivalent in learning and practice.

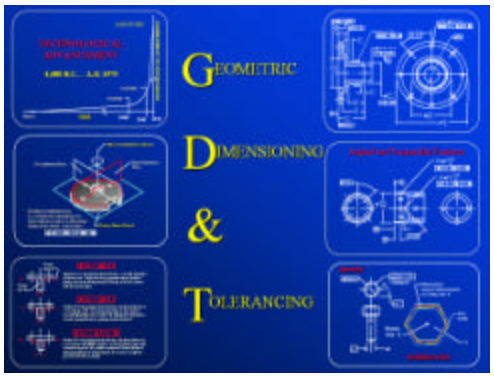
Both Jensen and Raisor have brought many years of teaching experience and CAE/CAD research and applications instruction to an interdisciplinary team of Web designers, programmers, and network services personnel, to create a fully functional interactive distance-learning course, with a required hands-on laboratory component. The most unique element of their accomplishments (related to this experiment) is remote student *access* to third-generation CAD software, which is resident on the BYU fileserver. Prior to this effort it would have been difficult if not impossible for remote students to access a commercial CAD package such as CATIA, Ideas, Pro/E, and Unigraphics, which are available at BYU.

Professors Jensen and Raisor have recently published three articles that discuss valuable distance-learning insights gained from their research during the past three years[1-3]. In addition, they have recently presented their work and findings at two international engineering educators' conferences, e.g. *2000 International Conference*

on Engineering Education, in Tiapei, Taiwan and *InterAmerica Council on Engineering and Technology Education- INTERTECH 2000*, in Cincinnati, Ohio. Their efforts reveal some essential points to consider, as well as "traps" to avoid, as Semester-on-Line, and Independent—or Distance Learning digital courseware is expanded to integrate *hands-on* laboratory elements.

Background

Geometric modeling and analyses, using sophisticated CAE/CAD systems, has been an integral part of engineering education at BYU since 1976, and current standards for geometric dimensioning and tolerancing have been continuously maintained in the curriculum.



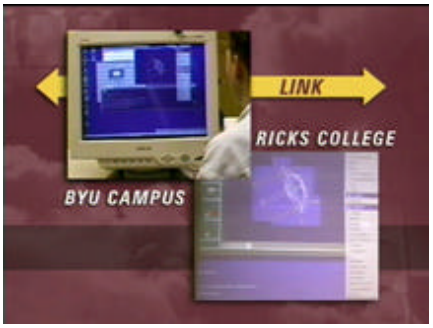
ME 172 was identified as a course rich in theory while complex and demanding in its hands-on laboratory component. Both the lecture and the laboratory require individual study, concentration, and practice to demonstrate mastery of related concepts, and likewise, have enduring linkages to industrial practices.

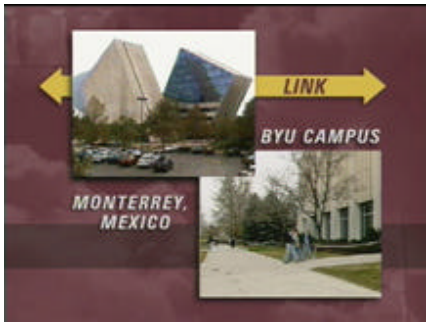
In 1995, multimedia sequences were implemented into the course to assist in content delivery and student understanding. These included photographic and CAD images, demonstrations, animations, and video clips, all of which, are posted on the class website, along with practice

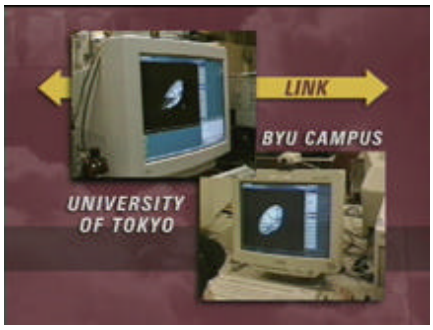
quizzes and examinations. Lecture notes, instructor comments, suggestions, helps, etc., are likewise posted on the class website at regular intervals. Time limitations demanded efficient teaching and learning solutions, leading to greater reliance on students to learn independent of instructor involvement.

Starting in the summer of 1997 experimentation began with interactive third-generation CAD tools over the Internet. While participating in a NSF-sponsored Collaborative Manufacturing Initiative at Purdue University, Dr. Jensen was able to remotely share Parametric Technology Corporation's Pro/Engineering software. He was also successful in remotely controlling a 3-axis tabletop milling machine, via the Web. Since then Microsoft's NetMeeting has been used over the Internet to remotely control or share a 2-axis lathe, surface analyzer, tensile tester, coordinate measuring machine, plus a number of high-end CAD/CAM packages.

The sharing or remote access of BYU's CAD/CAM packages was done from such places as Rexburg, Idaho, Monterrey Mexico, Tokyo Japan, Stockholm Sweden, etc. These activities were so successful that Jensen and Raisor set out to develop the first interactive distance-learning computer-aided engineering graphics course with remote sharing of the BYU CAD Laboratory.







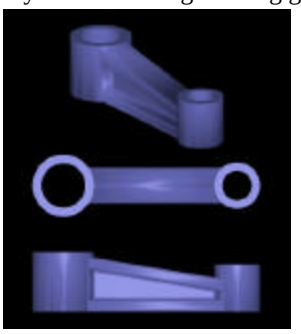
Web-based Interactive Engineering Graphics Course

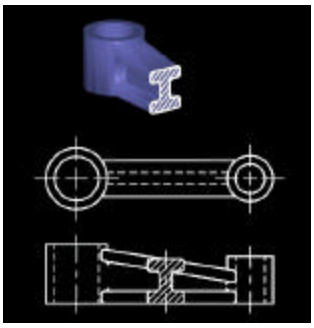
During the fall and winter semesters, 1998-99, a BYU classroom was linked via the Internet to a classroom at BYU-Idaho in Rexburg, Idaho, allowing lectures to be interactively shared by 260 students in the BYU lecture hall in Utah, and 54 students at the Idaho campus. A fifty-minute connection was made three times a week for fifteen weeks each semester. Collaborating students from both locations were required to complete nineteen laboratory exercises (ten tutored lessons, and nine production drawings—including final assembly drawings), using the Pro/E software to model and define each mechanical

component or assembly. The Pro/E software was resident only at BYU's CAD Laboratory. Before each lab project was assigned, a live lab session was conducted, similar to the lecture periods, the only difference being that instead of PowerPoint slides being displayed, Pro/E was interactively shared over the Internet between the two schools.

The primary objective of the ME 172 experiment was to develop a philosophy that would help to (1) quantify the effectiveness of using the Internet for course instruction and delivery, and (2) satisfy student interaction requirements for hands-on laboratory practice, using third-generation CAD systems. Jensen and Raisor developed a digital course extension that accomplished both tasks.

The knowledge gained from the ME 172 experiment has been expanded and tested in two additional ways (1) students at BYU collaborated on a design, analysis and manufacturing epicyclic air engine project via the internet with California State University at Los Angeles and Institute of Higher Learning at Monterrey, Mexico, and (2) the BYU Center for Instructional Design is in the process of converting Raisor's approximately 4000 PowerPoint slides, dozens of avi/Mpeg movies, and numerous Jpegs (used in the traditional class, and currently available on the Class Website) to a commercial quality rigorous interactive asynchronous engineering graphics course.





Findings

The following results were collected from the aforementioned two-semester ME 172 experiment:

- 90% of the students at BYU-Idaho related the *overall experience* as very favorable.
- 63% of participating BYU-Idaho students rated the *class interaction (two-way multimedia)* as very favorable.
- The BYU-Idaho students were evenly divided in their opinions regarding the importance of *viewing the live video of the instructor* during lectures and labs.
- In spite of the scheduling difficulties, a majority of the students (65%) at BYU-Idaho rated the *collaboration experience (working with a team of students at BYU)* as very favorable.
- A favorable (70%) rating was given to the *in-class PowerPoint instruction methods.*
- When considering the *usefulness of the asynchronous PowerPoint resource materials*, 78% of the BYU-Idaho students rated them very useful to hard to do without.
- *Usefulness of the comprehensive class Website*, 70% of the students at the remote site rated it very useful to hard to do without.

Other data suggested that BYU-Idaho students learned CAD skills on a par with students at BYU. BYU students scored an average of 6.5 (out of 10) on a Pro/E skills rating test, while the students at BYU-Idaho scored an average of 5.3. In all other tested areas, however, the BYU-Idaho students either matched or exceeded the BYU scores. The data also indicated that coaching by BYU students was not as effective as was initially surmised.

Future

While CAE/CAD/CAM tools have been a part of BYU for over twenty-five years, Jensen and Raisor recognize the need to reach beyond the confines of the BYU campus to extend laboratory resources to students who are at a distance from the university and therefore not available for on-campus instruction. Jensen and Raisor have just completed another experiment sharing Pro/E and CATIA to campus locations in Sao Paulo, Brazil. These findings will be reported in the near future.

References

1. C. G. Jensen, C. A. Rodriguez and V. A. Seaman, "An Experiment in Concurrent Engineering via a Web-Link," The Third World Congress on Intelligent Manufacturing Processes & Systems, Cambridge, MA, pp. 259-266, June 27-30, 2000.
2. C. G. Jensen and E. M. Raisor, "Engineering Theory and Practice via a Web Link," *2000 ASEE Annual Conference*, St. Louis, Missouri, June 18-21, 2000.
3. E. M. Raisor and C. G. Jensen, "Interactive and Collaborative Distance Learning of Third-Generation CAE/CAD/CAM Systems at BYU," *InterAmerican Council on Engineering and Technology Education – INTERTECH 2000*, Cincinnati, Ohio, June 13-16, 2000.