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ABSTRACT

This qualitative case study assessed web-based instruction in a computer-aided design/computer-assisted manufacturing (CAD/CAM) course designed for workforce development. The study examined students' and instructors' experience in a CAD/CAM course delivered exclusively on the Internet, evaluating course content and delivery, clarity of presentation of complex technical concepts, and student receptivity to the Internet delivery mode. Components of student experience examined were motivation, nature of interactions, advantages and disadvantages, issues associated with Internet delivery, and student outcomes. Narrative data from telephone interviews (n=20) with students in the United States and Canada was the principal source of data. The course packet, provided electronically, included a syllabus, faculty, calendar, assignments, notes, e-mail link and index, as well as links to industrial and educational sites and the university home page. Findings indicated that the Internet delivery met the expectations of the students by offering a course not available through traditional delivery; participants were satisfied with all components of the course except for selected technical problems and they felt that this distance learning course was as effective as a traditional course. (Contains 40 references.) (CH)

**CAD/CAM at a Distance:
Assessing the Effectiveness of
Web-Based Instruction to Meet Workforce Development Needs**

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**CAD/CAM at a Distance:
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Distance education has existed for many years through delivery methods like correspondence courses (Watkins and Wright, 1991). However, the last decade has brought about changes in distance learning due to the technological revolution (Olcott, 1997), resulting in the need for assessment of the effectiveness of delivery methods such as interactive television, the Internet, and other new technologies (The Institute for Higher Education Policy, 1999). This qualitative study assessed web-based instruction in a Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) course designed for workforce development, utilizing the case study method. The central question was: What did the students and instructor experience in a CAD/CAM course delivered exclusively on the Internet? The findings confirmed an overall positive evaluation for the course. Students recognized the advantages and potential of this delivery mode, but also identified problems associated with it. Results indicated that the course was as effective as a traditional class.

**CAD/CAM at a Distance:
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Introduction

Distance education has existed for many years through delivery methods like correspondence courses (Watkins and Wright, 1991). However, the last decade has brought about significant changes in distance education due to the use of technologies such as interactive television, the Internet, and other new technologies (Olcott, 1997). As a result of these technological advances, many higher education institutions are utilizing various new distance learning delivery methods to provide instruction. Thus, further assessment of the effectiveness of these delivery modes is needed (The Institute for Higher Education Policy, 1999).

This paper will provide an overview of the qualitative investigation of a university/corporate partnership that utilized web-based instruction in a highly technical and graphics intensive Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) course designed to meet specific workforce development needs. The central question of the study was: What did the students and instructor experience in a CAD/CAM course delivered exclusively on the Internet? Major themes included the strengths and weaknesses of the delivery mode and the implications of the new teaching approach for this highly technical and graphic intensive course. The findings confirmed an overall positive evaluation for the Internet course. Students recognized the advantages and potential of this delivery mode, but also identified problems associated with it.

Purpose

The purpose of this study was to provide an in-depth assessment of a CAD/CAM course which was delivered on the Internet for the first time in the United States and Canada. Since the course was developed to meet specific training needs in the fundamentals of Computer Aided Design/Computer Aided Machining, a thorough assessment of the course and the delivery method was critical to both the University and the corporate partner. The study included evaluation of the course content and delivery, the clarity of presentation of complex technical concepts, student receptivity to the Internet delivery mode,

and student assessment results. Components of the students' experience that were studied included motivation, nature of interactions, advantages and disadvantages, issues associated with Internet delivery, and student outcomes.

Significance of the Study

No research to this point has been reported on conducting a CAD/CAM course entirely on the Internet. Although other courses in a variety of subjects are available on the Internet, a complete CAD/CAM course with corequisite subject matter was not. Thus the findings of this inquiry may be of interest to business, industry, and educational leaders, as well as potential distance learning students. This study also contributed to the existing body of literature on distance education by analyzing both technological and pedagogical issues related to distance learning.

Research Questions

The central question for this case study was: What did the students and instructor experience in a CAD/CAM course delivered exclusively on the Internet? The following subquestions became the focus of the study:

- Why did the students decide to take the course?
- What did the students experience during the course?
- What were the students' opinions of the course?
- What modifications were necessary to deliver the course on the Internet versus the traditional classroom?
- What were the strengths and weaknesses of the course?

Review of the Literature

The feasibility of this course was based on research literature that documented attempts at distance learning over the past few decades and revealed significant evidence of its success (Alexander, 1993; Harris, 1939; Langford, 1994; Ross, 1994; Strom, 1994; Turner, 1989). Distance education, in many forms such as interactive television, video, interactive CD ROM, and the Internet, is being used at all levels of education. The exclusive use of the Internet for full course delivery has been developed more recently than other formats. However, this development has been more limited to

courses containing largely cognitive material, i.e., philosophy, mathematics and continuing medical education courses (Hamalainen, 1996; Enockson, 1997; Pitt, 1996). It would be presumptuous and incorrect to infer that this development stands on its own prerogative, when in fact it depends on the development and skills of the course designer and faculty, in addition to the student to achieve the desired outcomes. The review of the literature in this study focused upon four content areas: (a) Distance Education, (b) Distance Education and the Internet, (c) Distance Education and Industry, and (d) Learning and Technology. A compilation of the review is presented below.

Distance Education

Distance education is a term used to describe a process of education or training in which participants are separated by space and/or time from the instructor (Moller and Draper, 1996). For over a century, distance education has existed through delivery methods such as correspondence courses (Watkins and Wright, 1991); however, new delivery methods resulting from the technological revolution have provided greater access to education and training opportunities (Olcott, 1997).

Johnstone (1991) reported on a study of the effectiveness of distance learning since the 1930s, focusing upon evaluation of communication technologies available during that time. The study concluded that when properly designed and used, these instructional formats were as effective as instruction in the traditional format. Distance learning projects studied by Hawkins (1991) and Blumenstyke (1991) demonstrated the extension of learning opportunities to larger student populations in the arts and sciences. They found that each technology has unique benefits and that success is related to the degrees of competency of the participants and the number of learning sites and schedules. Macbrayne (1993) stated that since course location was pivotal in the decision to enroll for most students, distance education reduced previous barriers of limited time and money, distance, and family responsibilities.

Regarding the effectiveness of distance learning, much research suggests that there is no significant difference in the effectiveness of courses delivered via distance education than in courses delivered via traditional methods (Russell, 1999). Findings of several studies indicated that there was no statistically significant difference between the number of successful completers of distance education courses as compared to those of traditional classroom courses (Anderson, 1994; Allen, 1995; Britton,

1993; Dexter, 1995; Foster, 1993; Hinnant, 1995; Thomerson, 1995) and that there was little difference between those who graduated from traditional on-campus programs and those who graduated from external degree programs. It was also found that there were no statistically significant differences in student grades and outcomes; however, motivational differences did appear. Davis' (1996) results indicated that successful distance learners are intrinsically motivated, set small, realistic and practical goals, and have high volitional control over their behavior because they were very goal-oriented.

Distance Education and the Internet

Distance education utilizing the Internet is being offered for subject matter from elementary to graduate studies, and most educational institutions have begun some activity with this delivery method. Liu's (1996) study analyzed a graduate general chemistry course delivered entirely on the Internet with a central theme that asked what the students and the instructor experienced in this endeavor. Liu's findings demonstrated an overall positive evaluation of the Internet chemistry course in relation to providing an otherwise impracticable educational service, creating a highly collaborative teaching and learning environment, and meeting several needs of chemistry teachers. The students thought highly of using a CD-ROM as the course textbook and of the immediate class interactions. They realized the values and potential power of distance learning, but the participants met annoyances that were connected with this learning mode. The obstacles consisted of technical problems such as e-mail being difficult to access, shortage of hardware and software, a deficiency of technical training support, and academic issues including attitude toward distance education, time management, and class participation management.

Haehl (1997) found distance education to be very popular with adult learners, the new majority on college campuses, since it allows the learners to take courses at a time and place that are convenient for them. A central theme of Haehl's study was to find out if adult learners enrolled in an Internet class displayed like learning style characteristics. Other purposes were to ascertain if distance education courses would help meet the needs of the adult learners, and to recommend advances for the design and teaching of distance education courses. Results were found to agree with the assumptions of how the learning styles would react to learning methods necessitated in an Internet course. Analyses of the research data and case studies produced recommendations for inclusion in the design of lecture and

curriculum to meet the needs of the adult students' learning patterns, as well. Likewise, the study found the need for the use of technology to address individual student needs.

Distance Education and Industry

Intense global competition, coupled with rapid technological changes and an aging workforce, has created a sense of urgency in retraining America's workforce, especially in the area of technical professionals (Kaufman, 1994; Meister, 1994). Recent studies suggest that the use of distance education in training and upgrading the technological skills of the workforce has been beneficial and widely accepted, citing advantages of availability, technological currency, quality, and cost effectiveness (Enhancing Education and Training Through Technology, 1997).

West (1995) conducted a study that found little difference between groups who graduated from traditional, on-campus programs and those who graduated from external degree programs. This study also concluded that a negative perception of the non-traditional degree does exist in the workplace but that despite where the degree was earned, it does provide a competitive edge in promotion decisions.

Learning and Technology

Mayor (1996) states that steps must be taken to use the mobility, flexibility, and leanness of speed of the new information technologies to bring about new sharing of knowledge. This reinforces the report from the Software Publishers Association that technology does have an impact on student performance. There seems to be a common belief that more sophisticated technologies have livened things up and the one-way information flow--teachers addressing groups of passive students--is gone. Now, with the Internet, multimedia, and networking, teaching is two-way, collaborative and interdisciplinary. The way companies conduct business today, especially with large-scale downsizing and the shift to an information-based economy, requires workers to be more flexible and better trained, particularly in the use of technology. A class taught exclusively on the Internet seems to be a method of utilizing technology to eliminate the passive student and the one-way information flow of teaching.

Li (1996) states that teachers know and educational researchers confirm that the most meaningful learning takes place when students interact with technology with concrete materials; students learn best by doing. Computer based programs coupled with the Internet holds tremendous instructional

power due to the fact that the medium itself requires the students to interact. This is in line with today's thinking that teachers and students alike are no longer simply consumers of information but producers of information as well. Technology is not a panacea for education, but it can serve as the proximal cause for mobilizing folks to action (Solway, 1995).

Hayden (1997) found that computers and computer-based communications technologies have devised new and exciting opportunities for learning through distance education. The success of these programs presumes the willingness to use them, along with the requisite computer skills which make them accessible.

Procedures

The primary method of inquiry utilized was the qualitative case study method. This method was selected to enable the collection of extensive narrative data to gain insights into the phenomena of the distance education delivery method of web-based instruction. Utilizing the two strategies of direct interpretation of the individual instance and categorical aggregation, the analysis of the narrative data provided deeper understanding and interpretation of the information reported by the students' perspectives. Quantitative approaches were also utilized to generate simple descriptive statistics.

Narrative data from telephone interviews was the primary source of data in this study. Other data sources included a questionnaire from which descriptive statistics were generated, along with student grades from the class. Due to the technical nature and initial development of this course, class size was limited to twenty students from throughout the United States and Canada.

Design

This study utilized a case study framed by the traditional definition. In this case, the main objective was to understand the uniqueness of what the students experienced in this CAD/CAM course delivered exclusively by the way of the Internet. According to Best and Kahan (1989), data collection methods utilized for the case study were: 1) observation by the researcher or his or her informants, 2) interviews with the subject(s), and 3) questionnaires.

This study examined in detail how the students learned about the program and what they expected to learn from the course, by utilizing a combination of the above methods. The study examined

how and to what extent the students and instructor interacted with each other and what the students benefitted from the program. It also examined what obstacles they encountered and how they were handled in the attempt to gain a thorough understanding of the student's experience through in-depth interviews. These findings were related to the commonality of other programs so that insights and patterns could emerge, be identified, and offer directions for further research.

The Researchers' Role

The emphasis on the class in this study is not on the class, but on the delivery method of the class. The observation and recording process was defined with proper supporting documents and forms available for information entry. The researcher defined the inquiry and the assessment questions identified in the purpose of the search, but was aware of the potential for any ancillary questions which might arise.

There were two informants and a researcher involved in this study. The researcher has taught CAD/CAM for the past nine years and also has twelve years experience in the 'real' world of machining and CAD/CAM, thus the researcher provided the information in the issues that led to the research, collected data, and designed and instructed the course. The first informant was a technician with prior knowledge in the machining, CAD/CAM, and computer fields. The technician participated in the class and gave feedback to the professor. The second informant was a representative from the company who provided the software. Consequently, this person was concurrently evaluating the course from the company's perspective. A secretary conducted the telephone interviews.

Certain biases may have been brought into this study due to the researcher's involvement in the authoring of the CD 'textbook', teaching CAD/CAM for the past nine years and participation in several courses on interactive television. This may have influenced how the data were understood and interpreted. The study was started with the assumption that there were advantages in the Internet approach in terms of making the course available to students who could not leave their homes and work in order to take a course. Another assumption was that a curriculum designed specifically for the Internet could achieve similar outcomes as a class taught in the traditional manner.

Based upon Stakes' (1995) assertion that a case study is somewhat of a search for the merits as well as the flaws of a case, an emphasis of a qualitative evaluation is based on the quality of the activities and processes. This was presented as narrative description, and the researcher served as evaluator of the case as well as data interpreter.

Data Collection

The informants in this study were a lab technician, a company representative, and the individuals enrolled in the course from the contiguous United States and Canada. The students all had to be computer literate and competent with Internet and e-mail procedures, and most of the students were in a machining environment.

A majority of data were collected via e-mail, telephone interviews, and through responses to both pre-tests and post-tests on the tutorial CD used in the course. The individual tests consisted of questions that were randomly generated from a testbank. At the end of assignment 15, at the end of assignment 20, and at the end of assignment 25, interviews were conducted. During the course, face-to-face interviews were also conducted with the informants to find areas that were troublesome to the students and possibly clarify them before it became a problem to those away from campus and to collect data for the analysis of the case. At the end of the course, telephone interviews were also conducted with the students.

Data were collected in the following forms: (a) e-mail correspondence, (b) e-mail interviews, (c) telephone interviews, (d) Professor's notes, (e) pre-tests and post-tests, and (f) computer usage statistics. An aggregate of this information is presented in the results.

Data Analysis

According to Stake (1995) two strategies are used in deriving meaning from case studies. The first is the direct interpretation of the individual instance where meaning or the lack of meaning can be derived by taking it apart and putting it back together again in some meaningful structured way. The second strategy is referred to as categorical aggregation. Using this technique, the researcher collects, classifies, and aggregates instances in such a way that something meaningful can be said about them as a class. Generally, most interpretations of data are derived by the direct individual instance method, but both methods are used to fully assess the data which have been obtained.

The analysis of the data contained in this study required the application of both these methods of analysis in an effort to understand the responses from the students, the effectiveness of the methodology, the assessment of the technological component and the potential use of these data in future development of course work. Anticipated results and patterns as well as potential difficulties were considered in the analysis of these data to validate or deny their legitimacy.

Verification Methods

The external validity strategies used in this study were:

1. Direct detailed descriptions of the project. This account details the purpose of the study, the role of the researcher, the students, the development and delivery of the material, and the context from which data were selected (LeCompote and Goetz, 1984).

2. Data collection and analysis methods. Multiple methods of data collection and analysis confirms validity and reliability.

3. Expert review. The methods presentation and analysis relative to this study were subject to the evaluation and supervision of an external expert in qualitative research methods.

Internal validity was established by employing three strategies in this study:

1. Multiple data collection methods. Data were collected via e-mail, e-mail questionnaires, e-mail correspondence, telephone communication, telephone interviews, pre-tests, and post-tests.

2. Informant checking. An e-mail copy of the data analysis was given to informants for their comments and verification.

3. Researcher bias clarification. Under the heading "The researchers role" the researcher bias was established.

Description of the Case

Development of CD Text

As an outgrowth of the development of a tutorial CD, it appeared the successful delivery of the CAD/CAM instruction material via the Internet seemed promising. A CAD/CAM curriculum used for traditional course delivery started the initial translation process. During this screening the opportunities, obstacles, and plan for Internet course delivery began to emerge.

Individual learning styles also had to be addressed within the purview of this CD material and Internet process. Traditional educational values involving cognitive and manipulative skills were considered. The enhancement that this process provides without traditional classroom interaction allowed the students to progress at their personal best.

Development of Course Materials

Well ahead of student enrollment, all supportive, directional and ancillary material had to be developed and available for distribution to the students. Essentially a complete course packet was provided electronically that included the following information: syllabus, faculty, calendar, assignments, notes, e-mail link and index, all hyper linked together. Also contained were links to Mastercam's industrial and educational sites and TTU's home page.

Noting the essential differences between Internet and traditional delivery can best explain the underlying necessity for the development of this course packet. The material had to be provided in HTML format. The hours the professor would be available had to be established after the students were registered, with some evening hours scheduled to accommodate the students' work schedules. For the purposes of this course the professor was available two hours per day, five days per week as opposed to four hours per week during traditional instruction.

E-mail was the main vehicle for delivery of completed assignments and was the method of interaction between the teacher and the students and student to student interaction. The often cited criticism of Internet instruction focuses on the lack of this interaction. Despite the physical absence of the students from the classroom, their interaction was at the common levels of classroom interaction. A total of 1188 messages evidenced this for the class. This Internet interaction was more focused and subject matter relevant than the traditional classroom discussion.

Course Administration Process

In a traditional course delivery system, instructional and administrative processes are clearly defined and the administrative process is not an instructional responsibility. However, in the Internet delivery of this CAD/CAM course, the administrative functions were directly related to the delivery itself.

Another administrative procedure the professor encountered was in the procurement of a grant to provide the CAD/CAM software, the CD text and tutorial texts. In a traditional course delivery the

professor would not be responsible for these administrative processes. The verification of the receipt and return of the course materials was part of the process as well.

Registration Process

Normally, registration and payment for courses are a well established and relatively routine procedure for the students and staff. However, with the use of proprietary courseware an external third party became a stakeholder in the registration process. Providing the software required the approval of each student by Mastercam. In the interest of control for this beta run, students were enrolled from the United States and Canada. Of the initial 990 queries about the course, twenty were selected and allowed to register. An online registration form was provided with instructions about how to complete the process.

Results

Course Results

The main question to be considered in this study was, "What did the students and instructor experience in a CAD/CAM course delivered exclusively on the Internet?" The following subquestions were also considered:

- a. Why did the students decide to take the course?
- b. What did the students experience during the course?
- c. What were the students opinions of the course?
- d. What modifications were necessary to deliver the course on the Internet versus the traditional classroom?
- e. What were the strengths and weaknesses of the course?

When the students were asked why they decided to take this course their responses were very similar. Generally the students indicated their desire for the acquisition of additional CAD/CAM knowledge and proficiency. Direct relationship to their jobs and promotional potential was also cited. Course credit or CEUs was not a major issue with this group of students.

Responses to information on the students' experience during the course were the most difficult to summarize. Of the twenty who initially enrolled, two dropped out due to reasons beyond their control. Of the two students who did not drop nor complete the course, one simply said he let life get in the way and

apologized for taking a spot that someone else could have had. The other student finished all the course activities except the tests since he was not interested in grades or CEUs.

To get the students' opinions of the course, the following questions were asked during a telephone interview and in a questionnaire:

1. Overall, how would you rate the course?
2. Would you take another Mastercam course on the Internet?
3. Did you get out of the course what you expected?
4. Are you pleased with the course up to this point?
5. Would you recommend the course to others?

In response to the first question, 60 percent of the respondents replied excellent, 27 percent replied good, and 13 percent replied fair. One respondent who answered fair stated that the rating was due to the beta test state of the software, but the course had great potential.

When asked if they would take another Mastercam course on the Internet, 87 percent answered yes. Of the 13 percent who said no, one said he would send his employees. This student was taking the course to evaluate it as an option for training his employees, so the course was successful for him.

When the students were asked if they got out of the course what they expected, all but two respondents answered yes. The responses to "are you pleased with the course up to this point" were all yes, and all of the respondents would recommend the course to others.

The summary of students' opinions regarding the strengths and weaknesses of the course are presented in Table 1. The main strengths are related to the course not being on campus and the course's inherent flexibility and self-pacing of the material. The weaknesses were centered around not having an instructor for the face-to-face discussions and the instant feedback.

Student Profiles

Distance learning in most formats serves a more diverse range of student profiles than traditional course delivery. However, the Internet delivery of technical courses such as CAD/CAM has the potential of serving student profiles of many varieties in age, gender, and professional status, and allows the geographic expansion to the international community. The Internet delivery also affords students the opportunity of proceeding and practicing at their own paces.

Table 1

Strengths and Weaknesses of the Course	
Strengths	Weaknesses
Good start in Mastercam CD good Not going to campus Flexibility of Internet Assignment at own pace Availability of software at home Flexible hours Hands on learning Well thought out and presented material Ability to work at your own pace Self paced – did not have to go to campus	No scheduled advanced courses Not enough explanations in tutorial text When stuck had to wait for answer More detailed instructions Easy to fall behind Must send software and CD back Lack of some of the tools needed to complete the lesson Frustrating when instructor not available to talk to Class too short

The twenty students in this course were spread geographically from nine states in the United States and Canada. They were all male and ranged from twenty-four to fifty-six years of age. They all had diverse educational backgrounds. Among the students, two possessed Baccalaureate degrees, one in Industrial Technology and another in Agricultural Education. One student had an Associate's degree in Machine Tool Technology. At the end of the semester while taking this course, another completed an Associate's in Machine Tool Technology from a different school. Two of the students had some training beyond high school, but no degree. The remainder had high school educations. Two of the students have served apprenticeships, one in tool and die and the other as a machinist. A characteristic that the students had in common was that they all had machining backgrounds of varying degrees. Their experience ranged from thirty-five years to machining occasionally. Most of the students had sufficient skills in operating the computer and loading the software.

Planning the Internet Instruction

At the inception of developing the online CAD/CAM course, the issue of the necessity of background information was researched in detail. The planning of the Internet instruction used the objectives of the traditional course as the core of the delivery plan. Beyond that, the planning addressed the issues of the creation of a home page, the enrollment process, delivery of books and materials, communication procedures and the delivery and evaluation of completed work and projects. It was also important that the planning provided the students with specific course information, including a course outline, assignments, examinations and project assignments.

Reviewing the Content of the Course

Because of the novel nature of the course, reviewing the content was an ongoing process during the course. The best sequence of the material, the rate of delivery and the expectations required constant assessment. Feedback from the students was a valuable tool in the content review. The expected diversity of student experience and preparation influenced the content and delivery. The most thorough planning benefitted from the review of the course during its delivery and at the conclusion.

Motivation

The participants in this course were mainly toolmakers and machinists already employed in manufacturing. Their need was to learn to use a CAD/CAM programming software, Mastercam, to enhance their already existing skills and their productivity. They had a varied range of manufacturing backgrounds and formal education, as well as a variety of reasons for taking the course. Their primary reason was to acquire the skills to create programs to run a CNC milling machine and to enhance their productivity. As indicated above, the students were highly motivated to register for the course.

Expectations

One questionnaire asked, what do you expect to learn from this course? Many answers were given. Some of them were general and others were very specific. Three of them stated they simply wanted to learn the basics of Mastercam. One participant wanted an easier way to program CNC machines and another wanted to program and operate a CNC machine. Another hoped to be more practical in creating his programs and be more creative with the additional tools Mastercam has to offer.

The most ambitious one hoped to learn new techniques in programming such as more complex surfaces, 3D geometry, the basic CAD/CAM principles, and how to post a program. This participant was motivated enough that his expectations were fulfilled. The results from the questionnaires revealed that the expectations of the students were primarily met. In the telephone interviews conducted at the conclusion of the class the question was asked, "did you get out of the course what you expected". The answers from all the respondents except one was a resounding 'yes'.

On the negative side, one student noted that they probably would have been more motivated and would have learned more if in a classroom with a teacher. One of them noted that they would have learned from others' mistakes. The professor also voiced concern over the absence of face-to-face interaction with the students. The professor's teaching style depends heavily on being able to see the students' faces, their expressions and their reactions and then tailor the remarks accordingly. However, when asked in the telephone interview "do you feel that the flexibility of the schedule and not having to physically go to the classroom was a fair tradeoff for not having a teacher to answer your questions in person," all the respondents answered yes.

Outcomes

The most significant outcome of this distance learning format of Internet delivery did not appear in the course syllabus. It was the outcome of obtaining this instruction and experience without the costs and inconvenience of lost time away from the job and the usual travel and per diem costs. Frequently, the rapidly changing, competitive nature of technology does not afford the technician or his employer the luxury of scheduled traditional classes.

Did the participants attain what they had expected? To 93 percent of the respondents the answer was yes, but to others, the answer was much more than a simple yes or no. Out of twenty students, sixteen completed the course, two did not complete the required assignments to attain the CEUs for the course and two dropped out of the course.

Assets and Deficits

The assets and the deficits of Internet delivery of a CAD/CAM course are in the nature of the course delivery itself. The assets of this method of delivery are:

1. The course content is computer based in both CAD and CAM.
2. The level of student skill required in computer technology is definitive and measurable.
3. There is a high level of congruence of course work and workplace demands.
4. The progression of technology in Internet delivery of design and production programming across the nation and around the world will utilize the skills developed in the "Internet Classroom."
5. The CD tutorial developed specifically for this type of class utilizing hyper media helped to facilitate the learning process.

The deficits were:

1. The course is very graphic intensive, demanding supporting software and hardware.
2. The design and delivery of the course demand that the instructor has a high level of CAD/CAM and machine tool experience and competence.
3. The student must be academically mature enough and motivated to work at length without close supervision.

With the innovative classroom technologies one must be sure to not be distracted by the glitz of the new technologies and forget assuring an effective methodology that addresses all learning styles. Nor should the use of these strategies become a substitute for the creative interaction between teacher and student. However, more learning styles were addressed in this class because multimedia is multisensory. It has often been stated that while the use of information technology initially involves the porting of current materials to new environments (e.g., photographic slides to presentation software to simply translating existing materials to an electronic format), the real impact begins when it alters the curriculum itself. Here the curriculum has been positively affected.

Difficulties

Some difficulties encountered involved the registration process, setting the number of class assignments, and administering the questionnaires. The original intent regarding registration was to allow the students to register completely on the Internet. However, since TTU did not have a secure server,

credit card numbers could not be accepted via the Internet. Therefore, directions were added to the registration form to call the Extended Education Office to complete the registration process.

Administration of the questionnaires also posed a problem due to difficulties with the mainframe mail server. After the problem was corrected, the students were reluctant and slow in responding to them.

Evaluation

This was a ground breaking undertaking for the professor and most of the participants. Only one participant had experienced an Internet course before. A follow-up telephone interview was completed to determine if the participants viewed the course as a success. The two informants who participated in the course were also interviewed at length to get their opinions, and the participant from CNC Software was interviewed to get a view of the course from the company's perspective.

Each participant was evaluated before taking the course and the effectiveness of the course delivery system was measured by a post-test. Scores of the sixteen successful completers ranged from 70.87 to 99.73, as indicated in Table 2. Seven of the sixteen completers reflect an additional indicator of the delivery system scoring ninety or above. It should be noted that the high standard deviation is distorted by the inclusion of the scores of the two participants who did not complete the course. Descriptive statistics were generated for the eighteen participants who remained in the course. The maximum average, the minimum average, mean, median, and standard deviation were calculated, and Z scores were included for the potential assessment of the delivery system effectiveness for individual students. Table 2 depicts the differences in the averages of the pre-test and post-test scores.

Potential for Improvements

The problems associated with this course fell into two major categories: technical and non-technical. The technical category related to the facilities and technology that made the course delivery possible. It included the hardware, software and support systems involved. The non-technical refers to issues related to course design, course management, the registration process and such other matters. A viable distance learning program relies on a solid technical infrastructure. Efficient support systems such as reliable and convenient network connection and sufficient hardware and software support are essential for an effective delivery of any distance learning course that involves telecommunications.

Table 2

Difference in Pre-Test and Post-Test Score Averages				
#	POST-TEST		PRE-TEST	DIFFERENCE
1	89.33		71.13	18.20
2	89.80		44.40	45.40
3	90.00		62.20	27.8
4	93.87		79.00	14.87
5	86.87		74.07	12.8
6	93.47		93.47	
7	88.87		35.87	53.00
8	Dropped			
9	96.53		82.87	13.66
10	83.80		75.27	8.53
11	92.93		67.87	25.13
12	Failed	6.00	45.07	-39.07
13	83.67		65.73	17.94
14	99.73		78.33	21.40
15	Failed	0	2.00	-2.00
16	70.87		64.93	5.94
17	87.27		58.27	29.00
18	Dropped			
19	89.87		69.73	20.14
20	85.33		52.60	32.73

Regarding the non-technical issues, an under-powered technology-based curriculum hampers the schools of today and, to stay competitive, the American educational system must do a better job of incorporating technology. Teachers must take a leadership position in designing and implementing technology-powered classroom curriculum, and invest a considerable amount of time and energy to familiarize themselves with the many available resources. The time investment in this course and its attending technology was

monumental. This researcher estimates that it required approximately four times as much time investment as compared to a traditional course delivery. Time invested in coauthoring the CD tutorial text was not included. However, the next time this course is delivered, it is estimated to take approximately one half the time to incorporate the changes and redeliver.

Limitations

This study was largely bound to a description and analysis of the information provided by the students and the professor involved in one course. Therefore, valid interpretation is limited to the materials and course delivery mode at this particular time for these students. The study was limited in at least two additional aspects: 1) there was little face-to-face contact between the researchers and the students; and 2) the method of data collection was largely confined to e-mail and telephone communications. Due to these limitations, the findings could be subjected to criticism and other interpretations. It is important to utilize the limitations revealed by the research in the review and subsequent rework of this course and the development of other similar courses for future delivery.

Implications for Future Research

Additional research is recommended to study the time involved in preparing and delivering courses via the Internet. The willingness of the university to support the faculty in spending the time necessary to create or find materials suited to this delivery system needs to be explored, as well as the current support systems for the faculty involved in this type of delivery system. Factors that require further research for this delivery format include the following: faculty/student satisfaction, student self-motivation, frequency of interaction, and incorporation of cooperative and active learning strategies.

This research provides potential for the evaluation of transferability of this delivery system to other computer-based courses such as CNC, and programmable logic controller's (PLC's). The educators who experienced this course assessed the applicability of these strategies to their particular disciplines. Also, this study did not attempt to measure the positive or negative impact of individual Internet study versus traditional, faculty guided classroom instruction.

As higher education institutions continue to utilize various methods of distance learning, institutional research professionals will be called upon by their institutions to assist with evaluation of those

methods. The findings and conclusions of this work will enable institutional researchers and administrators to become more aware of implications for practice and the need for further research in distance learning.

Conclusions

Compared with traditional classroom learning, distance learning is in its infancy and is facing tremendous growth surges due to the burgeoning technology of today and of what is coming tomorrow. Consequently, faculty must adjust their teaching methods and derive a new set of both useful and effective problem solving skills required for distance education delivery. Therefore one must strive to study, create, and generate pedagogically sound and cost effective models that can only come from experience and an aggregate of many trials and failures.

The findings of this study indicate that the Internet delivery met the expectations of the students by offering a course that would not have been practical or possible through traditional delivery. By using the Internet, the participants were not required to quit their jobs or relocate. Participants were satisfied with all components of the program except for selected technical problems, and they felt that this distance learning course was as effective as a traditional class. Thus, it can be concluded from this study that it is possible to have the flexibility and responsiveness of web-based instruction and still meet students' learning expectations in a course as highly technical and graphics intensive as CAD/CAM.

References

- Allen, B. A. (1995). Measurement of factors related to student and faculty satisfaction with video based and interactive television courses in distance learning [CD-ROM]. Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 56/06.
- Alexander, G. H. (1993). Flexible and distance Learning. Choice, 31(1),185.
- Anderson, M. R. (1994). Success in Distance Education Courses Versus Traditional Classroom Education Courses [CD-ROM]. Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 54/12.
- Best, J. W. & Kahan, J. V. (1989). Research in education. Englewood Cliff, NJ: Prentice Hall.
- Blumenstyk, G. (1991). Many attempts at 'distance learning' are impeded by unforeseen political and financial problems. The Chronicle of Higher Education. 38, A23-25.
- Britton, O. L. (1993). Interactive distance education in higher education and the impact of delivery styles on student perceptions [CD-ROM]. Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 53/12.
- Davis, M. A. (1996). The interrelationship of conation, goal accomplishment style, and psychological type in distance learners. [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Item: DAI-A 56/08.
- Dexter, D. J. (1995). Student performance-based outcomes of televised interactive community college distance education [CD-ROM]. Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 56/06.
- Enhancing education and training through technology (1997). National Alliance of Business Workforce Economics Trends, 1-8.
- Enockson, J. O. (1997). An assessment of an emerging technological delivery system for distance education. [CD-ROM]. Abstract from : ProQuest File: Dissertation Abstracts Ondisc Item: DAI-A 58/03.
- Foster, B. B. (1993). The effects of interactive teleconferencing as an instructional medium on the learning environment for students [CD-ROM]. Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 54/04.

- Mayor, F. (1996, December). Higher education and new technologies. UNESCO Courier, 2, 38.
- Haehl, S. L. (1997). Characteristics Common to Adult Students Enrolled in a Distance Education Course via the Internet [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Item: 9708669.
- Hamalainen, Matti Aarne (1996). A Product View of Education: Education Brokers and Electronic Markets for Learning [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Item: 9705856.
- Harris, D. (1989). Beyond distance teaching - Towards open learning. Journal of Higher Education, 60, 242-244.
- Hawkins, J. (1991). Technology-mediated communities for learning: Designs and consequences. The annals of the American Academy of Political and Social Science. 514, 159-175.
- Hayden, J. W. (1997). Computer-based distance learning in emergency medicine: an Analysis of attitudes between physicians and nurses [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Item: 9717218
- Hinnant, E. C. (1995). Distance learning using digital fiber optics: a study of student achievement and student perception of delivery system quality [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Ondisc Item 9507523
- Johnstone, S. M. (1991). Research on telecommunicated learning: Past, present, and future. The annals of the American Academy of Political and Social Science , 514 , 49-57.
- Kaufman, H. G. (1994). Obsolescence and retraining of technical professionals: A research perspective. The Journal of Continuing Higher Education, 42(2), 2-11.
- Langford, D.A. (1994). Case study of development of distance-learning course. Journal of Professional Issues in Engineering Education and Practice. 120, 333-340.
- LeCompote, M. D., & Goetz, J. P. (1984). Ethnography and qualitative design in educational research. New York: Academic Press.
- Li, P. (1996). Teaching effectively with telecommunications. Technology and Learning, 16, 56-62.
- Liu, D. (1996). Teaching Chemistry on the Internet. (Doctoral dissertation, University of Nebraska, 1997). ProQuest Dissertation Abstracts. 49, 5710.

Macbrayne, P. S. (1993). Rural adults in associate degree distance education: What motivates them to enroll in college [CD-ROM]? Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 54/05.

Meister, J. C. (1994). Corporate Quality Universities: Lessons in Building a World-Class Work Force. New York: Irwin Professional Publishing.

Moller, L. and Draper, D. (1996). Examining the viability of distance education as an instructional approach. The Journal of Continuing Higher Education, 44(1), 12-21.

Editor, (1996, November). Where's the proof? (Report on high technology impact on student performance). NEA Today, 15, 25.

Olcott, D. Jr. (1997). Renewing the vision: Past perspectives and future imperatives for distance education. The Journal of Continuing Higher Education, 45(3), 2-11.

Pitt, Tina Joy (1996). The Multi-User Object Oriented Environment: A Guide with Instructional Strategies for Use in Adult Education [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Item: 9708340.

Russell, T. L. (1999). The No Significant Difference Phenomenon. Chapel Hill, NC: North Carolina State University.

Ross, L. R. (1994). Educators overcome difficulties with partnerships, 'distance learning'. Chemical & Engineering News. 72, 35-37.

Stake, R. E. (1995). The art of case study research. Thousand Oaks, CA: Sage.

Solway, E. (1995, January). Beware, techies bearing gifts. Communications of the ACM, 38, 17(8).

The Institute for Higher Education Policy (1999). What's the difference? A review of contemporary research on the effectiveness of distance learning in higher education. Washington, DC: Author.

Thomerson, J. D. (1995). Student perceptions of the affective experiences encountered in distance learning courses [CD-ROM]. Available: UMI ProQuest File: Dissertation Abstracts Ondisc Item DAI-A 56/05

Turner, I. A. (1989). 'Distance learning' courses get high marks from students, and enrollments are rising. The Chronicle of Higher Education, 36, 39-40.

U. S. Congress Office of Technology Assessment (1989). Critical connections: Communication for the future. Washington, DC: Government Printing Office.

Watkins, B. L. and Wright. S. J. (Ed.Ss.) (1991). The Foundations of American Distance Education: A Century of Collegiate Correspondence Study. Dubuque, Iowa: Kendall/Hunt.

West, J. A. (1995). A comparative analysis of selected on-campus and external graduate engineering degree programs [CD-ROM]. Abstract from: ProQuest File: Dissertation Abstracts Item: 9519847



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