Online Learning in Engineering Graphics Courses:
What are some of the Big Issues?

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ABSTRACT- For years we have had the ability to offer courses at a distance through online instruction. Many instructors have taken advantage of online tools to supplement their classroom instruction, but few embrace the full potential of online learning technologies. Some of these tools include course web pages, course management and development tools, and online tutorials. Reasons for not embracing online learning technologies include inadequate training in the necessary tools to develop an online course (Bhattacharya, 2004), perceived lack of interactivity or dialogue between the students and instructor and between students in online courses (Sherry, 1996), lack of technology support at one's institution, or time required to develop online materials. In some cases, online courses are not developed because face-to-face courses are sufficient to meet student demand. Engineering graphics instructors face additional challenges with issues such as finding appropriate ways to demonstrate CAD software, preparing materials that are graphics intensive, and determining adequate methods to evaluate student work. More recently, synchronous communication tools for learning have been developed that allow instructors to communicate with students in real-time. These technologies have increased the level of community with an online course by integrating audio, video, and other means for students to interact (Motteram, 2001).

This paper gives a brief history of online learning, summarizes research from engineering and other disciplines related to online instruction, discusses some of the tools available that can be used to deliver instruction synchronously and asynchronously, describes some of the issues related to delivering engineering graphics instruction online, and provides some solutions to issues related to online learning.

I. Introduction

Distance education or distance learning is the planned learning that normally occurs in a different place from teaching and, as a result, requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements (Moore & Kearsley, 2005).

Distance education has an extensive history, extending from print, to instructional video or television, to current interactive technologies. The early age of distance learning started as correspondence courses in Europe.

In 1873, Anna Ticknor created the Society to Encourage Studies at Home in the United States for the purpose of educational opportunities for women, regardless of social class (Ticknor, 1891). Since then,

correspondence course study has been the subject of many debates and discussions. Many believed that correspondence degrees would never replace traditional instruction (Watkins & Wright, 1991).

As correspondence study grew in popularity during the time between the World Wars (1918 – 1946), the federal government granted radio broadcasting licenses to hundreds of colleges, universities, and school boards (Watkins & Wright, 1991). When television was introduced to the public, the development of educational television was set in motion, and a new form of instruction began. As correspondence study grew, issues related to learner characteristics, student needs, effectiveness of communication, and the comparison of correspondence with face-to-face study were of interest to many in educational fields. This interest was the reason for the research studies that have contributed to the knowledge base of distance education today.

During the 1960s and 1970s, alternatives to traditional higher education developed in the United States. This was due to escalating costs of traditional education, interest in nontraditional education, a more mobile population, and general public dissatisfaction with educational institutions (Gerrity, 1976).

With the advancement of technology in the last 30 years, independent study has become more accessible for distance education students. Factors, such as a rapidly changing economy, changing demographics, technological advances, and intense competition has produced a need for distance education in higher education (Shuman, et al., 2002).

Even with the growth of distance education and the more extensive knowledge base gained through research studies, it is essential that more studies be conducted concerning students' learning experiences, the effectiveness of instructional methods, and the strengths and weaknesses of this method of teaching and learning.

This paper will examine audience and learning styles, some of the tools available for distance education, the methods and design considerations of distance education courseware, the different communication methods, advantages and disadvantages of online instruction, and conclude with a discussion of the issues and recommendations for solutions to these issues.

II. The Audience and Learning Styles

The reasons for pursuing a distance education course are many. The adult learner may have constraints of time, distance, and finances, the opportunity to take courses or hear outside speakers who would otherwise be unavailable, interacting with students from different cultural, social, economic, and experiential backgrounds, and the ability to control some of the learning experience (Willis, 1992).

Learning effectiveness can be influenced by the student's individual learning style. Many distance education projects incorporate cooperative learning, collaborative projects, and interactivity within groups of students as well as between sites.

In order to have effective learning, the instructor must have knowledge of the preferences of the student for a particular mode of learning. If an instructor can recognize the existence of these learning styles and make alterations of the course material to accommodate the different styles, these factors can then influence the success of both the student and the distance education course (Sherry, 1996). Many learning style indicators exist and can be implemented with a small amount of training. These instruments include, but are not limited to, the Myers Briggs Type Indicator (Consulting Psychologists Press, Inc., 2005), Kolb's Learning Style Inventory (Kolb, 1981), and the Gregorc Style Delineator (Gregorc Associates, Inc., 2005).

III. Tools of Distance Education

Today, the tools, along with the technology, have increased tremendously. In the not-to-distant past, the only tools available were audio and video. Today, with the growth of the Internet and web-based tools, distance education courses can be developed and managed with less difficulty than in the past.

There are several software suites that can be used to develop distance education websites. These include Macromedia Dreamweaver, which is an inexpensive tool that allows an instructor to create websites without knowledge HTML coding techniques. Dreamweaver provides templates with the software and for those that are adventurous can search the worldwide web for more templates to download and use. A no-cost alternative to creating website are Netscape composer and Mozilla. These tools, while not as robust as tools such as Dreamweaver, can still create an effective website for use in a distance education course.

If video or audio media are necessary for a distance education course then some kind of video or audio editing software usually is required. This software is typically more expensive but can produce very effective media for use in a course.

Image processing software, such as Adobe Photoshop, is needed if any image editing is required for photos. There are several no-cost or low cost software tools available, but usually the less the cost, the fewer features are included with the software.

With the rapid growth of distance education, learning management systems have come into existence to provide a total solution for courseware development. A learning management system (LMS) is the platform used by most institutions for the delivery and tracking of blended learning, i.e., online and traditional learning. A robust LMS should provide a seamless integration for educational, administrative, and supervisory tasks. As with any online system, a LMS system must offer security by selectively limiting and controlling access to online content. It must also be scalable to meet future growth in the volume of instruction and/or the size of the student body. The system must be user-friendly to facilitate the distance learning experience. It also should be built on an open architecture that supports content from different sources and is interoperable with different platforms (MUC, 1999). Some of the most popular LMS systems are Blackboard™, WebCT™, Desire2Learn™, and Angel™.

Virtual laboratories for distance education are a new technology in its infancy. These labs enable a user to quickly and effortlessly control and publish results of instrumentation and experimentation. The new technology available with National Instruments (NI) LabVIEW_ Remote Panels enables a user to quickly and effortlessly publish the front panel of a LabVIEW_ program for use in a standard Web browser. Once published, anyone on the Web with the proper permissions can access and control the experiment from the local server. If the LabVIEW_ program controls a real-world experiment, demonstration, calculation, etc., LabVIEW_ Remote Panels turns the application into a remote laboratory with no additional programming or development time (NI, 2005).

Another type of virtual laboratory being developed is the Virtual Computing Lab (VCL). The Virtual Computing Lab **(VCL)** Project is a joint venture of the College of Engineering Information Technology and Engineering Computer Services (**ITECS**) group and the High Performance Computing (**HPC**) team in the Information Technology Division (**ITD**) at North Carolina State University in Raleigh, North Carolina. VCL provides on-demand reservation-based remote access to NC State's extensive library of Engineering, Design, and Scientific software applications. It is

intended to address the increasing needs of both local and distance students and faculty by providing 24x7 access to these advanced computing laboratory facilities.

IV. Design Considerations & Methods

The traditional approach to higher education entails a group of students meeting at a specified time in a classroom or laboratory to meet with an instructor or teaching assistant (Ssemakula, 1999). Usually there is a lecture involved with possibly some activities to keep the students involved. The instructor typically has ultimate control of what occurs in the class and directs the actions of the students.

The traditional classroom environment does not exist in a distance education course, and the instructor does not have control over the students' actions aside from the constraints established within the context of the course. The methods utilized for a distance education course is completely different than those used in a traditional setting. Likewise, the design of the distance education course needs to engage the students differently than an instructor would in a face-to-face situation.

One of the principal factors to avoid is the instructor becoming an entertainer in a distance education course. Learning materials and media should be designed to encapsulate and preserve the attention of the students without trying to entertain as in a television program.

When designing a distance education course, the customary stages of design, development, evaluation, and revision must be adhered to. In order for instruction to be effective, the instructor must consider not only the goals, needs, and characteristics of instructors and students, but also consider the content requirements of the course.

For a distance education course to be successful there must be interactivity between the students and the instructors, the students and the learning environment, and among the students themselves.

Students that are active learners in a distance education course have a sense of ownership of the learning objectives. They must be willing and able to receive the instruction given. The instructional materials must be relevant and meaningful to the student.

The learning modules should be presented in short units and be both visually stimulating and keep the students' interest.

Communication is an important aspect of an effective distance education course. Instructors must recognize the students as individuals whose position may be different than their own. The instructor must provide a sense of presence to ensure that the students know that the instructor is paying attention to what happens in the "classroom".

There are several methods and strategies that instructors can use in a distance education course. First, and foremost, instructors must be trained with the instructional design and delivery process. Instructors need plenty of guided, hands-on practice developing and delivering courseware using different media techniques.

Instructors must learn that they are no longer the deliverer of information. Instructors in distance education courses become a facilitator of discovery learning for their students (Carr-Chellman & Duchastel, 2000).

V. Asynchronous vs. Synchronous Communications

Communication is a key factor to a successful and effective distance education course. Within a learning environment there are two types of communication: asynchronous and synchronous. Both have features that may be appropriate in different settings (Davidson-Shivers, Muilenburg et al., 2001).

Until recently, asynchronous communication was the only type of distance learning communication available outside of the telephone. Some of the more common types of asynchronous communication methods are email, discussion boards, websites, video, and audio media. For email and discussion boards, students would typically email or post their messages or feedback and the instructor or students would respond, anywhere from a few minutes to days. This type of communication has the advantage of allowing students and instructors to formulate their messages before sending it. The disadvantage is that there cannot be any brainstorming or sharing of ideas with immediate feedback.

Synchronous communication is almost instantaneous. It is almost like having a conversation with an individual. Brainstorming and transfer of ideas is immediate. Methods, such as chat rooms, virtual classrooms, and web conferencing are but a few of the different synchronous communication technologies available today. However, since these technologies are relatively new, there are some drawbacks. With web conferencing and virtual classrooms, video images may be choppy and disjointed. There may be more play than work in chat rooms. Some methods of synchronous communication may be cost prohibitive and usually require advanced scheduling.

An example of a synchronous learning tool is Centra Symposium™ (Centra, 2005). This tool allows the instructor and students to communicate with one another via Voice-Over Internet Protocol (VOIP) and video. Instructors can take advantage of whiteboards, break-out rooms, application sharing, web-browsing, as well as many other interactive tools.

VI. Advantages/Disadvantages of Distance Education

Distance education offers exciting and new learning experiences for both instructors and students.

Nevertheless, there are both advantages and disadvantages of distance education.

Due to the success of some online courses, corporations are busy creating course building software that makes converting traditional courses to online courses relatively simple. Materials that are created for distance learning must be created to be self-sufficient. The materials must be able to provide support, be it technical or otherwise to help the student be successful.

Many students who have engaged in a distance education course report that the experience was a good one. Students are able to attend class when it is convenient, without ever leaving home, and have time to reflect and give more thoughtful insight to the course. This is particularly important for lifelong (adult) learners returning to school with full time jobs and a family (Ebeling & Gubernick, 1997). However, it is more time consuming to teach and participate in a distance education course. It is ongoing from the beginning to end (Guernsey, 1998).

Although training can be an issue, the technology will become an instructor's best asset if he/she is willing to learn. These individuals are also able to teach others and persuade some to try the new technology in their classes. Staff training is a requirement. Instructors have to be trained on the technology being used in the distance education course (Matthews, 1999).

Discussion boards, bulletin boards, listservs, chats, and email make it more possible than ever to communicate in a distance education course. Students are able to interact with one another and instructors at any time, at their convenience (Davey, 1999). Asynchronous communication allows the students time to read postings submitted by fellow classmates, process the information, and give an insightful response, without having to respond immediately as in an traditional class discussion. Online discussions are superficial and lack much depth. Distance education courses limit the way

students interact with one another as well as the instructor.

In any discussion, be it face-to-face or virtual, it is possible to be unproductive. Any good instructor knows that it is not the actual communication medium that makes the discussion, but the content of the communication. People talk all the time and say "nothing". With any class, the instructor needs to give students the opportunity to build a rapport with each other. This creates a community of learners who are willing to make the class interesting and successful. In class discussions are vital to higher order learning, they provide instant clarification, continuous and immediate feedback and elaboration, and the depth is robust. Virtual chats can allow students to be "anonymous" in class and conversations lack direction and substance.

Although the startup costs are substantial, costs become equal to or lower than traditional classes over time. In addition, the cost of building and maintaining campus buildings is reduced (Barket & Holley, 1996). The cost of experts to create materials, as well as maintenance of the technology is necessary. Additionally, staff and faculty need to be trained to use the various technology tools.

There will be more college students attending school over the next decade and some schools will not be able to accommodate this increase in their present facilities. Distance education will be able to alleviate some of this pressure (Matthews, 1999). Distance education facilities are built and then remain underutilized, and technicians are underemployed (Wilson, 1998).

In copyright law, ownership follows authorship. This means that course materials are the property of the teaching faculty and staff that developed them. Traditionally, universities have acknowledged that faculty have owned their course materials and the copyright to them (Noble, 1998). Instructors who post course information, such as syllabi, online may have their information "borrowed" by others without permission.

VII. Issues and Solutions of Distance Education

With distance education, there are several operational issues that involve planning, administration, management, and economics, all of which are crucial for a successful distance education course.

The distance education instructor is the common thread throughout the distance learning process. The instructor not only must be knowledgeable in the subject matter and of teaching methods, but must now acquire the training in effective distance education strategies. Proper training and guided practice must be accomplished in order for instructors to fulfill their responsibilities of teaching.

Another issue is the acquisition of the technology necessary to facilitate the effective use of distance education. There must be a commitment to not only purchase and maintain the new technologies, but to train the instructors to use it effectively. The equipment must be user-friendly and be able to expand as the distance education program grows. Involving the personnel early in the process will help facilitate the initiation of the new technologies.

There are scheduling and cost/benefit tradeoffs to consider when implementing a distance education course. Implementation of distance education is resource-intensive. Sufficient time and money must be allocated to ensure that the course is completed as planned (Sherry, 1996). If the budgeted funds run short, then either downsize the project or extend the time period. Many proposals are written without considering the amount of time it actually takes to create a distance education course. It may be better to start with a small project and then grow into a larger project in the future.

There is always an issue of presence with a distance education course. Because class time is set by the student and not the instructor, immediate feedback, both from and to the students is lacking. One way to alleviate this is to establish a chat room and have virtual office hours during the time that the instructor would have regular office hours. This way, the students can get immediate feedback to questions that they may have regarding the course material.

Authenticating work from students in a distance education course is a major issue and there are no set rules for preventing this from happening. A systems approach that make the "costs" associated with cheating offers the best chance of success. For example, increasing the penalties for cheating, making the student expend more energy to avoid detection, and making it easier for the instructor to detect cheating. Some other tips include structuring assignments carefully to emphasize the synthesis of material rather than just reporting facts. Verify the student identity by using multiple identification factors. Create time limits on assignments and exams so that copying is difficult.

There are many things to consider when teaching engineering graphics courses online. Engineering graphics instructors typically rely on live demonstrations to introduce students to CAD commands and concepts. For asynchronous instruction, tools like Camtasia Studio™ (TechSmith, 2005) can be used to capture an instructor's screen and voice while doing a demonstration. The video file can then be saved to a CD for distribution or streamed out of the Internet. Synchronous tools like Centra Symposium™ (Centra, 2005) can be used to give real-time demonstrations to students over the Internet. A main consideration here is that the instructor and the students have broadband Internet connections to accommodate the large amount of information being sent synchronously.

Another issue to consider when teaching engineering graphics courses online is handling image files for web-based tutorials or instructional materials. Instructors may need to convert drawings or other graphics to images that are included in online materials. This may require scanning existing documents or creating new documents and then converting them to a format that can be used within web documents.

Finally, evaluating student work can be challenging within an online course. The learning management systems mentioned earlier all have built-in assessment tools for multiple-choice, essay, matching, or other types of quizzes. To evaluate students' CAD work, instructors must evaluate the students' individual files. This can be one of the most drastic changes in how an instructor manages a course. Opening individual files and examining solid models or drawings can be a time consuming task.

VIII. Conclusion

Distance education can be a powerful system for enhancing a training or college program. However, the obligation necessary to execute such a program may be resource intensive and cost prohibitive to do all at once. Implementation in small stages may be necessary to successfully put distance education program into practice.

IX. References

Barket, R., & Holley, C. (1996). Interactive distance learning: Perspectives and thoughts. *Business Communication Quarterly, 59*(4), 88-97.

Bhattacharya, B. (2004). *Distance education through technology mediated learning: The engineering education scenario in India.* Paper presented at the Third Pan-Commonwealth Forum on Open Learning, Dunedin, New Zealand.

Carr-Chellman, A., & Duchastel, P. (2000). The ideal online course. *British Journal of Educational Technology, 31*(3), 229-241.

Centra (2005). *Centra Symposium*. Retrieved October 19, 2005, from http://www.centra.com.

Consulting Psychologists Press, Inc. (2005). *The Myers-Briggs Type Indicator*. Retrieved October 19, 2005, from http://www.cpp-db.com/products/mbti/index.asp.

Davey, K. (1999). Distance learning demystified. *National Forum, 79*(1), 44-46.

Davidson-Shivers, G. V., Muilenburg, L. Y., et al. (2001). How do students participate in synchronous and asynchronous online discussion? *Journal of Educational Computing Research, 25*(4), 351-366.

Ebeling, A., & Gubernick, L. (1997). I got my degree through e-mail. *Forbes, 159*(12), 84-90.

Gerrity, T. W. (1976). *College-sponsored correspondence instruction in the united states: A comparative history of its origin (1873 - 1915) and its recent development (1960 - 1975).* Unpublished Dissertation, Teachers College, Columbia University.

Gregorc Associates, Inc. (2005). *Gregorc Style Delineator.* Retrieved October 19, 2005, from http://www.gregorc.com/instrume.html.

Guernsey, L. (1998). Distance education for the not-so-distant. *The Chronicle of Higher Education, 44*(29), A29-A30.

James, W. B., & Gardner, D. L. (1995). Learning styles: Implications for distance learning. *New Directions for Adult and Continuing Education, 67,* 19-31.

Kolb, D. A. (1981). *Learning style inventory*. Boston, MA: McBer & Company.

Matthews, D. (1999). The origins of distance education and its use in the united states. *Technological Horizons in Education Journal, 27*(2), 54-60.

Moore, M. G., & Kearsley, G. (2005). *Distance education: A systems view* (2nd ed.). Belmont, CA: Wadsworth.

Motteram, G. (2001). The role of synchronous communication in fully distance education. *Australian Journal of Educational Technology, 17*(2), 131-149.

MUC. (1999). Comparison of online course delivery software products. *Marshall University's Center for Instructional Technology*, Retrieved October 10, 2005, from http://www.marshall.edu/it/cit/webct/compare/comparison.html

National Instruments. (2005). What is labview? *National Instruments Corporation*, Retrieved October 14, 2005, from http://www.ni.com/labview/whatis/

Noble, D. (1998). The coming battle over online instruction. *Sociological Perspectives, 41*(4), 815-818.

Sherry, L. (1996). Issue in distance learning. *International Journal of Educational Telecommunications, 1*(4), 337-365.

Shuman, L. J., Atman, C. J., Eschenbach, E. A., Evans, D., Felder, R. M., Imbrie, P. K. et al. (2002). *The future of engineering education.* Paper presented at the 32nd Frontiers in Education Conference, Boston, MA.

Ssemakula, M. E. (1999). *Transforming a traditional course into a long distance course.* Paper presented at the 29th Frontiers in Education Conference, San Juan, Puerto Rico.

TechSmith. (2005) *Camtasia Studio*. Retrieved October 19, 2005, from http://www.camtasiastudio.com.

Ticknor, A. (1891). A precursor of university extension. *Book News*, 351-352.

Watkins, B. L., & Wright, S. J. (1991). *The foundations of American distance education: A century of collegiate correspondence study*.Dubuque, IA: Kendall/Hunt Publishing Company.

Willis, B. (1992). Strategies for teaching at a distance. *ERIC Document Reproduction Service*, No. ED 351008.

Wilson, P. (1998). To be or not to be? Selected economic questions surrounding distance education. *American Journal of Agricultural Economics, 80*(5), 990-993.