

Including Distance Technology in the Traditional Classroom

Douglas R. Carroll
Missouri University of Science and Technology

Abstract

The author has been working for several years toward developing a cost effective way to bring distance education technology into the regular classroom. Two methods have been studied. For the first method a high quality digital tablet and a noise canceling microphone were installed on the podium in a regular classroom. The total cost was about \$2500.00 per classroom. This system allows faculty to transmit and record their lectures. Faculty have found this system to be easy to use and very reliable.

The second method was to have faculty bring a tablet PC and wireless microphone to the classroom and use the system to transmit and record the lecture. The wireless microphone gives faculty freedom to move around the classroom while lecturing. The added complexity of hooking up the hardware and linking the microphone made this system less reliable than the first method.

Introduction

The purpose of these efforts has been to develop a cost-effective way to bring distance education into the regular classroom. The author has taught from high-tech distance education classrooms at Missouri S&T, and the students in the classes benefitted from the lectures being transmitted and recorded for their use. Traditional on-campus students benefit almost as much from the technology as the distance students. The technology allows students to view lectures live from home if they are unable to get to campus. They can view recorded lectures when they miss class, or when they want to review what was covered in a lecture. An advantage of the recorded lectures is that students can skip to the part they had difficulty understanding in class, and view it again to increase their understanding of the material. The disadvantage of the recorded lectures is that there is a temptation for students to skip class. When used properly, the recorded lectures are a benefit to the students.

There are two problems in bringing distance technology into the regular classroom, and they are both cost related. First, it is impractical to teach all classes from expensive high-tech distance education classrooms. The cost of purchasing the equipment and providing a video technician to operate the equipment makes this solution impractical. The distance education classrooms can be used to train faculty and help them become comfortable with the technology, but it is too expensive to provide enough distance education classrooms to teach all classes offered by the university. The equipment and manpower costs must be controlled to make the technology affordable.

The second problem is the amount of faculty time required to use the distance technology. Solutions that require a significant amount of faculty time to learn to use the equipment or software are impractical. Faculty time is expensive. Asking faculty to teach in a manner that is dramatically different from their traditional teaching method is also an impractical solution. In order to mainstream the use of distance technology in the classroom, faculty must be able to teach in a traditional manner using the same lecture notes they have always used.

Problem Statement

The goal is to mainstream the use of distance education technology in classrooms subject to the following constraints: (1) The solution must use inexpensive equipment so that it is practical to provide the equipment in most classrooms on campus. (2) The solution must allow faculty to teach using the same lecture notes they have always used, writing on the board and talking to the students. Using the distance technology must be an easy transition for the faculty.

Teaching Method

The author's goal has been to teach the problem solving classes in a traditional manner. Derivations and example problems are done by hand using the stylus to write on the digital tablet the same way the author used chalk to write on the chalkboard. The digital tablet offers some improvements to the chalkboard in that it is cleaner, easier to erase, and easier to change colors. With a good quality digital tablet, the images are crisp and clear, and the technology will continue to improve. Instead of erasing the board to write a new page of lecture notes, the teacher goes to a clean page, which saves class time. The digital tablet allows the lecture notes to be saved, projected on a computer screen, and transmitted over the internet. The digital tablet also has the "cut and paste" ability so that textbook pictures can be pasted into the lecture. This allows the teacher to use high quality graphics in the lecture, which is especially helpful when explaining the three dimensional problems, and other problems where it is difficult to draw a good picture by hand.

Homework, quizzes and exams for the classes are traditional. Students are assigned to work problems out of the textbook for homework, and work similar problems for quizzes and exams during class. The goal is to use the distance technology to help the students perform better on the traditional homework, quizzes and exams. The primary benefits to using the distance technology are (1) use of high quality graphic images in the lectures, (2) recorded lectures for students who miss class and students who wish to review what was covered in class, and (3) ability to conduct review sessions and homework help sessions without requiring students and faculty to be on campus.

In preparing the lecture files for the class, the author gets digital access to the textbook, usually by getting the textbook company to give him access to the on-line version of the textbook. Files are built in PowerPoint cutting and pasting the images and example homework problems that the author plans to do in class into the PowerPoint file. The author leaves lots of blank space on the

files so that the handwritten parts of the lecture can be written in class. The files are converted to pdf and posted on Blackboard. Students print the files and bring them to class, so that the high quality graphics will be in their notes too.

The PowerPoint files are imported into the software developed for writing on the digital tablet. Tablet PCs use the Windows Journal software. Most of the stationary digital tablets use the Softboard software. It is possible to use the PowerPoint or pdf files directly and write on the screen, but it doesn't work near as well as using the software specifically designed for writing on the screen. The system is much more stable and performs better using Windows Journal or Softboard. The author writes out the lecture notes on the tablet in a traditional manner, talking the students through the lecture. The students take notes on the printed sheets that were posted on Blackboard. This allows them to take full advantage of the high quality graphics in the lecture because the graphics are printed on the sheets. The example problem statements and figures are already printed in their lecture notes too. This allows for more lecture time to be focused on explaining the material and answering questions, and less time spent copying down the figures and problem statements.

For review sessions and homework help sessions, the author prepares PowerPoint files that have one homework problem per page, by copying and pasting the problems from the textbook. The PowerPoint files are imported into Windows Journal. Webex is used to transmit the session on the internet. The author wears a wired headset, and his voice and the work done on the screen is transmitted. Students normally ask questions about specific homework problems during these sessions. The author pulls up the problem in Windows Journal so that everyone can see the problem being worked on, and answers the questions. Students are at home on their computer, or in a computer lab on campus. The author is in his office, at home, or in a motel room. The advantages of the on-line sessions are that they are more convenient and can be recorded for students who miss the review. Students are free to get up and move around, tune in and out, and chat with their friends without disturbing the class. The author feels that doing the sessions on-line is more convenient for everyone, and is a good substitute for office hour type help.

It takes a few sessions for students to learn to use Webex and get into the virtual sessions. After the initial learning curve, students request that the author offer Webex sessions the night before homework is due and the night before exams. More than half the class will participate in the homework help sessions to get the help that they need. The author has experimented with other software packages to potentially replace Webex, because other packages are significantly less expensive, including WIMBA, Adobe Connect and Elluminate Live. In the author's opinion, the performance and reliability of Webex makes it worth the extra cost.

Digital Tablet Requirements

There have been a number of studies illustrating the benefits of using digital tablets and tablet PCs in teaching math, science and engineering courses.¹⁻⁶ The digital tablet is a key piece of equipment in allowing the problem based courses to be taught as distance education. A high quality tablet and microphone can be provided for a classroom for about \$2500.00. There are less expensive tablets available, but they are not suitable for teaching the problem based courses. The author has tested several tablets that cannot keep up with normal handwriting, and skip. It is frustrating for the faculty member and it makes his/her writing and figures messy. An easy test for a tablet is to write on the screen at a normal writing speed and see if the tablet can keep up. After writing a paragraph or two, most people can make a judgment as to whether or not the tablet will be acceptable. The digital tablet and podium are shown in figure 1 below.



Figure 1. Digital Tablet and Podium.

The digital tablet shown is a very high quality art tablet. It has a large (12" X 16") writing area, and is very responsive to the stylus. The tablet is mounted on a moveable arm and can be adjusted and tilted for individual faculty. There is a computer inside the podium; the system can be used to run PowerPoint and other software in addition to the tablet features. The advantage to

this system is that everything is in the classroom, hooked up and ready for use. Faculty bring only their lecture notes and class demonstrations. The digital tablet system shown in figure 1 is reliable and easy to use.

Another solution is to provide faculty members with tablet PCs and have them bring it to class when they teach. All of the tablet PCs tested by the author have been very responsive and able to keep up with his handwriting. The tablet PC has a ribbon connection from the tablet to the motherboard and can transfer data much more quickly than the typical serial connection between a stationary monitor and computer. The tablet PC system is shown in figure 2 below.

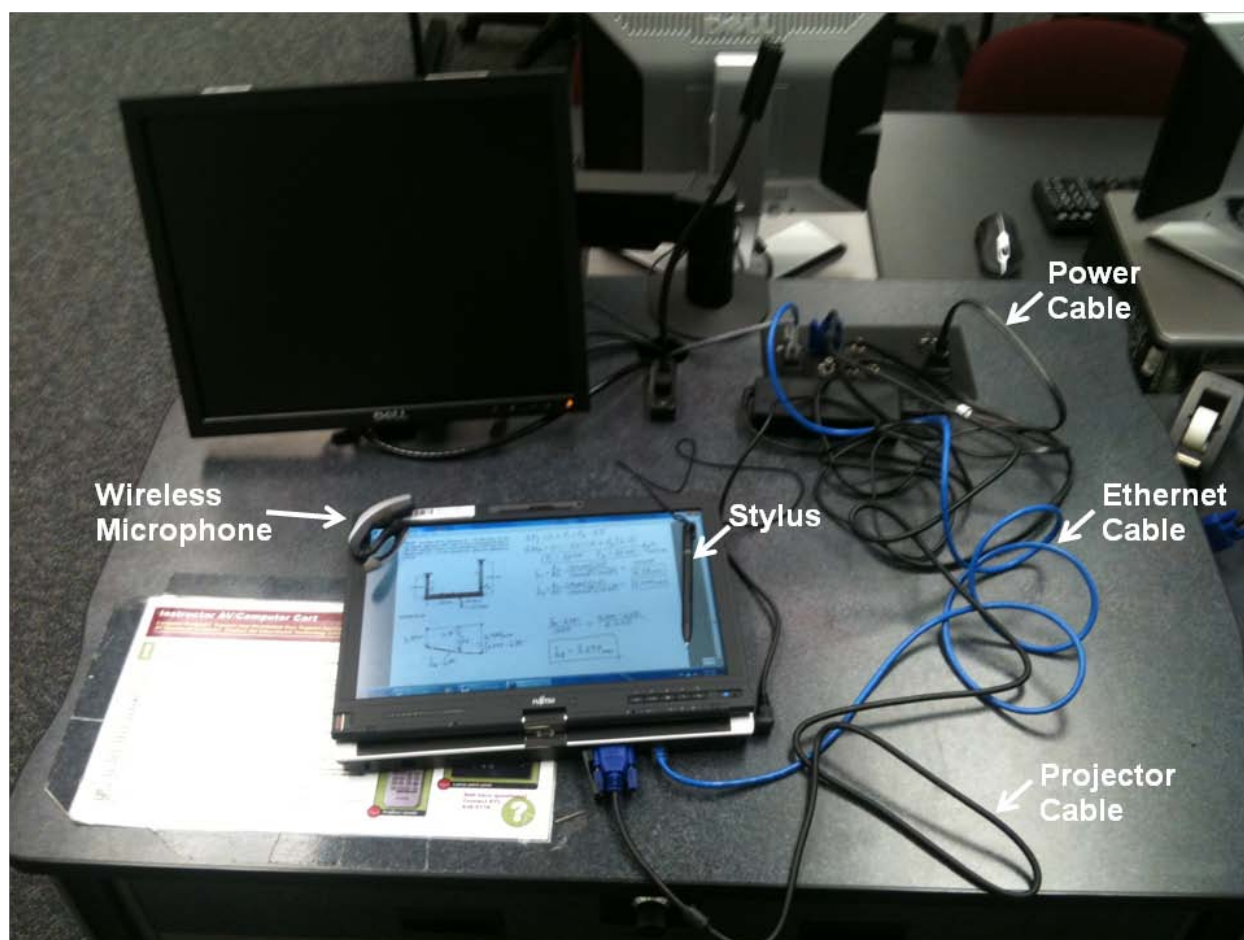


Figure 2. Tablet PC and Equipment.

For the tablet PC approach shown in figure 2 above, the faculty member brings the tablet PC, wires and microphone to a standard classroom. The advantage to this approach is that it is possible to use the technology in almost any classroom on campus. The disadvantage is that faculty must bring the equipment to class each time and get it all hooked up, linked and working properly. Faculty first hook up the Ethernet and power cables, get the software started, and turn the screen around flat as shown in figure 2. The wireless microphone is linked using Bluetooth. Different classrooms have different equipment for linking the tablet PC to the projector, which

can be frustrating to figure out at the beginning of the semester. Once everything is set up, this system works as well as the digital tablet system shown in figure 1.

The author has also taught classes in the high-tech distance classrooms at Missouri S&T. These classrooms have a podium set-up similar to figure 1 where the teacher uses the digital tablet in writing out the lecture notes. The teacher wears a wireless microphone, and there is wired microphones near all of the seats in the classroom. There is a video production specialist working in a control room adjacent to the classroom that controls the camera and sound systems, assists the teacher with the technology, and produces a high quality recording of the lectures. The teacher can teach class in a normal traditional manner in these high-tech distance classrooms without a lot of extra preparation or having to learn a lot about the technology. It is a great way to do distance education and to learn to use the technology, but it is an expensive solution. We cannot afford to offer all classes in these high-tech distance classrooms. The author has been experimenting for several years trying to develop a less expensive solution to incorporating the distance technology into the regular classrooms.

Over the past five years, the author has taught ten classes in high-tech digital classrooms⁷, six classes in regular classrooms that had a digital tablet⁸, and six classes in regular classrooms using a tablet PC⁹. The author conducted office hours and review sessions for all of the classes over the internet using a tablet PC, and has many hours of experience working with students on-line. This paper summarizes his experiences, and makes recommendations of cost effective ways to include distance education technology in regular classrooms.

Audio Requirements

Audio technology has improved significantly over the past five years. Some improvements have been in the noise cancelling capabilities of the microphones. Even relatively inexpensive microphones today do a good job of reducing unwanted background noise. The other improvements have been in transmitting the audio signal over the internet with VoIP. A mid-priced Bluetooth wireless microphone (developed for cellular phones) provides a good audio signal and gives the faculty member the ability to walk around the classroom while lecturing. The wired headset microphones used by video gamers are inexpensive and provide the best audio signal of all the microphones the author has tested. A headset microphone is generally the best solution for on-line office hours and review sessions. The microphone built into the newer tablet PCs delivers a good audio signal, but it picks up the tapping noise from writing on the screen, and students find the tapping annoying. The built in microphone is adequate for on-line review sessions, but not as good as the wired headsets.

Office Hours and Review Sessions

In problem solving classes, much of the learning takes place as students work homework problems and prepare for exams. Distance technology can be used to allow the faculty member to be present in a virtual manner and assist students with their homework and exam preparation. The author normally conducts these sessions from home in the evenings when the students are most likely to be studying. He has also conducted sessions from motel rooms when traveling. Virtual office hours and review sessions have been very popular with students.

The office hours and review sessions are conducted using a tablet PC and a wired headset microphone. The author opens a virtual classroom on the internet and students log into the classroom using their home computer. Sessions are typically conducted the night before a homework assignment is due or an exam is scheduled. On average, approximately half the class will log in. The percentage is higher on nights before exams and lower when the homework assignment due is relatively easy. The author has worked many sessions where more than 50 students logged in for help. Students ask questions verbally and using the chat box. The author uses the tablet PC like it was a chalkboard to draw figures and write equations and talks to the students through the microphone.

Many students will have the same basic question or problem, so the author can answer the question once for all of them rather than answering the question many times as they drop by the office. The students like the convenience of being able to get help at home. It is much better than waiting in line at the professor's door or finding that the professor is not in. It feels like a very personal service to them, even though there may be 50 students in the virtual classroom with them. When they are not interested in the question being discussed, they can get up and get a Coke or talk with their roommates without disrupting the class. The tablet PC and wired headset for the on-line Webex sessions is shown in figure 3 below.

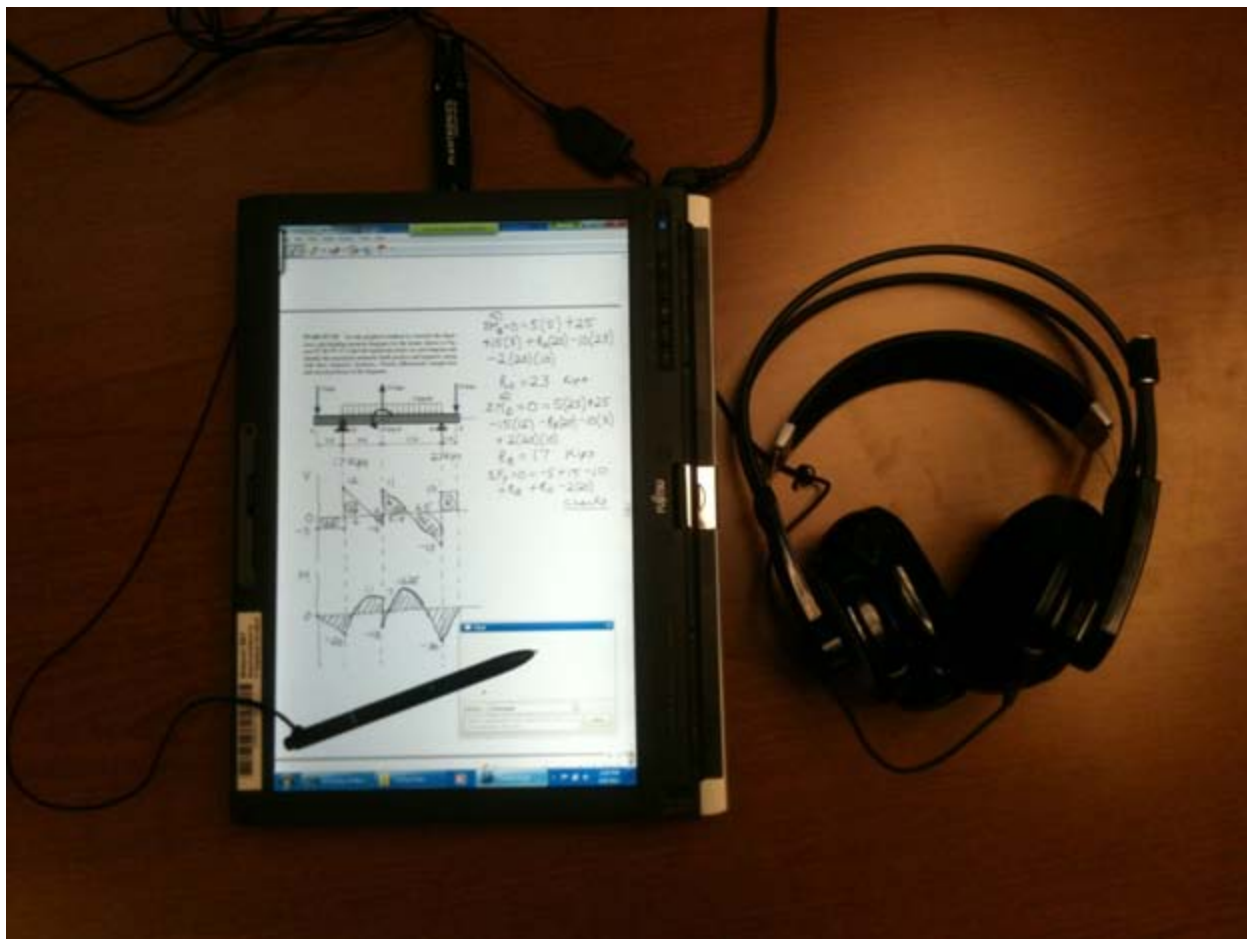


Figure 3. Tablet PC and Headset

For these on-line sessions, the image on the screen is rotated 90 degrees (portrait) as illustrated in figure 3. Tablet PCs are designed to be used in this orientation. It makes writing on the tablet more like writing on a sheet of paper, and seems more natural. Projectors in the classroom are not designed to accommodate this orientation. The landscape rotation must be used in the classrooms. For the review sessions, the author captures the left half of the student computer screens, as illustrated in figure 4 below. The audio comes through the students' computer speakers or headphones. Students can ask questions using their microphone, if they have a good quality microphone, or they can ask questions through the chat box, illustrated in figure 4.

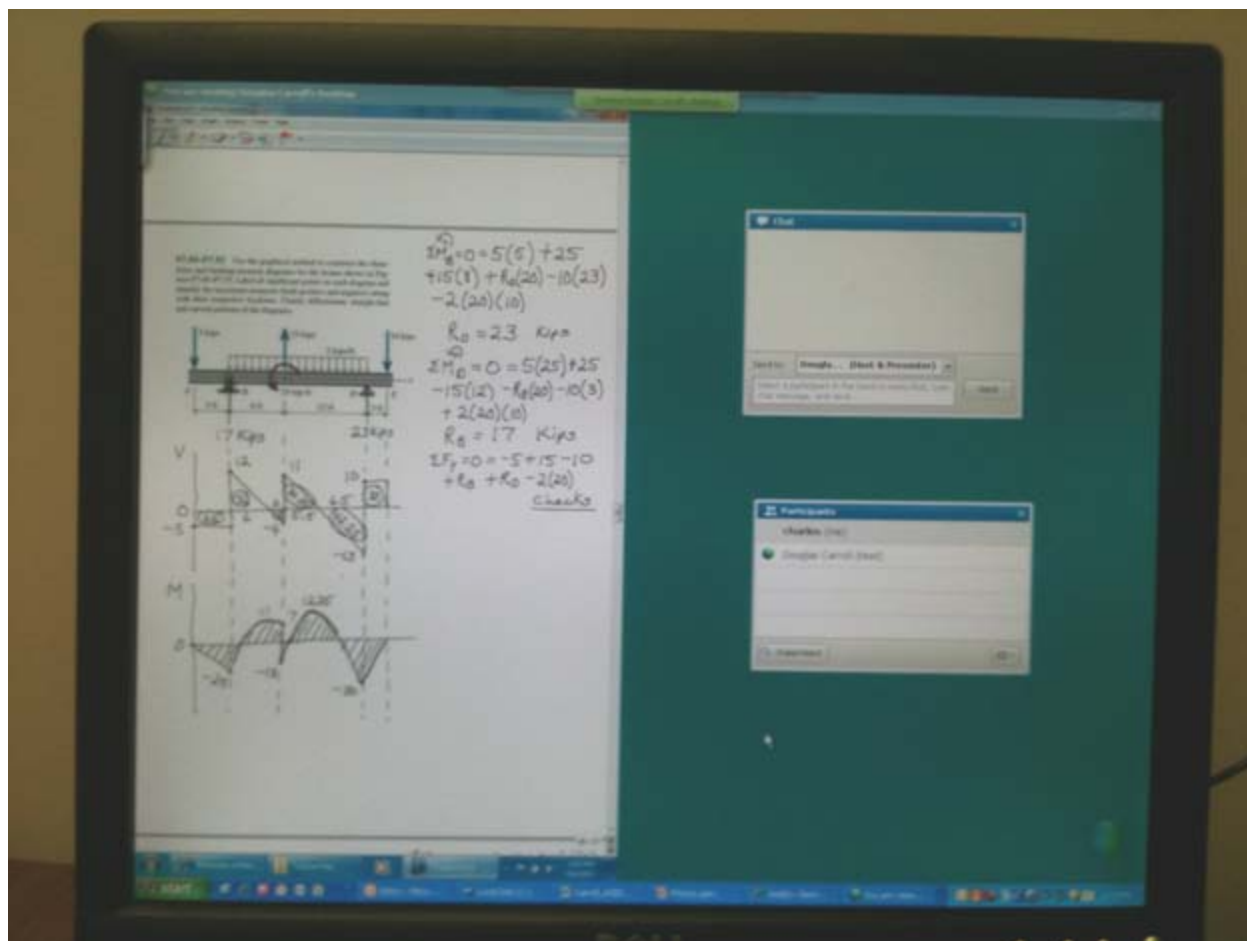


Figure 4. View of Student Screen.

Figure 3 shows the image on the tablet PC used by the faculty member. For comparison, figure 4 shows the image transmitted through Webex to the student computer screens. Students would normally open the chat box and participants box on the right side of their screen as illustrated in figure 4 so they can keep up with the chat and see who else is in the session. The chat box is open on the faculty screen in figure 3 in the lower right corner of the screen. The chat box “floats” allowing the faculty member to move it around on the screen. Notice that the “floating” chat box in figure 3 does not show up on the transmitted image in figure 4. This is important because we do not want the chat box to obstruct the student’s view of the screen.

Five years ago the microphones and VoIP were of such low quality that allowing the students to talk would create too much noise and feedback in the system. The students would use the chat box and the faculty member would use a microphone, and that system worked well. The audio has improved to the point that it is now possible to allow the students to use microphones, as long as they mute their microphones when not in use. Two or three good quality microphones can be open in Webex without creating a lot of noise and feedback. Students are asked to mute their microphone when not speaking, and to un-mute them when speaking. Many students still prefer the chat box though; it embarrasses them to address the class on the microphone.

High-Tech Distance Classrooms

The high tech distance classrooms at Missouri S&T are set up to allow faculty to teach in a traditional lecture manner. There are students in the classroom taking the class live. The lecture is transmitted live over the internet and there are students taking the class live at a remote site over the internet. The lectures are recorded so that students can view them at a later time. Many students choose to view the recorded lectures rather than attending the class live or watching it live on the internet. There is a video production specialist in a control room adjacent to the classroom who assists the faculty member with the technology, and who controls the audio and video and pulls everything together to produce the lecture.

The advantage of the high-tech distance classroom is that it is very easy for a faculty member to integrate distance education technology into the class and to offer the class for distance students. The quality of the recording produced is very good. The video communication specialist is there to assist the faculty member when he/she has trouble with the technology. The video communication specialist also takes care of all of the details of producing the lecture as a show, and posting the recordings for the students.

The disadvantage of the high-tech classrooms is that they are expensive. The equipment is expensive and providing the video communication specialist and IT support is also expensive. It is currently impractical to offer the majority of university classes through the high-tech classrooms. Teaching in the high-tech classrooms is a good way for faculty to become comfortable with distance technology, and better able to use the technology outside the high-tech classrooms.

Regular Classroom with a Digital Tablet

The first attempt at bringing distance education into a regular classroom involved modifying the classroom so that it had a high quality stationary digital tablet at the podium. Classes were taught in a traditional manner with the faculty lecturing to the students but the faculty would write on the digital tablet instead of writing on the chalkboard. The images were projected on a screen in the room and also transmitted over the internet and recorded. A high quality noise-canceling microphone was permanently mounted on the podium to pick up the audio. The sound quality was excellent when the faculty member was at the podium, but the quality decreased when the faculty member was away from the microphone. The audio was still understandable even when the faculty member was about 15 feet from the microphone.

An advantage to this method is that all of the technology is permanently mounted in the classroom. The faculty member does not need to bring anything except his/her lecture notes. The faculty member must learn to start the software and have it transmit and record the lecture. Faculty who have never used distance education equipment are able to teach in the classroom, with very little training. This is an easy system for faculty to learn to use. The digital tablet has many capabilities that are not possible with a chalkboard, and as faculty become comfortable

with the equipment these capabilities are gradually incorporated into their lectures. The only complaint from faculty is that the digital tablet does not have as much writing space as a chalkboard, so faculty must learn to deal with the equivalent of about half as much space as is available in a room with a chalkboard spanning the front of the room.

Most classrooms already have a computer, projector and screen in place. The main costs of upgrading the classroom are to replace the monitor with a high quality digital tablet, and provide a high quality noise-cancelling microphone mounted on the podium. This costs about \$2500 per room. This is a reasonable solution for bringing distance technology into the classroom.

However, if the faculty member provides office hours and review sessions outside of class time, he/she will need a tablet PC in addition to the equipment in the classroom.

Regular Classroom with Tablet PC

The second solution attempted was to have the faculty member bring the necessary equipment to a standard classroom. The faculty member brings a tablet PC to the classroom and hooks the tablet PC up to drive the projector in the room. He teaches in a traditional manner, except that he writes on the tablet PC instead of writing on the chalkboard. A Bluetooth wireless microphone like the ones used in talking on cellular phones is used to capture the audio. The lecture is transmitted on the internet and recorded.

An advantage of this approach is that it does not require that classrooms be modified. Another advantage is that the faculty member has more control over the software and files that are installed on the tablet PC. The tablet PC is available to the faculty member outside of class and the distance technology can be used for office hours and review sessions. The cost of purchasing a tablet PC and wireless microphone is about \$2500.00 for each faculty member interested in teaching using the distance technology. It is an economical solution. The main disadvantage of this solution is that the faculty members must bring equipment to the room, hook it up and get everything started before class begins. Hardware connections are required to connect the tablet PC to the internet and projector. The Bluetooth microphone must be properly linked to the tablet PC and the software must be started. This takes time and some specialized knowledge. The author has not been able to make the system work reliably and consistently. The problems have been human error. The author continues to teach his classes using this method, and is trying to find a simplified approach.

Comparisons and Conclusions

The best quality lectures and recordings are created in high-tech distance classrooms. However, the purpose of this research and testing effort has been to find a lower cost option that can provide good quality lectures and recordings. The comparisons made here are between the regular classroom with a digital tablet permanently installed and the regular classroom with a tablet PC brought in by the teaching faculty member.

For reliability and ease of use, the regular classroom with the digital tablet is the better solution. Faculty have been able to consistently start the system in a few minutes and teach the class without hardware or software problems. The system has been very reliable.

The tablet PC is very reliable, but it is a more complicated process to get the system started. The faculty member must bring the tablet PC, microphone (charged), wires to connect the tablet PC to the internet and projector, and the tablet PC battery charger. The hardware has been very reliable, but the human has been less reliable. There are many steps in getting the system ready for teaching, and it is easy to make a mistake. The most common mistake of the author has been to broadcast and record without the audio because of failing to make the Bluetooth connection, failing to select the correct microphone in the software, or failing to get the microphone set up correctly in the software. The author is working to find a better solution for the wireless microphone needed in the classroom.

The tablet PC is the only solution that the author has tried in conducting virtual office hours and review sessions. He normally uses a wireless connection, and there have been a few times over the years where the connection was lost due to a power or modem failure. However problems are rare. Overall the system has been very reliable.

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8. Courses taught in regular classrooms with a stationary digital art tablet: F2009 – statics and computer engineering, S2010 – mechanics of materials and dynamics, S2011 – mechanics of materials and dynamics.

9. Courses taught in regular classrooms with a tablet PC: Spring 2007 – biomechanics, Summer 2007 – mechanics of materials, F2010 – mechanics of materials and structure analysis, F2011 – mechanics of materials and structure analysis.

Biographical Information

DOUGLAS R. CARROLL

Dr. Carroll is a Professor of Mechanical Engineering at Missouri S&T. He is also the Director for the Cooperative Engineering Program, which is a cooperative effort between Missouri S&T and Missouri State Universities.