Distance Learning: Teaching a Course from a Remote Site to an On-Campus Classroom

Eric W. Johnson, Douglas Tougaw, Jeffrey D. Will, and Alan Kraft
Valparaiso University, Department of Electrical and Computer Engineering, Valparaiso, IN 46383
eric.johnson@valpo.edu, doug.tougaw@valpo.edu, jeff.will@valpo.edu, alan.kraft@valpo.edu

Abstract - Most applications of distance learning involve an instructor at a central, technology-rich location delivering a virtual classroom experience to students at one or more remote sites. However, there are many occasions when instructors need to be away from campus to attend conferences, perform on-site research projects, or administer off-campus academic programs, and they may need to remotely teach from a technology-poor environment (such as a hotel room or an apartment) back to a centralized location such as a campus classroom. During the spring semester of 2005, the electrical and computer engineering department at Valparaiso University conducted just such a course, which was taught by a member of the department who was spending the semester in Reutlingen, Germany. The authors describe the technology used to make this connection, appropriate course policies related to examinations, homework, and design projects, and unique challenges and opportunities presented by the nature of such a course.

Index Terms – Distance Learning, Remote Teaching, Team-Teaching, Educational Technology.

INTRODUCTION

Distance learning has been a natural outgrowth of the rapid improvements in computational and communication power available to educators over the past several decades. It seems natural that engineering educators would play an important role in leading the progress in this area. Almost all engineering programs have begun to investigate delivering at least some of their course using a distance-learning model, and many have found that there are special challenges and opportunities presented by the nature of such a course.

A natural question to ask about distance learning classes is whether they are as effective as face-to-face classes in achieving student learning objectives. Research at the New Jersey Institute of Technology, among many others, demonstrates that distance-learning courses can be just as successful as regular classes at helping students to learn the course material. It appears that the withdrawal rates for distance-learning classes may be higher than for in-person classes, though, and research continues in an effort to maximize student retention in distance-learning classes.

From a strategic perspective, there are many issues that faculty and administrators must consider when deciding whether or not to offer a distance-learning class. Questions such as how to motivate faculty to teach these courses, how to fund their development, how faculty should be compensated, how to balance faculty workload, and how to acquire the necessary hardware and software will be pivotal in determining the degree of success achieved by a particular program in this area.
One way to successfully develop a distance-learning course is from the ground up, including the development of computer hardware and software that will enable students and faculty to interact effectively. [10] However, a much more common way to develop a distance-learning course is by methodically transforming an existing in-person course into a distance-learning course. [11] Such a transformation can be very challenging at first, but it becomes much easier once one has developed a level of expertise with the technical and pedagogical issues to be addressed.

In spite of this significant experience base in the area of distance learning, it appears that the work has primarily focused on the delivery of information from a professor at a centralized, technology-rich site to students at a widely dispersed set of technology-poor sites. In this paper, the authors will reverse that traditional directionality, studying the opportunities that exist for delivery of distance learning from a professor at a remote, technology-poor site to traditional on-campus students in a technology-rich classroom.

AN OVERSEAS ASSIGNMENT

The need for a distance-learning course at Valparaiso University arose rather quickly through some unusual circumstances. Due to the development of a new engineering exchange program between the Reutlingen Study Center in Reutlingen, Germany and Valparaiso University, Eric Johnson, who was key in the organization and formation of the new German program, was needed to coordinate the local implementation of this program in Germany.

Professor Johnson teaches one of the most popular elective courses in the computer engineering curriculum, VLSI (Very Large Scale Integration) design. Since the departmental faculty possesses very diverse technical backgrounds and expertise, he is also the only member of the department who is qualified to teach this course. The assignment for the new exchange program, which requires a two-year assignment in Germany, means that students in the computer engineering program would graduate without the chance to take this important elective course unless something was done. This unusual situation created a challenge that could only be effectively addressed by temporarily modifying this course into a distance-learning format.

The faculty initially considered an asynchronous delivery style such as that presented in [12], but it was quickly decided that the complexity of the material in this course would require the sort of interaction that would not be supported by a video-taped presentation format.

TECHNOLOGY AND PEDAGOGY

The technology used in this course consisted of a combination of software and hardware. Though many professional companies exist to set up commercial-grade turnkey teleconferencing centers, these solutions typically cost tens of thousands of dollars. Our effort sought to find a solution for one-tenth that cost. This included using freely available software and selecting appropriate hardware that balanced concerns of cost and quality. Of course, choosing to solve the problem in this way involves additional effort by the faculty involved in the course, who have to design a distance-learning system rather than simply installing a turnkey device. In the case of this project, it was decided that the benefit of designing a customized low-cost system outweighed the additional work required to do so.

Hardware for the local classroom system includes the control center, a video input device, and sound delivery system. A mid-grade PC was chosen for the control center, as it was capable of running standard software, had TCP/IP communication, was available for a low cost (approximately $1500), and consisted of commodity parts. It was desired to have as much screen “real estate” as possible for displaying video feeds and applications. Therefore, the main video card installed in the computer was a Chaintech AGP GeForce FX-5200, a double-headed video card allowing for projection to two screens.

For video digitization, a Hauppauge WinTV 401 card was installed in the PC. Video capture was performed using a Sony EVI-D70 pan-tilt-zoom camera installed on the ceiling of the room. This camera had an SVGA output that was readable directly by the video capture card of the PC. Additional features included pan-tilt-zoom-focus control via both IR handheld remote and a software application running on the PC. Sound input was accomplished via Gentner AccuMic II teleconferencing microphone, placed near the middle of the room.

The PC video output was projected onto pull-down screens using 2000-lumen NEC XGA projectors. A facilitator for the class controlled the PC applications using a keyboard and mouse with 10' USB extension cords from the front row of the classroom.

When deciding upon the communication channels for information, it was important to consider constraints upon the classroom setting. We felt that the vocal channel from instructor to students was the most important consideration, and for that we desired a dedicated channel. Visual feedback was secondary, and we were willing to sacrifice quality in this aspect. Finally, it was important for the content of this course that the lecturer be able to demonstrate software applications, so it was essential that we be able to share applications, including PowerPoint presentations of lectures.

For these reasons, we utilized a standard telephone channel for voice communication due to high quality and lack of delay. In early tests, it was found that Internet-based voice communication was of such poor quality as to render it unacceptable for this purpose. However, for video communication, we found that a low-quality (240 x 320, 5 frames/s) Internet-based channel was sufficient to give the students a satisfactory impression of lecturer presence, while not requiring vast amounts of bandwidth. Application sharing, especially PowerPoint presentation sharing, requires much lower bandwidth, and it was found that Internet-based sharing was sufficient for this purpose as well. Therefore, we utilized two channels, a telephone voice connection and a standard Internet connection, for all media of communication.
Software implementation of both video communication and application sharing was achieved using Microsoft NetMeeting, a built-in feature of Windows XP. Thus, no additional cost was associated with the use of this software. However, in practice it was found that when using applications, it was advantageous to pause video transmission during times of application focus, as dedicating bandwidth to applications improved the quality of the demonstration of software.

Figure 1 shows the final result of this effort: A distance learning facility with one screen allowing virtual presence of the instructor, while the second screen is used for application delivery.

![Figure 1](image1)

**Figure 1**
THE DISTANCE LEARNING CLASSROOM.

Overall, this technological solution provided a good balance of functionality, configurability, low startup time investment, and cost for hardware and software.

In Germany, the instructor’s apartment was the location for the course delivery. At this location, the hardware used for the course was a Dell Inspiron 5150 laptop running Windows XP, a web-cam, a graphics tablet, and a DLS connection through Deutsche Telekom which had a maximum download capability of 3000 kilobits/sec and a maximum upload capability of 384 kilobits/sec. Two headsets including microphones were purchased both for the laptop and for the phone. The total cost for the hardware, excluding the laptop, was approximately $400 plus $35 per month for the DSL connection.

The software installed on the laptop included Microsoft NetMeeting and PowerPoint, which were described earlier, and two other software tools that were purchased to support the course. First was NotateIt by Blade Software, which was used with the graphics tablet to act as a virtual white board that could be projected to the class. This software was used extensively to work problems during the class periods. The second was an advanced MP3 recorder by XAudioTools. This software was used to record the audio files in a MP3 format. A combination of PowerPoint slides and audio files were made available to the students when the instructor had to miss a class period. The cost for these two tools was approximately $50.

Figure 2 shows the technology arrangement in the instructor’s apartment in Germany.

![Figure 2](image2)

**Figure 2**
THE TECHNOLOGY SETUP IN GERMANY.

### Teaching VLSI Design from 4000 Miles Away

There were many challenges and opportunities from a faculty perspective that came from teaching a class from 4000 miles away, especially a senior-level elective course that involves design and the use of computer-aided-design (CAD) software. Of particular importance are issues of course logistics, class preparation, and teaching methodology.

Course logistics created challenges in some areas (collection of assignments, office hours) but in others (distribution of course materials) the students were already familiar with the technology that was utilized and so the challenge was minimal. When assignments were due, most were collected like any other course. They were then mailed to Germany, graded and returned. While this caused some delay in the assessment getting back to the students, they seemed to understand the situation. There were some assignments, especially those involving designing VLSI components, where the students simply email their entire design library to the instructor for grading. This allowed for much quicker assessment of the student work and was used whenever possible.

The instructor did not have posted office hours. Instead, he interacted with students through email and instant messaging. While instant messaging is a relatively new medium for interacting with students, the real-time capability allowed for the instructor to answer questions immediately. The instructor was available through instant messaging almost every weeknight for three to four hours. Many questions were solved using this method. Questions regarding the design projects were more of a challenge because each student’s problem was different and many needed help using the CAD...
tools. When the instructor was on campus and students would ask for help with a design project, he could typically go to the lab and work through the problem with the student. With this class, if there was a similar problem, the student would email the instructor his/her design library and they would work through the problem together, as they talked on the phone or used instant messaging. While there was no face-to-face interaction, this technique was successful in solving a majority of the student’s problems.

The distribution of course materials was helped by a web platform that was familiar to the instructor. The Blackboard Learning System™ has been used at Valparaiso University and by the instructor for a number of years. In previous classes, the instructor used the system to create a virtual academic environment where the students can download assignments, access presentation slides, view learning objectives for each of the individual lessons, check their grades, email the instructor, and participate in a discussion group that focuses on software questions. The instructor used the system to update the VLSI course information from Germany, and the students used the system to keep up-to-date on what is happening in the course.

Class preparation changed due to how the content was delivered. When this course was taught on campus, the instructor always used chalk/white boards to present information. His course notes were documented and organized using the “Board Notes” technique advocated by the ExCEEd teaching workshops [13]. After evaluating all the options for presenting information, it was decided to use electronic presentation slides for this course and to supplement the slides with Notate-It software, which acted as a virtual white board. This meant that all of the instructor’s notes had to be converted into presentation slides. This conversion became the most time-consuming part of the course. The textbook that was used did have presentation slides available but they had to be modified to work with the individual lessons. The changes included not only modifying certain topics but also adding active learning exercises to enhance the classroom experience.

All the students were given the slides as handouts before each class period began. These slides had parts of the presentation missing so that the students had to fill in information as the lesson progressed. At the beginning of the semester it was a challenge for the instructor to present material using presentation slides. However, by the end of the semester the instructor felt comfortable presenting information using slides. The virtual white board supplemented the presentation slides and was used to work problems or answer questions that the students had as the lesson progressed. Figure 3 illustrates the use of the Notate-It software to perform an example calculation for the students.

One of the strengths of the instructor is his interaction with the students in the classroom, whether it is sensing the normal responses from students as he presents material or when he assigns small in-class activities where he can walk around the room and see how the students are doing. With this class, this type of interaction was a challenge. When presenting material, students did not provide the same feedback (asking questions, making comments) that they did when the course was carried out in person. Therefore, it was difficult at times for the instructor to determine whether the students understood the material. When an in-class activity was performed, the camera in the classroom was moved to pan around the entire class. While this helped give the instructor a visual picture of the class working, it was difficult to determine the progress of the students because the camera couldn’t zoom in on each student’s work. Both of these challenges were addressed by continued prompting of the students until responses were received.

Enrollment in this course was limited to 13 students, although at least ten more would have taken it if the capacity had been increased. The size of the course was limited because the faculty involved had very little experience with distance learning classes and were concerned that a larger class would substantially increase the workload associated with teaching the course or would degrade the experience of the students. Twelve of the students were senior electrical or computer engineering students, while one was an advanced junior. None had taken a distance learning class before.

Overall, the instructor has found the course very challenging but also rewarding, as he had to adapt his teaching methodology and still try to be as effective as if he was standing in front of the classroom. The course has made him a better teacher because he had to really focus not only on the material being presented but also how to present it to the students given the technology that was available. The workload for the course, other than converting lessons to presentations slides, was similar to the workload of a regular class.

LEARNING VLSI DESIGN FROM 4000 MILES AWAY

From the students’ perspective, the course has also offered some challenges on top of learning the course material. To assess how the students were doing, a survey was given halfway through the course. The survey was split into two sections, one involving specific summative questions on
which the students could give a rating between 1 and 5 and the other where they were asked more open-ended formative questions that allowed them to provide short answers. The ten questions from the first section are given below. They are numbered so that the results provided later can be referenced:
1. Have the class sessions been helpful in learning the material (as opposed to a typical online course where you simply view the slides on your own)?
2. How useful have the power-point slides been in supplementing the material from the book?
3. How useful is the textbook?
4. Have you used the course webpage to view the information about the course and the class lesson learning objectives?
5. How easy has it been to use the Electric CAD tool?
6. How would you rate the workload of the course to date?
7. How much learning do you do outside of class? (reading the textbook, studying slides, etc.)
8. How difficult has it been doing more of the learning on your own (since the instructor is not on campus)?
9. Have you studied with other classmates or asked them questions?
10. Do you feel you are learning just as much information as a regular course where the instructor is present?

For each of the questions, an answer of 5 corresponded to the highest affirmative answer to the question while an answer of 1 corresponded to the least positive answer. Figure 4 summarizes the performance index (average score) for each of these ten questions.

![ECE 429 Survey Results](image)

**Figure 4**
**STUDENT ASSESSMENT OF THE DISTANCE LEARNING COURSE**

Only one student was absent on the day of the survey, so the results are very representative of the class population. These results showed that the course was generally effective from the students’ perspective. A number of observations were made from the results. First, the index for the question involving how well they were learning (question 10) had a good index rating (3.58/5.0) and therefore illustrates that the students believe they are learning as much as if the instructor were in the classroom. Other results of interest included the high index rating of question 1, the usefulness of the individual class sessions using the technology (4.17/5.0); the low rating of question 4, their use of the course web site (2.67/5.0); and the high index rating of question 8, suggesting the relatively high difficulty level of learning more on their own (3.67/5.0).

The second part of the survey included more open-ended questions where the students could write short answers. These questions included:
1. Is there any topic that has been discussed so far that you don't understand?
2. Is there anything about the distance-learning technology that could be improved to help you learn the material more effectively?
3. Is there anything that the instructor could do to help you learn the material more effectively?
4. Do you have any other suggestions for the course?

Some of the specific comments offered by the students outlined how well the course was going:
- Overall, I'd say the class is going very well under the circumstances
- Everything has been well prepared and more than I expected.
- (No improvements) that I can think of but doing the examples on Notate It helped.

Others gave specific suggestions on how to improve the course:
- More Notate-it as opposed to pre-made PowerPoint slides
- More in-lecture examples with working through homework type problems.
- Post example problems and old homework for students to review.
- If we could get our assignments and tests back faster, it would be helpful, but I can't think of how that would be accomplished.

Given the survey results, the instructor did make some minor modifications to the course to address the concerns of the students and to further increase the course’s effectiveness.

A second survey was given to students at the end of the semester as part of the standard departmental teacher/course evaluation (TCE) process. This survey gave the students an opportunity to answer both open-ended and multiple-choice questions about the course and to assess their own progress toward achieving the course learning objectives.

The overall quality of the course was rated as 3.9/5.0, while the overall quality of the instructor was rated as 4.6/5.0. This may indicate that students felt that the technology prevented the instructor from delivering the course as well as they recognized that he could have done in person. The students’ self-assessment of their ability to achieve the seven course learning objectives averaged 4.24/5.0, a result that is above average for the department’s conventionally delivered courses. When asked “How much did the delivery of the course (lectures given at a distance, professor not available on

**Session F1H**
Second, teaching a distance-learning course is certainly no less work than teaching a face-to-face course. In fact, it is in teaching a face-to-face course. In fact, it is

Student comments on the TCE specifically addressed the lag time associated with updating the Power Point document and the Notate-It display, suggesting that the speed of a standard Internet connection may have too much variability to support such a highly interactive application over such a long distance. They also suggested improving the quality of the video camera at both ends of the connection, which would have helped the students to more completely immerse themselves in the virtual classroom.

LESSONS LEARNED

The faculty involved in this project have learned several important lessons that will be helpful to others considering a similar distance-learning experiment.

The greatest challenge in teaching this course is lack of immediate feedback from the students to the instructor during class. Although the camera in the classroom can allow the instructor to see what the students are doing, it provides far less information than if the instructor were physically present and meeting with the class in person. It is easy to overlook the many subtle non-verbal cues that pass from student to teacher, telling the teacher to slow down, explain further, give an example, or move on to the next topic. These non-verbal cues are almost entirely absent in a distance-learning course, which makes it even more important to regularly seek explicit feedback from students.

Second, teaching a distance-learning course is certainly no less work than teaching a face-to-face course. In fact, it is at least the same amount of work for the primary instructor, who may or may not have to modify much of his/her course materials to meet the capabilities of a distance-learning environment. In addition, at least one other person is often needed to be available on campus to set up the room and to monitor the technology during each class meeting. In this case, a second faculty member volunteered to fill this role, but in the long term it would be a more appropriate role for a student aid or a computer technician.

Finally, the reliability of the equipment and software to be used in the classroom must be a primary consideration. If a technology failure occurs in a face-to-face setting, the instructor can at least continue to interact with the students without the benefit of the failed technology. But in a distance-learning environment, a technology failure means that the class will be at least several impacted and at worst completely terminated. One of the main reasons why the faculty involved in this project chose to use a telephone line for the primary audio link and the Internet for a primary video link is that this increases the chance that at least one of the two will continue to operate properly. This class never had to be cancelled due to a technology failure, but that was at least partly due to constant vigilance by the faculty involved.

CONCLUSIONS

This experiment in distance learning was generally very successful. The quality of the experience exceeded our expectations, as did the amount of time and work involved both by faculty on campus and the overseas instructor. Students were very appreciative of the opportunity to take a very popular upper-level elective class from the departmental expert in the field, and they were very supportive of the effort. It was a very rewarding experience, and one that will be performed again if the circumstances arise.

REFERENCES