AC 2010-1511: IMPLEMENTING TABLET PCS IN A DISTANCE LEARNING ENVIRONMENT

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IMPLEMENTING TABLET PCS IN A DISTANCE LEARNING ENVIRONMENT

History of CGEP and need for alternate delivery methods

The Commonwealth Graduate Engineering Program (CGEP) is a collaborative distance education program developed by leading universities in the Commonwealth of Virginia. It is over 25 years old and its main goal is to deliver graduate engineering courses to qualified professionals located across the Commonwealth of Virginia. Traditionally, the courses delivered to students in this program are done through interactive video conferencing (IVC) technology and most students are required to drive to a physical location. However, an increasing number of working professionals are beginning to want more flexibility with the timing and locations of these classes. With these changes in market demand in mind, the CGEP directors are seeking new ways to deliver these courses combined with a systematic way to manage the change.

This paper will discuss the approach each CGEP university is using to move from IVC to a fully online or hybrid distance learning environment. This change provides faculty an opportunity to critically re-think how to engage students by using interactive instructional technologies. Faculty among the five CGEP institutions are experimenting with instructional technologies that take advantage of the inking feature of the Tablet PC, like Camtasia©, DyKnow©, Centra©, and Elluminate©, to deliver engineering courses.

Moving graduate engineering courses online

The Sloan Foundation 2008 Report on Online Education in the United States reports that higher education online enrollments have shown significant growth, from 1.6 million in 2002 to 3.9 million in 2007, and comparable growth in the number of institutions offering online programs [1]. Of the eight disciplines examined, business, liberal arts and sciences (general studies/humanities), health professions (and related sciences), education, computer and information sciences, social sciences and history, psychology, and engineering; engineering is the only discipline where the number of online programs lags significantly behind other disciplines. It should be noted though whereas public institutions have the highest penetration rates for most disciplines offering online programs this is not true for engineering programs at these institutions. Thus the CGEP Institutions see this as an important area of growth.

In support of this initiative, moving engineering course and degree programs online, one of the CGEP corporate advisors sponsored a one day workshop for engineering faculty across the Commonwealth of Virginia to discuss strategies for teaching online.

CGEP desktop instruction workshop: Developing engineering online courses

In June 2009 a joint workshop [2] was held to draw together engineering faculty members from the universities in the CGEP consortium for presentations and discussion surrounding online course

development and delivery. Given that engineering faculty from the CGEP universities are most familiar with traditional classroom-based instruction and learning, the workshop sought to raise faculty awareness about how equally effective pedagogy can be accomplished in an online instructional environment, using appropriate technology in teaching solutions. Particularly, the workshop sought to convey to those in attendance that effective engineering pedagogy can occur in an online instructional environment.

The day-long workshop centered around five extended presentations by engineering educators actively involved in on-line instruction efforts. Several presentations focused upon the information technology hardware and software platforms used to prepare course materials for asynchronous delivery. In one instance, the presenter described his ongoing efforts to transform a traditionally-delivered engineering statistics class to asynchronous format. In another instance, two presenters partnered to discuss their organization and update of a course first delivered on-line four to five years ago. Two other presentations focused upon "best practices" associated with live on-line instruction and interactive discussion boards. A final presentation raised faculty awareness regarding accreditation and even national security issues surrounding the delivery of courses to students in an online environment.

During the day's discussions, faculty in attendance were clearly pleased to hear how engineering colleagues were working in the online instruction environment, delivering effective learning experiences, and using the capabilities of today's on-line instructional technology to meet the needs of the type of student targeted by CGEP, i.e. working engineers who would like to have anytime, anywhere access to top quality engineering education. The faculty returned to their home institutions with more information on how to prepare and offer an online course. Each of the institutions has developed its own strategies for moving courses online. These strategies are discussed below.

George Mason University

George Mason University's Volgenau School of Information Technology and Engineering is in a somewhat different situation from the other CGEP institutions, in that it does not have a history of offering CGEP degree programs through IVC. In 2008, Mason made its existing online Master of Science program in Computer Science available through CGEP. This program has existed online for several years and did not evolve from an IVC program.

The online MS in Computer Science at Mason grew out of the research efforts of Professor of Computer Science J. Mark Pullen. Pullen and his colleagues have developed an open-source tool for synchronous online course delivery called Network EducationWare (NEW) [3]. Using NEW, faculty are able to broadcast their live face-to-face courses simultaneously online. Pullen persuaded faculty colleagues to try adding online students to their existing courses using NEW, and these efforts gradually expanded to allow students to complete an MS in Computer Science entirely online.

The open-source NEW system has similar functionality to many widely-used commercial systems for online synchronous course delivery. The primary interface is a computer-based whiteboard, which can be used to display slides, share images of running applications, write, or draw. The system includes audio, so that the instructor's voice is broadcast along with the images, and students in the distance environment who have microphone-equipped computers can participate via voice as well. A text-based chat interface is also included. NEW also has the capability of broadcasting a video image of the instructor captured with a webcam, but in practice this feature has not proven to add much instructional value and is rarely used.

Faculty who do a lot of freehand work such as annotations of slides or writing notes will generally use a Tablet PC, although a Tablet is not required to use NEW. Mason has also experimented with using Sympodium® displays, which act as the monitor for a standard PC but have Tablet-like functionality. This type of display, now known as the SMART Podium, can be installed in a classroom as part of the standard instructional technology available in the room, eliminating the need for instructors to be equipped with individual Tablet PCs for this style of online instruction.

As the Volgenau School scales up its distance learning efforts, it has purchased a license to a commercial system with similar functionality to NEW, in order to move most of the network traffic off of Mason's network, gain 24-hour technical support, add some additional software features, and encourage adoption by faculty who have concerns based on much earlier versions of NEW. Some of the school's courses are now offered online using this tool instead. Pullen and colleagues are continuing to develop NEW to add requested features and improve scalability, with the hope of ultimately eliminating the need for the commercial product.

The Volgenau School does use IVC for some contract-based courses, but demand is increasingly shifting toward online courses. The typical Mason graduate engineering student is much like the target CGEP student: a working professional engineer. These students have demanding schedules and are frequently required to travel, and IVC retains many of the challenges of campus-based courses for these students, as it is still location-bound. The one IVC-based course the school had which was available to the general student population was offered via IVC only because of its position as part of a CGEP nanotechnology initiative, a cooperative program among the five CGEP institutions and the College of William and Mary. However, because of demand for the IVC facilities at the various institutions, the nanotechnology courses were scheduled during the workday, which is a challenge for both the CGEP and native Mason student populations, and enrollments were low. Because of the scheduling challenges, this course has been moved to a simultaneous online and classroom format as well, similar to the computer science program.

Distance education is increasingly important to Mason, particularly in the Volgenau School with a graduate student population including a high percentage of working professionals. All six of the school's departments are now delivering at least some courses in an online distance format, and several additional degrees will be offered online over the next few years.

The delivery methods for these courses and programs vary depending on many factors, including the needs of the students and the faculty's comfort with instructional technologies. One Bachelor's-level program is currently developing an online degree completion program, which, when combined with an existing community college program, will allow a student to complete an entire Bachelor of Science degree online. This program, like the Master's programs, serves a large population of working professionals, and flexibility is critical for these students.

Through all of these efforts, faculty are finding similar learning outcomes regardless of delivery method. The school is working closely with Mason's Office of Institutional Assessment on the evaluation of the online versions of two large undergraduate courses, and preliminary results suggest that students achieve a similar level of success, while requiring less direct support from faculty to complete assignments because of the ability to review course materials online. Based on the success so far, Mason plans to continue expanding its distance learning offerings and exploring new technologies for online education.

Old Dominion University

Old Dominion University's Batten College of Engineering and Technology is gradually expanding its distance learning presence. The College has an active CD-ROM program for the military as well as other engineering and engineering management distance learning courses. Registration in web-based engineering courses continues to out-pace that of televised and video streaming options.

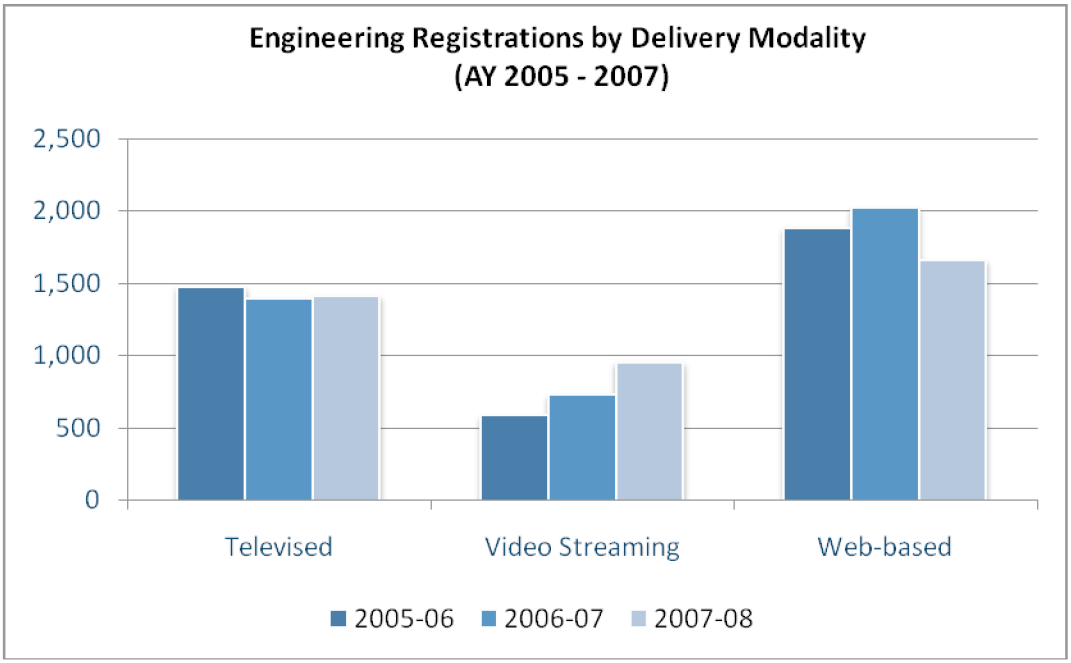


Figure 1 Old Dominion University Engineering Registrations by Delivery Modality

The College recently unveiled a new on-line master's program in Modeling and Simulation. Conversion of the curriculum from the classroom to an online platform was performed in response to the developing world-wide interest in our modeling and simulation graduate program.

Old Dominion provides excellent support for its distance learning programs through the Academic Technology Services division and the Center for Learning Technologies. The Academic Technology Services division provides production, technical and operations services for distributed education programs. The Center for Learning Technologies offers a wide variety of services such as instructional design assistance, course design, development and management, multimedia and graphics production, and various training workshops and demonstrations of new technologies.

The Center for Learning Technologies offers a wide variety of services related to faculty support including one-on-one consultation, instructional design, course design and development, individual course management, course website development, workshops, demonstration and evaluation of tools and technologies.

University of Virginia

Within the School of Engineering and Applied Science at the University of Virginia, the move to online instruction at the graduate level is motivated by a desire to support more effectively the formal and informal learning needs of students. It is also motivated by a desire to increase educational flexibility and convenience while shifting educational costs from technology to instructional design support.

In general, faculty and students feel constrained by the IVC environment used currently within CGEP. With IVC, students and faculty are able to connect in real time only during the limited, designated times when the IVC classroom has been "turned on" by the technical staff. When the signal ends, so does the interaction. However, with on-line instruction, the opportunities for formal and informal faculty-student and student-student interaction can greatly expand. Students and faculty can self-organize and connect in real-time, online, any time during the day or night for class, office hours, team meetings, or informal class discussions. Students strongly value the increased educational support afforded by this more continuous learning environment.

Additionally, the IVC environment used by CGEP today requires both faculty and students to be in specific, limited locations at specific (often undesirable) times in order to participate in classes. In reality both faculty and students would like to participate in live classes from anywhere, at times more convenient than those afforded by IVC classrooms. From an administrative perspective, the move to the more flexible, convenient environment of online instruction holds the prospect of at least modest cost reductions associated with the technology and personnel required to support IVC classrooms. Whereas IVC technology has traditionally been specialized, high cost technology requiring close oversight by technical staff, online

instruction increasingly makes use of mainstream information technology developments whose price points are driven by a larger consumer market. As the cost of distance learning technology decreases, resources can then be shifted to supporting faculty (and students) wishing to engage in robust online teaching and learning environments.

As faculty and students move into an educational environment that affords opportunities for more continuous interaction, both groups realize that they need to do more than just speak to one another in real time in order to exchange knowledge effectively. To engage in learning, they want to also share data and illustrate concepts with one another in written form. This desire to speak, share data, and sketch out ideas by hand with others at a distance has led to increased interest in information technology tools that allow for such interaction. At the University of Virginia this desire for real-time, on-line interaction has recently led the university to purchase a campus-wide license for Elluminate Live©, a package that allows for real-time audio and data exchange. The engineering school is also exploring different "electronic inking" solutions to see how each can be engaged for real-time written exchange between faculty and students. Electronic inking solutions under consideration include Tablet PCs from various vendors, Tablet monitors from Wacom©, and interactive pen technologies from LiveScribe©. Each of these technology solutions appears to have advantages in different parts of the educational arena. While Tablet PCs are wonderful for faculty who want to take their teaching platform on the road, Tablet monitors appear to be useful solutions in technology enabled classrooms. Interactive pen technologies appear to hold future promise as inexpensive accessories that students can acquire for use in individual classes, particularly in an educational environment like CGEP's where some students take individual classes for continuing education. Expecting those students to purchase a Tablet PC for a single class is cost-prohibitive. However, interactive pens may give such continuing education students the electronic inking ability desired, at an acceptable price.

Virginia Commonwealth University

Virginia Commonwealth University uses Blackboard® to provide online course content management, which uses Wimba Classroom© to set up online forums for instruction. Faculty who are teaching online courses also use podcasts, Wikis, Skype ™, blogs, etc. as means to relay course content and promote student and instructor interaction. Within the School of Engineering, the majority of faculty are using Blackboard®, but have not expanded to using other tools. In 2009 VCU requested all faculty and students respond to a survey about online education. Preliminary findings indicated substantial student interest in participating in online courses; identifying online courses as an effective means toward ensuring timely graduation. As one of the Commonwealth's largest universities and with a large working student population, course availability and course scheduling conflicts can impede a student's ability to graduate on time. Offering asynchronous online classes is one effective way to diminish the impact of scheduling conflicts on timely graduation. Of the faculty polled, about 50% have had some experience with delivering a portion or all of a class online. Most instructors are using an online course management tool, Blackboard®, and a much smaller percentage (5% of respondents) are

delivering their courses fully online. Even though this is a very small cohort, a larger group (70%) would be willing to offer a course online if provided the support and assistance needed. Some of the support and assistance needs identified by the faculty included release time to develop the course, access to the development support and appropriate hardware and software, extra compensation, and assistance with appropriate technology.

The School of Engineering is offering two degree programs through IVC, the MS in Computer Science and the MS in Mechanical and Nuclear Engineering. Both programs use synchronous instruction methods. The MS in Mechanical and Nuclear Engineering uses a hardware/software package, ECHO 360®, to capture and store lectures online. A poll of students participating in this program cited the value of having the recorded lectures available to them. Most stated that without the recorded lectures online they would not be able to participate in the program because work commitments can often impede their ability to actually attend the lectures at the prescribed class meeting time. For many of our faculty, using Blackboard® and recording live lectures is the lowest barrier of entry into online course delivery. This small step is the often first step toward online course delivery.

In order to facilitate/incentivize the move to online engineering instruction, the School of Engineering is providing a financial incentive to faculty to develop an online course and creating a faculty learning community[4]. The faculty will develop the online courses in the 2010 summer semester and use the learning community as a resource. The Center for Teaching Excellence has also developed a series on online tools that are available to faculty to assist in course development. The Online Teaching and Learning Resource Guide [5] which was developed in October 2009, provides step by step guidance for developing an online course. The School of Engineering will offer its first online course in the fall 2010 semester.

Virginia Tech University

Virginia Tech's College of Engineering is targeting a few key departments to transition its distance learning delivery method from IVC to totally online. While each CGEP university has different constraints for implementing online courses and degree programs, the benefits of using distance learning is consistent among all of the institutions. Probably the single most significant and obvious benefit of participating in a distance learning initiative is the opportunity to take courses without having to physically travel to the instructor's location. Additionally participants located in major cities, such as Washington DC or Northern Virginia are finding it difficult to travel from their workplace to an offsite location given the traffic congestion.

The Aerospace & Ocean Engineering (AOE) department has been one of the forerunners in creating and offering online graduate courses and continues to offer courses online, with 11 courses offered in the Spring 2009 semester [6]. The faculty and instructors are motivated to explore the various possibilities of teaching using mixed delivery formats like asynchronous

teaching and live interaction through Centra© [7]. Faculties are experimenting with podcasting as well as electronic grading using the Tablet PCs.

New assistant professors are finding creative ways to utilize instructional technologies in appropriate and effective ways. For example, Dr. Leigh S. McCue-Weil, an assistant professor in the Aerospace and Ocean Engineering (AOE) department, teaches graduate distance learning courses in ship dynamics and a new undergraduate, senior level technical elective distance learning course in dynamics of high-speed marine craft, which began in Spring 2009. These courses have enriched and expanded her classroom experience.

In leading both traditional in-class instruction and distance learning courses during her four years at Virginia Tech, Dr. McCue-Weil believes various instructional technologies allow her to reach beyond the classrooms on the Blacksburg campus. She manages these instructional opportunities by incorporating twenty-first century technology like Centra©, an online learning environment and DyKnow©, a software tool that enables digital inking for incorporating interactive presenting and note taking into her teaching. Additionally, she uses Centra© to teach synchronous online courses. This software also allows Dr. McCue-Weil to record each class and archive the file for working professionals to access at their convenience.

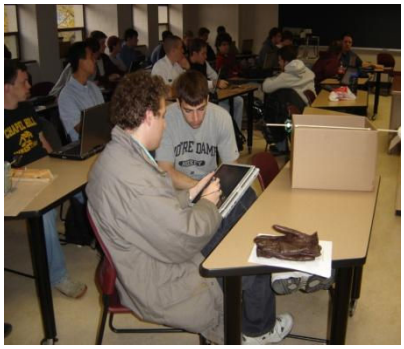
The AOE department is currently experimenting with various distance learning course delivery methods. Camtasia© is another tool currently used by the department to allow professors to record and archive both the audio and Tablet inking created during class.

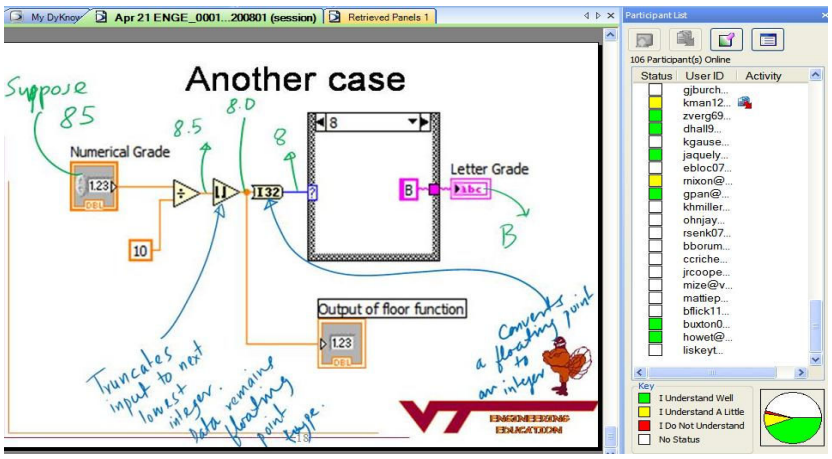
In 2006, the college became the first and largest public college of engineering to require all of its 1,400 incoming freshmen to purchase Tablet PCs. The features of the Tablet PCs have helped the engineering faculty introduce students to the countless diagrams, drawings, and equations that are integral to the discipline's study. Students are using the Tablet PCs for collaboration purposes, working on group sketches and sharing diagrams and notes with individual markups.

Faculty and students have access to a Tablet PC during the learning experience. Having the infrastructure: hardware, software and connectivity in place enables faculty to try new techniques.

It is important to note that Instructional technology, when utilized effectively, can play a role in creating educational environments that facilitate student learning. Learners in collaborative educational settings receive feedback and comments from peers and from the instructor during the various stages of knowledge acquisition rather than only receiving feedback from the teacher on their performance [8]. Increased opportunities for feedback and discussion can result in greater opportunities for knowledge transfer and performance of higher level cognitive functions [9,10].

Two innovative Engineering Education professors encourage students to collaborate by incorporating creative instructional design strategies that take advantage of the unique Tablet features such as using the digital ink for sketching diagrams and solving engineering problems. Given that the solutions are submitted electronically they are now in a format for the teaching assistant to grade the homework electronically. While the use of the Table PC is primarily with students sitting next to one another, the activities can easily accommodate students not co-located with the class.





Example – Instant Feedback from Students LabVIEW Programming Class- Spring 2008

According to the Dean of Engineering at Virginia Tech, it is technology like this, placed in the hands of skilled teachers like Scott Hendricks, which allows a large lecture class such as ESM 2104 to learn fundamental concepts in an active-learning environment. Prof. Hendricks who is the current holder of the Pete White Chair, illustrates the benefits of the Tablet-PC initiative from an instructor's viewpoint:

"For me the Tablet PC with DyKnow software is a wonderfully enhanced blackboard. Using a Tablet PC and DyKnow has transformed the way that I teach. I come to class with professional drawings of all of the structures/bodies that we will analyze during the lecture that day. This saves a great deal of time, allows the students to understand the structure better, and allows me to cover more problems. From that point I teach as if I were at the blackboard (except that I can draw perfect circles, rectangles, arrows etc., highlight in various colors and point precisely to draw attention to key points). I can work one problem several different ways and copy and paste various parts from one slide into the next. Students can ask about any problem in the book and within seconds I can pull up the professional illustration from the book. Each student can follow the lecture on the big screen or on their own Tablet PC. *Even in large classes there isn't* a bad seat in the room. At the end of the lecture, each student leaves with a complete set of notes that he/she has individually tweaked and annotated. The students are very positive on the whole *process."*

Strategy for managing change

Each CGEP university has a different approach toward delivering online engineering programs, one goal for the consortium is to develop a strategy based on Rogers' [11] Diffusion of Innovations theory suggests that several factors may increase the success of faculty adopting new pedagogical practices in support of online teaching regardless of his or her home institution.

The five attributes that define the characteristic of an innovation include:

1. Relative advantage: The degree to which an innovation is perceived as better than the old or traditional way.

2. Compatibility: the degree to which an innovation is perceived as being consistent with past experiences and the needs of potential adopters.

3. Complexity: The degree to which the innovation is perceived as difficult to use.

4. Trialability: The degree to which an innovation may be experimented with on a limited basis.

5. Observability: The degree to which the results of an innovation are visible to others.

According to Rogers, adoption of technology will be more likely if the complexity of the technology is reduced but relative advantage, compatibility, trialability, and observability are maximized.

Given that each CGEP university's approach toward online learning is extremely different, the CGEP directors agreed to focus on the observability attribute of an innovation first. Based on Roger's [11] theory, the directors hypothesize that if faculty members can see tangible evidence of the effectiveness of new pedagogical practices they are more likely to adopt such strategies. To promote this aspect of moving online learning forward in engineering the CGEP directors sponsored the first workshop on online learning for engineering. Faculty members involved in CGEP courses were encouraged to attend by invitation through email and other promotional materials. Additionally each university has a lead faculty adopter who is promoting online learning at each CGEP university. The lead faculty member serves as an example for innovative ways that courses can be delivered. They are encouraged to share pedagogical practices that they employ within their classes.

Following this semester, the degree to which new pedagogical practices have been adopted will be assessed by a survey administered to faculty. The survey will solicit information about the degree to which they were aware of the initiatives outlined above and their participation in them. The survey will also solicit data related to the degree to which faculty have adopted new pedagogical practices. These two measurements will allow program directors to assess the success of the new initiative.

Summary

The CGEP directors are working together to share institutional strategies for moving engineering courses and degree programs online. While the approach may be different at each institution the directors are investigating how to apply Rogers Theory of Diffusion as a framework to increase faculty interest and movement toward placing courses and degree programs online. The first step in the development of this process occurred in June 2009 with a workshop designed to promote the best practices for developing and delivering online engineering programs. Additionally a follow-up assessment is planned to help determine additional best practices.

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