2006-789: A DISTRIBUTED LEARNING NETWORK UNITES THE MID-SOUTH

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A Distributed Learning Network Unites the Mid-south

I. Introduction

In the spring of 2005, the Engineering Technologies Department (ENTC) of Southwest Tennessee Community College (Southwest) made its first attempt at distance learning. A computer-aided drawing course, part of the Manufacturing and Mechanical Engineering Technology programs, was taught at two locations at the same time. This grant-funded experiment was a success—in fact, so successful that ENTC gained three more grants to continue its distance learning development. The trial run validated many of the concerns faculty had about adapting technical curriculum to this medium but it also brought about solutions. Not everything went as planned and one unexpected problem in particular caused the department to rethink its strategy. This paper will examine the ENTC distance learning model and how it attempts to meet the needs of a two-year engineering technology program and the community it serves. The paper will discuss strengths and limitations of the equipment and software and will provide critical comment on the course management strategy used. Finally, the paper will discuss how the model was redesigned into what is now a "distributed learning network" along with plans for the future.

II. History and Distance Learning Model Development

The Southwest ENTC department promotes a positive learning environment through the use of hands-on laboratory experience. Large investments in training equipment combined with college level theory helped set Southwest apart from other Mid-south schools. Feed back from the 2002 ABET accreditation review included praise for the laboratories and hands-on curriculum. Feed back from employer surveys indicated a high degree of satisfaction with the technical proficiency of Southwest graduates. Finally, feed back from student surveys indicated satisfaction with the hands-on approach. Over 30 years of positive feed back made the faculty uneasy about changing the formula and uncertain how to maintain the quality of the curriculum if taught over a distance learning connection. This reluctance is understandable according to educational studies that link the method and effectiveness of distance learning to the technology being used[1]. It would not be possible to teach the same material the same way.

Early Internet-based distance learning programs were lecture-only in content with limited interaction between student and teacher, factors that made it easy to dismiss distance learning as a nice idea but one not suited for the two-year technical program. As distance learning went legitimate with big name universities offering courses and entire programs over the wire, it became obvious Internet-based distance learning was here to stay. However, the majority of courses offered remained non-technical and lecture only. Southwest invested heavily in distance learning technology and began promoting the idea of extending accessibility of degree programs throughout the college. Predictably, business and other lecture-oriented programs were the first to utilize the distance learning equipment. The Southwest college administration began putting pressure on its ENTC department to develop courses for distance learning. The ENTC department was unmoved and would remain so as long as questions of how to maintain the

hands-on formula and curriculum quality remained unanswered. Meanwhile technology continued to evolve.

The department spent these years developing certificate programs and streamlining the program curriculum. Downward trends in enrollment, shifts in market demographics, and changes in the local industry indicated that the traditional two-year program was no longer meeting the community's needs as well as it had at one time. Enrollment had dropped significantly in the late 1990's to early 2000's which was due partially to a merger and name change undergone by the college during that time. The college, once named State Technical Institute, became Southwest Tennessee Community College and overnight ENTC lost a decades-long reputation for technical education. The name change is considered by some to be a major factor in the decline of non-traditional enrollment. Employers and people in industry seeking technical education could no longer find State Tech and thought the college had been closed. This was not the only factor, however—the market was changing. Traditional student enrollment was also in a decline in the Mid-south. An estimated 80-90% of area high school graduates would not enter college immediately after high school graduation and less than half the population of 18-24 year olds would enroll in college at all[2]. Misplaced efforts on the part of high school teachers and staff to push students into the four-year university track prevented many potential college students from considering the two-year option. This represented a huge potential market for Southwest and many efforts to tap that market were begun including the basic Tech-Prep grant that enabled the ENTC department to offer its first distance learning course. Many ENTC students are married and can not afford the higher tuition cost of the university yet earn too much for federal assistance. Also, the pressure of school on the family dynamic discourage men and women from spending four to six years pursuing a two-year degree part-time. Finally, the Mid-south industrial community began to change at a very fast pace. Primarily biomedical, the Mid-south industrial community needed technically skilled workers for entry level employment. The companies were able to recruit degreed and experienced people for higher level positions but had—and still have—trouble recruiting the working staff needed for production and quality functions. These employers need employees to start off with a select technical background. Advancement within the company then depends on subsequent education and certification. In response to this the ENTC department developed six technical certificates that streamlined the technical education process and enabled a student to enter the job market in as little as two semesters. Two of these programs, the Manufacturing Fundamentals and the Quality Assurance Technical Certificates, were accepted by Smith & Nephew for placement in machinist and inspection positions.

The certificate programs were developed to bring together a technical workforce with high-tech employers. The concept worked equally well for both non-traditional and traditional students, the appeal of fast employability being universal. The ENTC department saw another use for the certificate programs, a means to tap into the high school market. Through the use of dual enrollment programs (now called joint enrollment), a high school junior completes the Manufacturing Fundamentals Technical Certificate at the same time as completing high school. The program enabled high school students to gain entry level technical skills before entering the job market. This also served to hook the student into an education-oriented lifestyle. Since its inception in the late 1990's, all of the students who participated continued their college education and are in industry working in their career of choice. The only obstacle encountered was the cost of tuition. That extra burden was often the limiting factor in student participation. The original

high school certificate classes were taught at the high school when ever possible as long as sufficient numbers enrolled to make the class. Eventually it became impossible to make classes and the few students who could afford tuition were forced to attend regular college sections at night and on weekends.

In the summer of 2004 technology advancements, the ENTC certificate programs, Southwest's distance learning department, and State of Tennessee Tech-Prep funding all converged and the time seemed right for the department to develop a distance learning course. Southwest had formed a department dedicated to distance learning. The staff of this new department tested numerous technologies before selecting the Tandberg 880 as the base standard for IP video conferencing connections. At this point the distance learning connection was limited to video and a secondary media stream for DVD, scanners, or other digital media. By the summer of 2004 they had purchased a trial copy of a conferencing program, NetOp School, which promised interactivity between locations. That was the same time that ENTC was looking for a new way to reach the high schools with the certificate program. The distance learning department was aggressively seeking expansion opportunities and wanted to partner with ENTC. The Tech-Prep program of the Tennessee Board of Regents (TBR) was aggressively seeking expansion into high schools with grant funding. The resulting grant proposal issued by the ENTC department promised to evaluate the interactive capabilities of the Tandberg and NetOp technologies while expanding the Manufacturing Fundamentals Technical Certificate to a local high school. The grant was approved just prior to fall 2004. With the support of the distance learning department and Fayette-Ware high school, the proposed CAD Design I class was offered. At the center of the proposal was the single critical idea that area high schools were unable to produce sufficient numbers of students to make special sections and the same economic constraints prevented many students from traveling to the college for evening class. The ENTC department proposed a way to unite a small group of high school students at a remote site with a regular section on the main campus, thus combining numbers and providing increased accessibility to the college within the Mid-south community.

III. From Concept to Reality

The original TBR Tech-Prep grant was awarded in varying amounts throughout the state of Tennessee to colleges attempting to enroll existing high school students in the expectation that their investment in postsecondary education at an earlier age would "hook" them into continuing college. The state was attempting to tap into the 80-90% market. The Manufacturing Fundamentals Technical Certificate was a proven success as a means of accomplishing the TBR's goal, and on the strength of that the ENTC department was awarded $21,000 to further develop the idea. The problem was accessibility to the program by interested students. Distance learning technology promised a means to accomplish this if the state of the technology permitted interactivity between the teacher and individual students at the remote location. Southwest was already committed to Tandberg 880 video conferencing equipment and was actively developing the communication infrastructure to key remote sites with the installation of T1 services. The newest T1 installation was at the Fayette-Ware high school 35 miles away near the Eastern edge of Southwest's service area. It was a logical location for distribution in a rural area that lacked alternative educational resources. With only three months available to design a customized Tandberg 880, evaluate the new NetOp School software and devise a teaching strategy—an

uncomfortably short amount of time—the ENTC faculty in charge of the project faced a considerable challenge.

Since the ENTC department had not as yet attempted a distance learning course, no equipment was available. The distance learning department stepped in and loaned ENTC a new Tandberg 880. A similar system was already installed at the high school. The distance learning staff also supplied technical assistance and support throughout the trial and the success of the project was due in no small part to their efforts. Once the video conferencing link was established the NetOp software had to be installed. At this time no one knew if it would handle sharing the network with a Tandberg system. A lot of data had to flow through a 100 bit Ethernet LAN and the Internet.

NetOp School was made up of two parts, a client called NetOp Student and an administrative workstation called NetOp Teacher[3]. Within each remote classroom was one designated server. The student workstations received their connection to the administrative workstation by way of the local server which handled all classroom traffic. The administrative workstation had various tools to allow differing levels of interactivity. The teacher could monitor the computer screens of the entire class at one time. This function was severely limited by bandwidth and was managed by taking screen shots captured every 3-10 seconds instead of a continuous stream. The teacher could monitor an individual workstation which provided a reasonably smooth display. When necessary, the teacher could take direct control of any individual workstation. Also, any workstation display could be relayed to the screens of the other students. Additional controls allowed for locking student workstations from use, rebooting, chatting, and file transfer. Documentation for NetOp was limited and installation was delayed nearly a week while the IT staff attempted to piece together the procedure. Eventually the network was setup and the software configured to run as designed. At this point it was up to the course instructor to make it all work together.

The combination of an unstable network connection with unproven communication software to teach a demanding technical CAD course to high school students quickly made clear the need to provide full-time technical support at the remote site. Staffing the site with another instructor defeated the purpose of the project so a lab technician with suitable CAD background was assigned to the remote location during the designated class time. Because this was a trial run with so many variables, the remote support needed to be as strong as possible in networking, computers, and AutoCAD and be prepared to take control of the class should communication fail. The goal of the department was to eventually polish the system to a point in which staffing of the remote site could be accomplished with part time local personnel or with scholarship students. The remote staff served as a facilitator, relaying special materials and student course work between locations. Also, as a facilitator the technician kept the students on task and improved the response time when teacher assistance was needed. General lectures and demonstrations were planned for delivery to all students at the beginning of each class followed by supervised lab time. The remote facilitator was able to assist students at his site with smaller issues but more involved problems were directed to the instructor. At the same time, the instructor provided assistance for the local students.

The original TBR Tech-Prep proposal specified four students for the trial group. Coordination with the high school principal and the graphics teacher were necessary to locate interested and qualified students. This, in itself, presented considerable challenge. The high school personnel were eager to host this partnership and to help recruit students. However, willingness to do something is not the same as following through on something. The high school staff was so busy with their own concerns that it was difficult and slow to make progress recruiting. Regular visits were needed to keep the project on track. It became necessary to enlist the help of the Director of Fayette County services for the college. Her office in a nearby town was close enough to the high school to permit regular visits as registration approached. Her efforts to recruit and register the trial group saved the program from failure before it began. The initial student body survey contained over 250 names of interested students. Subsequent selection by the high school staff produced 12 students. By the last day of spring registration only one of these students was able to afford the cost of tuition. In a last-ditch-effort, the director contacted the Vice Provost's office and discretionary scholarships were found for five students. The day before class was due to begin the five Fayette-Ware students were brought to the Southwest campus to tour the facility and receive an orientation to the video conferencing system they were to use. As a finishing touch, the Southwest Tech-Prep office donated textbooks for the students.

The remote site technician was instructed to open the classroom 30 minutes early on the two nights per week the class met. The Tandberg video conferencing system and NetOp software were brought online 15 minutes before each class and the remote students were given that extra time to ask questions. Class began as scheduled and generally ran as planned with lectures at the beginning of each session. Occasionally someone from the remote site would ask a question or request a clarification during the lecture but more often watched the presentation in the same manner as the local group. A dual monitor was installed at the instructor's workstation to reduce the amount of window manipulation necessary to monitor and demonstrate simultaneously. Only one monitor was able to be projected by the LCD projector. The other monitor was invisible to both the local and remote groups. This monitor permanently displayed the NetOp control screen and was usually set to scan the remote computers. At one glance it was possible to determine who was caught up and who was lost. In this manner the course went through the normal 14-week schedule with all students from both the local and remote sites completing the required course work and passing the final exam.

IV. Project Analysis

The distance learning project, under analysis, brought to light problems, obstacles, and successes. The more predictable issues were the technical problems that occurred occasionally throughout the semester. Technicians from the distance learning department and from the Information Services department were always quick to respond and made repairs and improvements as quickly as possible. Going into the project the question of bandwidth and communication were of primary concern but ultimately neither the hardware/software technical support nor the Southwest technical staff could predict system performance. Those problems that manifested were overcome as they were encountered, see list below.

The following technical problems were encountered:

1) T1 connecting hardware was lost from a power surge (1 time);

2) Video control on the remote end of the video conference system malfunctioned preventing view of the remote audience (2 consecutive class sessions);
3) Audio transmission could not be established (2 times);
4) Video stream became choppy due to sudden, unpredictable decreases in the data rate (more than 10 occurrences at different times and of variable duration);
5) Conference connection suddenly dropped (2 times); and
6) Student PC had to be rebooted to reestablish interactive connection (4 times).

Item 1 occurred the first week of class and may have come from a faulty installation by the phone company. It took several days to get the phone crew on site to make the repair. Item 2 was a malfunction of the motor control in the video camera housing that prevented panning from left to right. The faulty unit was replaced. Item 3 remains in the mysterious fault category as no direct cause was ever found. Loose or corroded connections were thought a likely source. Both times the audio came up the next day when the technicians examined the system. To date the problems have not returned. Item 4 was expected to happen at some point. The surprise was how infrequent the occurrence was. Both of the school's LANs and the Internet connection between them managed the traffic with satisfactory performance most of the time. It was suggested that slow downs may have been due to peak evening usage at the college. The network manager studied the usage patterns and found nothing out of the ordinary at the times the system slowed down. Another possible cause was of poor performance from the way the Tandberg negotiates data rates. Normally the Tandberg senses traffic and decreases data rate as needed. The automatic function is known to be unreliable so instead of decreasing the rate at high traffic times, the Tandberg maintains its initial high quality data rate. Some improvement in system performance was made by forcing the system to reduce the data rate. It is inconclusive at this time if this was the sole factor behind the problem. Items 5 and 6 appear to be software problems with both the Tandberg and the NetOp products with no obvious pattern associated with their occurrence.

The Tech-Prep grant project was considered a success by the ENTC department, the high school, the college and by the TBR. The main successes gained from the project are listed below.

The following successes were gained:
1) The remote students mastered the same material with comparable grades as the local students and as compared to previous classes;
2) Each senior of the remote student group went on to enroll in college after graduation; and,
3) Remote classroom software interaction proven to work in the engineering technology program opening the door for further distance learning developments.

Item 1, the best measure of success, is a comparison of performance between the high school students and their college counterparts. All topics and techniques normally taught in the CAD Design I course were covered in the trial distance learning course. The student workbooks collected at the end of the semester were comparable in content and quality to the local student group as was performance on the final exam. Comparison of the remote student work to previously taught CAD Design I courses were equally favorable. There was no discernable difference between the trial group performance and the normal class performance. Item 2 relates

to student retention in college after high school graduation. The trial student group included three seniors who graduated from Fayette-Ware immediately following the spring 2005 semester. One went on to the University of Memphis and two enrolled at Southwest. Of the two attending Southwest, one went into nursing and the other is majoring in the manufacturing certificates and the Mechanical Engineering Technology A.A.S. degree. Item 3 represents a significant step for the ENTC department by proving that technology has made interactive distance learning possible. This project became the springboard for a continuing development effort that will eventually build a list of distance learning courses leading to any of the ENTC technical certificates.

Teaching over a distance learning connection is radically different from teaching in direct contact with the student. The nuances of body language, eye contact, and sound are profoundly lacking in a video conference connection. Communication channels we take for granted in daily life become nearly as important as verbal communication when they are no longer available. It is not always what the students say as what they don't say, or how they try to say it that indicates what the instructor must do to help[4]. Students at a high school or first year undergraduate level often lack the technical vocabulary to articulate their thoughts. Distance learning is an artificial environment that relies on verbal communication skills to work. The two factors that compensated for this problem included the NetOp software and the skilled technician at the remote site. The software enabled the instructor to see a problem rather than rely on a student's question and then show the student how to correct the problem. The software reduced reliance on verbal communication, almost completely eliminating it in most cases, for both the student and the instructor. Transforming the communication process to a more visual exchange is not without a price. The price came in the form of time. It took longer to deal with student problems on a case by case basis using this technique. The skilled technician at the remote site prevented long delays and wasted time for the class by performing a triage operation as problems arose. He took the easier or repetitious problems and deferred the harder problems to the instructor. Expediting student questions reduced wait time and prevented frustration not only at the remote site but at the local site as well. Recall that the instructor was likewise working with a class of students—in this case an additional twelve students. Despite the software and team teaching approach, some obstacles were encountered that had to be recognized and dealt with by the instructor, see the list below.

The following teaching obstacles were encountered:

1) Instructor—confusion between teacher's screen and a remote student's screen;
2) Instructor—biasing lecture more toward either the local or the remote group;
3) Instructor—responding faster to the local group in an unfair distribution of attention;
4) Students—feeling of isolation from the local class causing students to withdraw their attention;
5) Students—reluctance for the remote group to ask questions or offer comment to the entire group;
6) Students—the remote students had unrealistic expectations regarding class structure due to inexperience with the college learning environment;
7) Institution—differences between college and high school calendars caused scheduling conflicts for the remote students; and,

8) Community—regardless of interest, career opportunity potential, or convenience the majority of high school student's families in the Mid-south are unable to afford college tuition.

Most of the teaching obstacles were addressed procedurally or through additional practice in the distance learning environment. Item 1 was quickly eliminated by adding a second monitor to the instructor's workstation dedicated to displaying the NetOp software interface and by assigning alternate Windows screen colors to the teacher's workstation. Items 2 and 3 proved an insidious obstacle for the instructor. Hard to recognize, the way instructor attention is distributed can have a negative impact on both the local and remote groups. The question arises, who do you look at as you lecture? How much time is too much when speaking to one side or the other? Looking directly at the video camera as if it were one individual seemed to help the lecture problem some but there remained a sense of isolation as mentioned in Item 4. The instructor had to constantly monitor and control how his attention was focused and discovered a subconscious affinity for the local group. The instructor later made the observation that it might be easier if all the students were equally removed from the instructor. In that way the instructor's full attention would remain at the video link and NetOp controls. Lecturing with a bias toward one group or the other, for the most part, is over come with awareness and practice. Response time leading to unfair distribution of attention is unavoidable. A heightened sense of urgency associated with the local group made it far too easy to avoid contact with the remote group. This effect was buffered considerably by utilizing the technical skills of the remote technician. Items 4 and 5 appear to be unavoidable in the sense that interacting with a television monitor is artificial. Assuming the instructor pays sufficient attention to the remote group, the students will still tend to tune out the video feed. The instructor found it useful to modify lectures to include more question and answer "games" throughout the lecture, a simple technique that greatly improved the remote group's participation. Item 6 may appear predictable in hind sight but with little experience at the secondary education level, it is hard for college faculty to appreciate the differences in teaching methods. Current distance learning theory stresses that "successful distance education systems involve interactivity[5]…" Even high school students who represent the highest percentile of their class are conditioned to an environment where responsibility for learning appears to belong primarily to the teacher and minimally to the student. The cultural differences were quickly noted and the instructor and remote technician increased efforts to orient the class to their new environment. The instructor should take time on the front end to define the college policies and redefine student expectations. Item 7 was an unavoidable result of coordinating two very different institutions. College and high school calendars do vary and the occasional extracurricular high school event will pop up from time to time. In the case of Spring break the instructor observed the college schedule and not the high school schedule. Despite a few complaints, everyone attended class as requested throughout the scheduled high school break. In return, the instructor allowed student attendance to a later high school social function as long as each student's work was up-to-date. The lesson learned in this case was not to expect high school students to conform perfectly to college norms but at the same time, demand more than they are used to and they will respond favorably.

Item 8 is an obstacle worthy of individual attention since it is possible to overcome only with the coordinated efforts of the entire community. The state and Southwest have launched serious efforts to enable worthy high school students to enroll in college courses. The state's Hope

Scholarship has been expanded to fund joint enrollment students. Special funding for joint enrollment is designated for targeted area high schools such as the Middle-College. Smith & Nephew, a biomedical company, is funding two high school students to attend the Manufacturing Fundamentals program. A grant proposal written by the Office of Grants and Contracts was approved by the Tennessee Valley Authority (TVA) for $5000 in student scholarships for the ENTC certificate programs. All these funds seem a lot but they barely scratch the surface. As previously discussed, the project nearly failed because of this problem. Since the trial course ENTC faculty have joined in the search for suitable high schools and funding opportunities for students in the Mid-south area and with time more businesses will come on board to help sponsor students.

The department is moving to the next phase by adapting another certificate class to the distance learning environment. This phase is currently underway with courses offered fall 2005 and spring 2006. The course selected for this phase is an introduction to engineering technology and is not as software intensive as the original course. The advantage of the second phase course is that it feeds additional technical certificates beyond the manufacturing certificates. It was felt this course would help feed the entire department. The third phase will come later in 2006 or early 2007 when consideration is made for adapting a more intensive hands-on course to the distance learning environment. Computer simulation will take a stronger role in future courses as well as utilization of mobile equipment and separately scheduled lab sessions. The department does not feel that a hands-on course such as Engineering Materials can be adequately taught at a two-year technical college level as a remote course. The current plan is to condense laboratory projects to a few weekend open lab sessions that minimize travel as much as possible. These labs will be supported with extensive video collections that explore key lab projects in detail.

The successful completion of the original Tech-Prep proposal opened the door for additional funding. In 2005 a proposal was approved by the Hewlett Packard Corporation to introduce wireless tablet PC technology to the existing distance learning model begun by the Tech-Prep project. The grant included 20 tablet PCs and the wireless network equipment to support a wireless classroom. As a result of the original Tech-Prep project TVA approved two grant proposals. The first was for a site license of NetOp School software and the second was $5000 for scholarships. Finally, the TBR is considering funding for continuation of the Tech-Prep project. Future advancements proposed to the TBR include digital archiving of lectures and increased marketing funds.

The original concept of joining a small remote group of high school students with a group on the main campus is workable. The original concept, however, was limited in scope concentrating on one high school site at a time. The limitations imposed by tuition funding inspired the department to rethink this concept. The Mid-south area can be linked in this manner with multiple sites running concurrently. Key locations such as Fayette-Ware High School, Middle-College High School, and Kingsbury High School have already been added to the list of sites. The goal is to add as many sites as possible to the list and thus distribute program classes throughout the area. Sites need not be limited to high schools either. Businesses or community centers are all potential network sites if they meet the communication requirements. Smaller groups spread over a large geographical area are brought together into one classroom. The idea of a “Distributed Learning Network” was born. These smaller groups will be easier to fund or be

self funded when possible and share the power of their numbers to assure classes make. The department foresees these distribution sites becoming more popular with students of all ages for the main reason it eliminates travel. The commute through the Mid-south area, especially around evening time, is becoming dangerous and slow with traffic congestion. By fall 2006 the ENTC department plans to link multiple sites to the same course.

V. Summary

To make this pilot distance learning class work took the cooperation, help, and hard work of the Distance Learning & Instructional Technology Department, Workforce Development Division, Grants Office, Office of the Vice Provost, Tennessee Board of Regents, Southwest Information Services Department, and the Fayette-Ware High School as well as the dedication of the Engineering Technologies Department. Everyone involved in this high profile project was aware that more was at stake than a normal class of CAD students. The delivery of the distance learning course had to measure up in all ways with a normal ENTC CAD course with no loss of content or quality. The project pushed communication software and video conferencing hardware to their limits but proved to the faculty's satisfaction that it is possible to adapt ENTC courses to distance learning. Moreover, the project launched the faculty into a flurry of development, proposal writing, and marketing. By waiting until the right time, the Engineering Technologies Department was able to enter the distance learning world in a way that has improved program quality and made the department a leader at Southwest.

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