DOCUMENT RESUME

ED 409 044 JC 970 358

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TITLE	The Development of a Strategic Plan To Provide a Multisite Electronic Engineering Technology Program at the Community College of Allegheny County.
PUB DATE	Mar 97
NOTE	180p.; Ed.D. Applied Research Project, Nova Southeastern University.
PUB TYPE	Dissertations/Theses - Practicum Papers (043)
EDRS PRICE	MF01/PC08 Plus Postage.
DESCRIPTORS	*College Planning; Community Colleges; Computer Networks; Course Descriptions; *Curriculum Development; *Distance Education; *Electronics; *Engineering Education; Program Development; *Strategic Planning; Two Year Colleges
IDENTIFIERS	Community College of Allegheny County PA

ABSTRACT

A project was undertaken to develop a strategic plan to implement a multisite electronic engineering technology (EET) program at Pennsylvania's Community College of Allegheny County. Specifically, the project sought to determine how electronic communication technologies could provide a virtual learning community for the program; appropriate plans for network communication, coordination between educational segments, and evaluation; and necessary changes in the program to adapt to the multisite format. Data were collected from a literature review, interviews with program coordinators of existing EET distance learning programs and directors of computer centers, and a review of the necessary hardware and software for the project. In addition, advisory group meetings were held with industry representatives and educators to develop and review the plan. As a result of the process, requirements were developed regarding the classroom model, faculty training, hardware and software, and the laboratory component. Appendixes provide the college's mission statement, a campus location map, an organizational chart of college divisions, a list of related programs, the new EET curriculum, assessment and planning charts, the coordinator and director interview forms, a list of advisory members, course syllabi, and the completed strategic plan for distance learning in EET. Contains 184 references. (HAA)

THE DEVELOPMENT OF A STRATEGIC PLAN TO PROVIDE A MULTISITE ELECTRONIC ENGINEERING TECHNOLOGY PROGRAM AT THE COMMUNITY COLLEGE OF ALLEGHENY COUNTY

Pearley Cunningham

A major applied research project presented to Programs for Higher Education in partial fullfillment of the requirements for the degree of Doctor of Education

Nova Southeastern University

March, 1997

ACKNOWLEDGEMENTS

The completion of the Major Applied Research Project represents the fulfillment of a lifelong dream. The Nova Southeastern University doctoral program for the working professional has afforded opportunities for growth both as a teacher and a scholar. Both seminars and practicums have provided extensive learning experiences that have improved my professional performance.

Special thanks are given to the members of my MARP committee: (a) Dr. Toni L'Hommedieu for her encouragement and advice; (b) Dr. Ross Moreton for his patience and guidance; and (c) Dr. Warren Groff for his advice, encouragement, and superb teaching. Dr. Groff is a role model of a teacher/scholar.

Thanks should also go to my colleagues at South Campus for their support of my research projects. A special thanks goes to Joseph Gavin, English Department, for his assistance in editing and to Linda Ohnhaus, South Campus Library, for her patience and diligence in locating references. Most of all I thank my wife, Ruth Ann, for her understanding, support, and loving patience as I worked toward the completion of a dream.

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March, 1997

Today's technology requires the electronics technician to have higher level skills than any time in the past. However, time and location limitations make acquiring skills difficult. The purpose of this project was to develop a strategic plan for student access to the Electronic Engineering Technology Program from any college site.

The research questions for this project were as follows:

1. How can the newer electronic communication technologies be used to provide a virtual learning community in the Electronic Engineering Technology Program?

2. What is the appropriate strategic plan: (a) to offer a multisite Electronic Engineering Technology Program by network communication, (b) to establish the needed coordination between high school programs, the community college, and transfer institutions, and (c) to develop an evaluation plan?

3. What changes in the existing objectives of the Electronic Engineering Technology Program will a multisite networked program require to achieve the knowledge and skill levels expected by industry?

The development problem solving methodology was used in this project. Two primary techniques were used: data analysis and plan development. Data analysis included a literature review, interviews with program coordinators of existing distance learning programs in engineering technology, interviews with the directors of the computer centers at each college site, and a review of the necessary hardware and software for the project.

Two advisory group meetings were held to review the concept of the plan with the industrial and educational members. Their comments were incorporated into a the strategic plan. This plan was reviewed again by the advisory group, the dean of the engineering and technologies division, the director of business and industry programs and the vice-president of academic affairs.

The results of this project led to eleven conclusions in four categories: classroom model (3), faculty (3), hardware and software (3), and laboratory component (2). The classroom model conclusions include (a) that computer networks can provide a classroom model based on active student involvement; (b) the Internet and the World Wide Web can provide for distance learning; and (c) a constructivist approach, using real world applications, is applicable to adult learning. The faculty conclusions include (a) the college faculty have necessary computer and networking skills, (b) the college faculty can adapt to distance learning formats, and (c) reasonable time to develop a distance learning course is equal to the time required to offer the course. The hardware and software conclusions include (a) multimedia based computer systems and support software are available to provide asynchronous and synchronous distance learning; (b) the college has an installed infrastructure that can support a computer based distance learning initiative; and (c) with a digital information exchange for assignments, homework, and quizzes, delays in student feedback can be reduced. The laboratory component conclusions include (a) simulation software is a useful learning aid to provide touchstone learning experiences, and (b) there is no agreement on the skill set that can be taught with virtual reality laboratories.

Recommendations resulting from this project are (a) the vision statement of the plan should be adopted by the college; (b) the college faculty and administration should work together to secure necessary external funding to support the plan; (c) the Institutional Research office should assist in using the network for formative evaluation; (d) the plan should be disseminated to all department heads in the college, the educational technology committee, and the wider two-year college community; (e) research should be performed on the role of simulation software and virtual reality in training technicians; and (f) research should determine if the digital scanner will provide effective feedback to allow students to perform in an unsupervised environment equal to those in a supervised environment.

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Chapter 1

INTRODUCTION

Nature of the Problem

Today's worker must be able to perform in a rapidly changing environment. Nowhere is this more evident than in electronics. In recent years the complexity of integrated circuits has doubled every 18 months (Grove, 1995). To succeed, the individual must have higher skills than at any time in the past. "The most desirable quality in tomorrow's workers will be the ability to learn and adapt to changing conditions" (Community College of Allegheny County, 1995a, p. 22). Today's technician must be a High Performance Worker and Learner (HPWL) to perform modern tasks and to continuously learn the new technology for tomorrow. Although the outlook for career opportunities is good, the student wishing to enter the electronic engineering technology field finds that the program availability is limited and that the times and locations may be restrictive.

Program Availability

The program reductions at the Community College of Allegheny County (CCAC) have been made primarily on economic considerations of the individual campuses. For example, the credit enrollments at CCAC have declined by 9.6% between 1993 and 1994 (Community College of Allegheny County, 1994b). With these reduced enrollments, it has not been economically feasible to offer complete technical programs at all sites. The recent reduction in enrollment is already making it difficult to have enough students in a class to meet the financial requirements of offering a course. The executive dean of South Campus has set a goal of 14 students per section for classes. Many technical programs have enrollments below this goal. Low enrollment is a particular problem in upper level courses. When the other campuses of CCAC eliminated their electrical offerings, the intent was to direct students to the South Campus program.

Time and Location Problems

The large size of the county makes travel between campuses difficult. Pittsburgh and Allegheny County have a very old road system. Many metropolitan areas have high speed roads criss-crossing the area or beltways allowing rapid travel. Allegheny County, however, relies on many two lane city streets for access around the county (Firth, 1990). In recent years the volume of traffic has overloaded these roads. Some students report spending three hours daily in commute time. This is nearly the same as the in-class time. Academic advisors at one campus have stated that when informed of the need to travel, students are either not enrolling or selecting a different major.

In reaching the goal of becoming a HPWL, the student must first learn the basics of the field. The combination of declining enrollments, concerns over cost containment in educational programs, and the increasing difficulty for students to reach the campus are problems that restrict the student from reaching that goal. This project proposed a new delivery system for the Electronic Engineering Technology (EET) Program that addresses these problems and produces for the electonics industry a high performance worker and learner.

Purpose of the Project

The purpose of this project was to develop a strategic plan for student access from any college site to the EET Program. To minimize geographical restrictions, attention was directed to the creation of a virtual learning community. Through the use of modern electronic communications, students at different campuses can interact, communicate, and work collaboratively with students at different locations. A technical infrastructure is forming at CCAC to address this problem. This technical infrastructure allows the use of video, e-mail, and networking across the college. With computer networks the college can meet the challenge to provide the education to the student at any time and at any place. By utilizing the traditional, local, campus-based courses in general education with network-delivered technical courses, this project developed a strategic plan for students at CCAC to pursue the associate degree in electronic engineering technology with considerable study at their local campus.

Background and Significance

Community College of Allegheny County

Description of the College

The Community College of Allegheny County (CCAC) is a multicampus comprehensive community college located in the Pittsburgh, Pennsylvania, metropolitan area. The college's mission statement commits the college to "... providing an accessible and affordable college education, greater educational opportunity, ... and quality instruction in its classrooms" (Community College of Allegheny County, 1994a, p. 2). The college offers a comprehensive program including vocational, technical, career, developmental and transfer educational programs. The complete mission statement is found in Appendix A.

Campus Geography

CCAC has four campuses located throughout the county. The North Campus serves the northern and western suburbs of Allegheny County. It is the newest of the campuses. The Allegheny Campus is located in the city of Pittsburgh. It is situated across the Allegheny River from the downtown area in the city's North Side neighborhood. It is the oldest of the campuses opening in 1966. The Boyce Campus is located in the community of Monroeville, some 15 miles east of Pittsburgh. It serves the eastern portion of the county. The campus began in 1966. The South Campus is located on a 200 acre site in the community of West Mifflin in southern Allegheny County. The South Campus began in 1967 in a nearby community in rented facilities and moved to its present location in 1973. Appendix B contains a map of the location and relative distances between each campus.

College Reorganization

During the spring term of 1996, the president of the college announced a complete reorganization of the administrative and academic structure of the college. This reorganization was designed to emphasize that CCAC is a single college with multiple delivery sites. Under this new structure all disciplines, such as engineering technology, are arranged across the college under a single division with a single college administrator responsible for the discipline at all sites. This reduces the number of divisions from three to five per campus to eight in the college. Appendix C shows the new structure of the divisions. The EET program is within the Engineering and Technologies Division. The president also announced that the college has received authorization by the Middle States Association of Colleges and Schools for the college to be treated as one school. This means that the campuses will not be individually accredited. One effect of this new structure is the scheduling of courses and programs. The new divisions are attempting to coordinate the schedule of classes for a single college wide publication in Spring 1997. The EET program as proposed by this project will be a college-wide program.

Demographics of Allegheny County

The college has completed an environmental scan process providing demographic information related to the Allegheny County area. The report presents information on both the county and its largest city, Pittsburgh. The report characterizes Pittsburgh as one of the most livable cities in the nation (Community College of Allegheny County, 1995a). Pittsburgh and Allegheny County have long been associated with the production of steel. Because of the number of mills and foundries that were located in the southern portion of the county, this region is known as the "Steel Valley." The decline of the steel industry in the 1970s and 1980s had a devastating effect on the economy of the region (Hoerr, 1988). In the 20 years from 1970 to 1990, the area lost 150,000 jobs with 90,000 of these directly in the metals industry. A bright sign is that from 1987 to 1992 the region has had a job growth of 6.82% (Community College of Allegheny County, 1995a, p. 23). These new jobs have often been in lower paying industries, and insufficient to replace the jobs lost in manufacturing (Community College of Allegheny County, 1995a).

During this same period, the population of the county has declined. The county lost 7.8% from 1980 to 1990. In terms of the college enrollment there has been a decline from 1990 to 1995. In the 1993-94 school year the credit enrollment dropped 9.6% from the previous year. Although college administrators believe the enrollment drop is related to the population changes, the number of variables involved make an exact explanation impossible (Community College of Allegheny County, 1994b). The population of the county is predicted to grow by about 1% per year over the next 20 years. In addition, from 1994 through 2004, the number of high school graduates in Allegheny County is expected to increase by 19.55% (Community College of Allegheny County, 1995a).

College Wide Curriculum

The college offers a variety of career and transfer programs through its four campuses. Some programs, such as Nursing, are offered at all campus sites. Others are available at only one location. The location of these programs is more a result of campus interest rather than any central planning operation. The college has only in the last few years begun a systematic strategic planning process. Until 1987, each campus had a unique catalog. Many courses had different descriptions depending on the campus. In 1987, a single catalog was initiated, and agreement on a single course description for each course across the college was developed. By June 1996, each course was supported by a single college wide syllabus. One proposed outcome of this consistency is to allow students to move freely between campuses. The belief is that this flexibility will allow the student to move between campuses in response to specialized programs. In current practice, because of geography and transportation considerations, this does not happen very often. In the past, each campus prepared its own unique schedule without consideration of the activities of other campuses. This led to conflicts preventing students from crossing campuses. The result was increased student travel or withdrawal from the specialized program.

Examples of these specialized programs are the Automotive Technology at the North Campus; the Radiologic Technologist, Physical Therapist and Occupational Therapist Assistant Programs at Boyce Campus; the Nuclear Medicine Technologist, Dietetics Technician and Chef's Apprentice Programs at Allegheny Campus; and Electronic Engineering Technology, Microcomputer Electronics Technology, Pharmacy Technology, and Robotics and Automated Systems Technology at South Campus.

Electrical Related Programs

Prior to 1987, each campus offered programs related to electrical engineering technology. Since 1987, the Allegheny Campus has eliminated all engineering technology programs. The North and Boyce campuses have closed their programs in electronics and electrical engineering technology. These closings were made in response to enrollment declines and to conserve financial resources by limiting program offerings. At present, the South Campus is the only campus offering a program in electronic engineering technology.

Despite the program reductions at CCAC, a survey of 2,146 two-year colleges showed that the associates in engineering technology was the fourth most frequently awarded degree nationally (Community College of Allegheny County, 1995a). Also, two surveys in 1995 show electrical engineering technology to be the most popular technical program offered by community colleges (Burton & Celebuski, 1995; Cunningham, 1995). Also, the CCAC (1993) document, Job Outlook 2005, predicts a 28% growth in jobs for engineering technicians and a 34% growth for electrical and electronic engineers. Computer engineering is the hottest job in America with a 112% growth rate (Marable, 1995). These are all careers that students can pursue through the Electronic Engineering Technology (EET) Program at South Campus.

The EET Program is one of several programs offered by South Campus. The department has articulation agreements with both Point Park College and California University of Pennsylvania, two schools in the area offering baccalaureate degree programs in EET. A complete list of all programs in the Engineering Technology Department is in Appendix D. All of these programs follow a common core of courses. This core is taken by all technology students. The format and the core sequence was developed under a funded project from 1976 to 1980. Appendix E contains a listing of the courses within the engineering technology core and the specialized courses required for the Electronic Engineering Technology major. Over the years the content of the courses has changed to reflect changes in the technology, suggestions of industrial advisors, and to incorporate new pedagogy. In 1990, the Department of Engineering Technology began a process of incorporation of computers into all technology programs. As part of that effort all computers in the department are connected to a network. The course Technical Computing, SET105, prepares the technology student to use software packages common to the engineering environment. The programs commonly used by South Campus students are Microsoft Office, Autocad, Mathcad, and electronic mail, or e-mail. A recent survey of two year colleges that are offering engineering technology show these software packages to be the most common (Cunningham, 1995). The students have access to the network through 60 workstations located within the engineering department laboratories and the campus computer center. With the easy availability of the network, students and faculty have developed considerable confidence and competency in working on-line. Through electronic mail, students are receiving and returning assignments, and communicating with peers and instructors. Future plans call for connection of the network to the Internet.

A New Classroom Model

There is a growing need to provide education to students at their location (Campbell, 1995). Through the use of technology, classroom time can be more efficient with students achieving equal or better performance. By providing a variety of learning styles, student success can be improved. One means of providing a variety of learning styles is through the use of media technology. Computer networks can provide, at any time or place, a cost effective education.

Current course delivery models require the students and the instructor to come together at a common location and at exactly the same time. However, the new technologies offer an opportunity to establish a new paradigm for the classroom. Nicholas Negroponte (1995), Director of the MIT Media Lab, states that in the future we must move bits not atoms. The current classroom model can be described as moving atoms to a common place. With modern computer networks, the movement of digital bits can replace the movement of people so that many knowledge-based activities can be accomplished independent of the location. Also, computer networks can provide interactivity at any time. Jones International through the Mind Extension University and the International University College is demonstrating that technology can reduce the barriers to education of time and geography (Jones, 1995). Through today's networks, it is possible for students and faculty at multiple locations to exchange text, pictures, and audio. In producing this new paradigm of the classroom, several factors needed to be considered. The factors considered in this project were (a) computer assisted instruction effectiveness, (b) multimedia and hypermedia, (c) the Internet and the World Wide Web, (d) distance education, (e) computer hardware, (f) the concerns of the faculty, and (g) the planning necessary to produce the new classroom model.

Research Questions

The following research questions were addressed by this project:

1. How can the newer electronic communication technologies be used to provide a virtual learning community in the Electronic Engineering Technology Program?

2. What is the appropriate strategic plan (a) to offer a multisite Electronic Engineering Technology Program by network communication; (b) to establish the needed coordination between high school programs, the community college, and transfer institutions; and (c) to develop an evaluation plan?

3. What changes in the existing objectives of the Electronic Engineering Technology Program will a multisite networked program require to achieve the knowledge and skill levels expected by industry?

Definition of Terms

The following terms have specific definitions in relationship to this project.

Asynchronous distance learning (ADC). This term applies to any distance educational delivery system that allows the student to engage in the learning activity at anytime or place.

Browser. A browser is a program designed to retrieve and display hypermedia files from either local or remote sources.

Computer-assisted instruction (CAI). This term refers to any instruction that is presented using the computer for all or part of the learning activity.

Computer-mediated communication (CMC). The term refers to an integrated use of computer techniques to deliver instruction.

Electronic mail (e-mail). E-mail is a message sending and receiving system used for rapid, text-based, individual communication over local networks and the Internet.

Gantt chart. A Gantt chart is a graphical representation of the anticipated sequence and duration of events in a project.

High performance worker learner (HPWL). The high performance worker learner is a person having both the basic skills in a chosen field and the ability to learn and adjust to changing conditions within the field.

Hypermedia. The term hypermedia relates to the non-sequential manner in which a user may access information on both local and remote connected computers.

Internet. The Internet is the system of thousands of interconnected computers world-wide.

Local Area Network (LAN). The term LAN is an acronym for local area network, and refers to a school or company-based network of computers. The systems are usually localized to a building or campus.

Macintosh system (MAC). The Macintosh computer system is one of the oldest windows based computer systems. It is available on systems manufactured by the Apple computer Company.

Meta-analysis. This is a report based on a statistical analysis of the summary findings of many empirical studies (Houston, 1990).

Modem. A modem is a device that connects the computer to the telephone system. Using the appropriate software, it allows the computer user to connect to other computer systems and exchange multimedia files.

Multimedia. Multimedia is the use of two or more media techniques such as text, graphics, sound, video and animation to convey information.

Network. A network is an interconnection of two or more computers for exchange of data files.

PC system. A PC system is a computer using the 86 series microprocessor and a Microsoft operating system.

Strategic planning. Strategic planning is a proactive process by which an organization develops a vision of its future and the steps necessary to achieve that future.

SWOT chart. A chart that is used to record the strengths, weaknesses, opportunities, and threats present in a given situation or project.

Tech Prep. Tech Prep is a program offered by the high schools and the community college to increase the preparation of high school graduates to enter technical programs at the college.

Virtual learning community. A virtual learning community is established by a network-based collection of users relying on computers to communicate, collaborate and learn in both a formal and informal setting.

Wide Area Network (WAN). The term WAN is an acronym for wide area network. A WAN is established by connecting several local area networks.

Windows. Windows is an operating system produced by the Microsoft Corporation. The Windows system allows multimedia based interaction with the computer.

World Wide Web (WWW). The World Wide Web, or just Web, is a program that allows multiple users to access information on a computer in a hypermedia environment. A Web may be established either on a LAN or the Internet.

Chapter 2

REVIEW OF LITERATURE

The Learning Environment

The Information Explosion

The rapid advance of technology has increased the need to provide the student with the ability to learn new material in a continuous manner. It is estimated that by the year 2000 there will be so much information electronic engineers must know, it will be impossible for them to learn it all (Brown, A., 1995). "As more and more information is generated, specialists and technicians find that the information they possess becomes more quickly out dated" (Brown, A., 1995, p. 2). This information explosion produces a double problem for the technical worker today. First, more information to learn makes entry into the field difficult, and second, over the past five yearsthese hard earned skills and knowledge have a short usable life time. This results in the need to continually learn. To gain entry into a technical field, the potential worker must take responsibility to receive the necessary education. However, recent surveys have shown more companies are expecting even existing employees to assume responsibility to maintain their skills. "Fully 45 percent of human resource managers in a recent survey say that skills and competency development is up to the individual" ("Skills Development," 1996, p. 1). The high performance learner worker must be able to access and process new information through a variety of sources. For the HPWL, maintaining competencies is a life-long activity.

The Cognitive Learning Paradigm

"You cannot teach anybody anything. All you can do as a teacher is to make it easier for your students to learn" (Redish, 1994, p. 798). This statement summarizes in a rather straight forward manner that what is important is the learning accomplished by the student. The literature of cognitive studies suggests some basic principles related to learning. By applying the findings of cognitive research, the teacher can make the learning process more efficient and easier for the student to deal with the barrage of information. Redish (1994) delineates four of these principles: first, that we organize our knowledge into mental models; second, that it is easy to learn what matches our existing mental model; third, that it is hard to change our existing model; and fourth, that every student has a different model for the same information. This constructivist approach to learning requires that the students must build their own mental models. The teacher telling the student something will usually not result in a change or improvement in the student's mental model. One of the most important strategies the teacher can provide to the student is the "touchstone" problem. When this type of situation or problem is understood and becomes part of the student's mental model, the student will return to it often in understanding new material. With a few well understood ideas and associated touchstone problems, the student will be able to adapt new information much easier (Redish, 1994).

In applying the principles of cognitive studies to technical education there are specific techniques and strategies to assist the instructor to design efficient learning environments. Cognitive learning theory states that students construct learning through social interactions and experiences based on what they currently know. Johnson and Thomas (1994) hold that "...the cognitive view requires a stimulating learning environment in which students are active participants in planning, implementing, and evaluating teaching and learning" (p. 39-40). Key to this approach is the use of flexible, active, discovery activities to develop complex thinking skills. Johnson and Thomas (1994) provide six instructional principles and strategies below to promote cognitive learning.

1. Reduce memory load. The student must be taught how to use notes, outlines, and concept maps to promote organizing information into chunks.

2. Activate existing knowledge structures. Any new information presented must build on the existing knowledge of students. The use of analogies and metaphors help to place information in existing context.

3. Representation of new knowledge. Place new knowledge to be learned into a purposeful context and encourage the use of contrast, multiple representations, and mnemonic clues.

4. Encourage deep thinking. Use activities that allow the student to reflect on the new material. The student can accomplish this task by talking with others, engaging in peer tutoring, or working with laboratory experiments and computer-based simulations that demonstrate the key information.

5. Enhance Cognitive control processes. It is important that the student learn to learn. The direct teaching of cognitive skills such as reciprocal teaching or thinking aloud will allow students to apply these techniques in less structured situations after formal schooling is complete.

6. Support the use and transfer of knowledge and skills. All activities should have real world applications with increasing complexity as the students progress. Each activity should lead the student toward more autonomy and less dependence on external support.

A school or program following these guidelines would be using what Barr and Tagg (1995) called a Learning Paradigm. Under this paradigm "... a college's purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge themselves ..." (p. 15). The prevailing paradigm in schools today is an Instructional Paradigm. In this paradigm, knowledge is broken into defined departments, credit hour courses, and time frames. The responsibility for learning is with the students. In the Learning Paradigm both teachers and students share responsibility for learning. This new paradigm goes from the lecturer-student model to one that is more of a coach-student model. While reducing the importance of lecture, they encourage "... what ever approaches serve best to prompt learning of particular knowledge by particular students" (Barr & Tagg, 1995, p. 14).

Although, Barr and Tagg (1995) believe that the model holds the promise of providing a means of increasing the productivity and outreach of colleges while holding down costs, they offer no specific plans. Distance learning and computer assisted instruction have been suggested as techniques to improve instruction. The use of these techniques would be consistent with the Learning Paradigm.

Computer Applications to Education

Computer Assisted Instruction Effectiveness

The computer has been used to assist in education for many years, and its effectiveness as a learning tool has been studied. Liao (1992) conducted a meta-analysis of 31 studies related to computer-assisted instruction (CAI). Liao found that "... CAI has moderately positive effects on student cognitive outcomes" (Liao, 1992, p. 376). With appropriate software, cognitive skills such as reasoning, logical thinking and planning, and general problem-solving skills can be improved by CAI. In another meta-analysis of 200 studies, Kulik and Kulik (1987) found that students generally learned more in less time in classes that featured computer-based instruction. In addition, the time requirement for instruction was reduced by up to 32%. One suggestion that has been made to explain the positive results demonstrated by computer-based instruction is that the novelty of the computer contributed to the learning and that after the novelty wears off the positive benefits will disappear. However, an analysis of both long term and short term projects using CAI show improvements in instruction (Kulik, 1985).

Many of the studies above are related to school-aged children. A study of computer assisted instruction with adult drafting and design professionals found the computer instruction to be an effective learning environment. With adults, however, four criteria were identified as necessary for them to view the training situation favorably. The criteria were (a) the material must be related to the job, (b) the training must be done on-the-job, (c) the computer must have an easy to use interface, and (d) the adult learner must feel in control of the instruction, both for pace and for entry/exit points (Shaw, 1992). These criteria for adult training are consistent with the basic features of adult education. Adults respond best to education when it (a) is related to their work, (b) includes prior learning, and (c) allows immediate feedback through hands-on activities using the new knowledge (Knowles, 1984).

Multimedia Technology

What is multimedia? One definition is "... anything that uses more than one way to present information" (Tway, 1992, p. 5). When focused onto computer applications, multimedia involves programs that use any two or more media techniques such as video, text, graphics, sound, and animation (Galbreath, 1994). Although computers have been used in education for many years, it was not until the introduction of microcomputers in the late seventies that computer-based multimedia became possible. In 1977, IBM introduced an interactive laserdisk system. Between 1977 and 1984 advances in the multimedia industry were driven by advances in the video game industry. In 1984, the Macintosh computer introduced many of the basic tools needed for multimedia. In 1985, the introduction of the Intel 386 microcomputer chip allowed multimedia on the IBM PC and similar systems. With the 386 systems, Microsoft offered the Windows 1.0 operating system. Although the Windows system had many of the features necessary for multimedia, it wasn't until the introduction in 1990 of the newer Windows 3.0 that the PC systems were competitive with the Macintosh systems (Calica & Newson, 1996). Today, two systems, the Windows based PC and the Macintosh, dominate educational multimedia. In technical education at the two-year college level, a recent survey reported that PC systems were available to 95% of the technical students, while MAC systems were available to only 30% of the technical students (Cunningham, 1995). Galbreath sums up the reason multimedia has attracted so much interest in education. "The bottom line is that multimedia technology can aid in the assimilation of information. Multimedia technology can aid student's ability to receive, process, and act on the tremendous amount of information presented to them in their school years" (Galbreath, 1994, p. 18).

Popular software packages for use in education are Action! and Director by Macromedia, Toolbook by Asymetrix, and Oracle Media Objects. These packages provide excellent software environments to produce highly visual, colorful, graphic-rich, interactive multimedia. "The visualization of information can be extremely beneficial to the present generation of American students who are visually oriented ..." (Ferguson, 1994, p. 49).

One disadvantage in these systems is the time required for training in their use before an instructor can develop classroom materials. Also, these programs are expensive, ranging from $200 to over $1000 dollars for a single user license (Elia, 1996; Lynch, 1995). In addition to the training and acquisition cost of these programs, considerable time is required to develop programs for use in class. Currently many instructors are using multimedia to enrich lecture presentations. Presentation programs such as Power Point and Harvard Graphics allow the instructor to prepare visual slides that can be displayed on large monitors or screens. These types of presentations tend to be instructor controlled and linear in sequence.

CCAC initiated a project in 1993-94 to train faculty in the use of Toolbook. Eight faculty, two per campus, were given release time to develop materials for a class. Although some materials were developed during that project, the faculty report that, without release time, it is difficult to find the time to prepare new materials.

Hypermedia

Where multimedia refers to the presentation of information by the use of many different techniques, hypermedia refers to the way these different media techniques are selected within the total program (Tway, 1992). For example, within a text document a certain word, called a hot-word, will allow other text, graphics, or sound to be presented on demand. This is usually accomplished by using the computer mouse and screen cursor to point to the word and by clicking a button on the mouse activating the desired media. The new document or graphic is said to be linked or hyperlinked to the original document. The software program used to develop the presentation will determine the exact underlying structure needed to produce this hyperlinking. In addition to the hot-word technique, a graphic picture or portion of a picture could be used as the hyperlinked field. This type of interface is very intuitive. If additional information is needed, the user only needs to "point and click."

Another important feature of hypermedia is that it is non-linear. When used by individuals, the path through the material is controlled by the user. The amount and sequence of assistance is dependent on the user's rate of learning. In a training and educational environment, those users who have more experience can proceed through the training quickly. The less experienced user can link to as much additional information as necessary (Tway, 1992). Although this interactive feature of hypermedia provides a more intensive learning environment, it does allow the learner more control over the pace of instruction.

Industry has turned to multimedia aand computer-based training as a cost effective way to train a large number of people in a consistent way. Sales of multimedia CD-ROM software to business and industry in the first quarter of 1995 was $53 million dollars, a 246% increase over the same quarter in 1994 (Morri, 1995). Business and industry is making this investment because the use of user controlled interactive multimedia training has proven itself to be cost effective (Waldman, 1995). Waldman (1995) points out that although the cost of developing interactive lessons is more than the live class room, this cost is offset by the reduction of time to acquire competency and the increased flexibility of delivery.

The use of interactive materials is not limited to industry; colleges are also moving into the use of interactive software. The technical colleges of Wisconsin are using a video disk based multimedia system to teach math and algebra skills. The video disk is controlled by a computer. The student works at the computer in a self-paced, interactive environment. Testing, as well as instruction, is presented by the system. All records of achievement are stored by the computer. Wisconsin schools have reported increased student satisfaction with the basic math and algebra courses and increased student retention (Brumm, 1995).

Virtual Reality and Simulation Applications

The term "virtual reality" has received a great deal of attention in both the popular press and education. Virtual reality (VR) is a form of human-computer interaction involving an artificially created and computer controlled environment. Within this environment the individual must operate within parameters set by the program designer and controlled by the computer program. In a VR environment the imagination, not physical laws, control what occurs. To be effective a VR environment needs both software and hardware that allow the user to be immersed in the scenario with defined navigation aids and the ability to manipulate portions of the environment (Helsel, 1992). The more elaborate VR systems consist of a head mounted display, headphones that create a three dimensional sound field, and some means of monitoring head, hand, and body motions. This information is used by a computer to present a visually graphic and audio rich environment. As the individual moves in response to the visual and audio stimulation, the computer presents new appropriate displays (Bailey, 1994).

The use of such elaborate systems in the classrooms is not practical at present. However, a less expensive approach can be taken with a multimedia based computer having a CD-ROM player, and a modem or network connection (Moore, 1992). Using this "low end" VR system, it is possible to simulate a great many real world events for the student to experience. Such simulation or modeling can help the student to develop the mental models necessary to understand the real world (Andaloro, Donzelli, & Sperandeo-Mineo, 1991).

New computer languages and software are available to allow the creation of simple VR environments. These environments can be made to simulate real world events that are either too dangerous or too expensive to carry out in a physical laboratory. These techniques can be applied to provide complex electronic experiments that simulate the actual behavior of lab components. These virtual reality laboratory (VRL) experiments have been shown to improve student learning. At Vanderbilt University a series of simulations of standard experiments were developed to allow the student to gain VRL experience in preparation for the actual experiment (Mosterman, Bourne, Brodersen, & Campbell, 1995). One of the first programs used to simulate electronic circuits is called pSpice. A version of this program is available free to students and schools. A recent survey of schools offering engineering technology shows 56% of the EET programs used pSpice in their curriculum (Cunningham, 1995). The program Electronic Workbench provides a simulation of any experiment in the standard electronics textbooks. The manufacturer of the program provides a student version of the software with disks customized to text books (Interactive Image Technologies, Ltd., 1995). George Brown University and Aims Community College have both adopted this program to provide all or part of the laboratory work to their distance learning students in electronics (C. Simpson, personal communication, April 14, 1996; L. Scott, personal communication, July 23, 1996). Northern Iowa Community College recently offered a distance learning course in electrical concepts to seven high schools over a fiber optic network. The Electronic Workbench program was used to allow students to practice with circuits before building them in the laboratory. The instructor felt the students had good transfer of what was learned in simulation to the actual equipment ("Electronics Workbench Enhances Distance Education," 1995-96). These schools have demonstrated that the VRL approach can be used in a distance learning environment and provide good transfer to real-world skills.

The Internet and the World Wide Web

"In the not-too-distant future, those schools not actively involved in using the Internet and other PC-based electronic communications tools in the classroom will put their students at a tremendous disadvantage, one that will be difficult to overcome" (Gingrich, 1995, p. 39). The Internet began in 1969 with the formation of the ARPANET. This network consisted of several Department of Defense research sites that needed to share information. Over the years more research sites were connected to this network. In 1986, the National Science Foundation established a network (NSFNET) to allow researchers and scholars to share in the benefits of network information exchanges. In 1990, the ARPANET was closed, but all operations were carried by thousands of interconnected computers. This collection of computer networks is called the Internet. The Internet is not owned by any one agency or group, but exists through the mutual cooperation of all participants (LaQuey & Ryer, 1993).

The World Wide Web was born in 1989 as a system for file sharing by a group of high energy physicists at the CERN laboratory in Geneva, Switzerland. The purpose was to allow researchers world wide to quickly share information and data over the Internet. Initially the Web was a text based system, but in 1993, the National Center for Supercomputing Applications (NCSA) introduced a graphically oriented program to handle all the activities of the Web. This program, called Mosaic, was written for a variety of different operating systems such as Windows, Macintosh, and Unix. Mosaic is a free program, and first of a group of programs called browsers. Some typical commercial browsers are Netscape, Internet Explorer, and commercial versions of Mosaic. These Web browsers allow the display of text, video, graphics, and audio. This provides a full range of multimedia presentation tools in a hypermedia environment. Mosaic was very easy to use and resulted in more people beginning to use the Web

(Fox & Downing, 1995). The growth of the Web has been rapid. In June of 1993 there were only 130 sites, but by June of 1995 there were 38,796 sites world wide (Bournellis, 1995). The Web activity has spread from the research community to all areas of the culture. A study by Jupiter Communications found that nearly four million children under the age of 18 have web access. Additionally, 967,000 of these children are regular users of the Web (Murphy, 1995). Recent statistics on the Web suggest that by the year 2000 the median age of the Internet user will be 15 years old (Conway, 1995). This activity is attracting commercial groups like the Walt Disney Company, Nickelodeon, and Sports Illustrated to provide content to the Web (Murphy, 1995). However, the Web, like the Internet, is uncontrolled in content. Anyone, anywhere, can produce and make available any information desired. The specific content for that information can be on the local hard drive, or CD-ROM, or from any Internet connected computer in the world. As in any publishing activity, not all information content is suitable for all age levels, and abuse can and has occurred. Some groups are calling for controls to be placed on the information available on the Web and Internet. The open nature of the Internet may change in the near future. Two factors are at work to effect content control of the Internet. First, new federal legislation is pending to prohibit the transmission of obscene materials, and second, new Web browsers are being produced that will allow screening of objectionable materials (Van Name & Catchings, 1996; Wang, 1995).

Despite these difficulties, many companies and schools have turned to the Web as a teaching tool. Some of the advantages of using the Web are (a) keeping materials current is as easy as changing one central file, (b) distribution costs are lower than CD-ROM or disks and tape, and (c) the Web lends itself to a self-paced distance learning mode. In addition to the content problems mentioned above, the Web has other disadvantages for a training tool. These are (a) the hypermedia structure can allow the student to get off the subject, (b) too much hyperlinking can make the training confusing, and (c) some students dislike not having the personal contact of an instructor (Brown, J., 1995).

Hypertext Markup Language

The primary vehicle that makes the World Wide Web so universal is a language that is generic to the computer system on which it is to be run. The hypertext markup language (HTML) is a series of commands that are imbedded in the text to be presented. These commands are not seen by the viewer. The commands direct the browser how to display the document. The browser will take whatever action is needed to display the file on the specific computer. This allows files written on a Macintosh to be displayed on an IBM even though computer formats are not compatible. Although the HTML language has many commands, as few as 12 can be used to provide documents with attractive text, and graphics display. This ease of use has helped to drive the adoption of the Web technology. With HTML the programmer can access files that are text, graphics, audio and video on either the local hard drive, a CD-ROM, or the Internet (Guenette &

Gustavson, 1996). Many of the newer versions of multimedia development program are beginning to support the Web and the HTML format. The recent release of Asymetrix Toolbook II will provide multimedia lessons in HTML ready to be read by any browser. This eliminates the need to provide a special multimedia player program to the person receiving the lesson (Asymetrix presentation, July 30, 1996).

Distance Learning

Distance Education

> Distance learning will inevitably become a major component of our system of higher education because of pressures now being placed on the system. First, demand for higher education and advanced training is increasing at a pace that is straining the system's ability to respond. The transformation of the workplace caused by the information technology and the emergence of global economics competition has placed a premium on higher levels of education and training, which for most adults, will be met within the context of the nation's system of colleges and universities. (Doucette, 1993, p. vii)

Since the 1800's, schools have been involved with distance education. People living in rural America could receive correspondence courses by mail (Lever, 1993). Today, rather than physical separation, it is time demands and constraints that lead adults to distance learning programs (Baird & Monson, 1992). This time requirement can be used to classify distance learning into two categories. First, synchronous distance learning (SDL) refers to any delivery method that requires the students to be involved in the learning activity at a specified time of day. Distance learning examples of this type of delivery are interactive video conferences, electronic conferences and telephone audio conferences. With these techniques, the students can be geographically scattered, but they are scheduled at the same time. Second, asynchronous distance learning (ADL) refers to any delivery system that allows the students to engage in the learning activity at any time or place. With ADL it becomes possible for a single student to engage in the class activity. The earliest correspondence courses would fit this description, as would video tape courses and some computer-based courses.

In addition to the postal service, modern distance learning uses many delivery systems and modes. Some of the modes used are print, audio, video, telephone, and computer-based approaches. Each of these delivery modes has advantages and disadvantages.

Print. Print media has been used for years. Using textbooks, study guides, and assignment sheets is both inexpensive and reliable. However, the long time delays of the postal service results in a sense of isolation on the part of the learner. Also, since the only media used is print, little attention is given to different learning styles.

Audio. Audio methods used for distance learning are radio and tape recording. These methods appeal to those students with an aural learning style. The telephone has introduced an interactive feature to the use of audio in distance learning. With the telephone, the time response for feed back is instant and an improvement over mailed responses.

Video. Video is a rich medium for the delivery of instruction. This medium mixes visual images with audio. Video may be delivered by broadcast, cable or video tape. These methods usually lack interactivity, although two-way live video conferencing has become more popular. If broadcast and cable are involved, video may be expensive. Two-way video requires a substantial amount of computer hardware for video equipment for production and reception. With distribution by mail, video tape is the least expensive form of video (Lever, 1993).

Computer-based techniques

The introduction of the microcomputer has produced several new techniques useful in distance education. Electronic mail, or e-mail, has made communication between students and faculty much quicker. Electronic bulletin board systems provide a convenient method of distributing assignments and course materials. These bulletin boards can operate from a network or through modems. In many respects this represents a computer-based version of the asynchronous print medium, without the time delay associated with the postal system (Lever, 1993). A modification of the bulletin board system allows posting of responses in an interactive manner. These electronic conferences may be held between two people or a large group. In 1983, Nova Southeastern University pioneered the use of this delivery mode through the use of the electronic classroom. This technique allows the instructor a 16 line screen to present text-based information. Students may respond or ask questions in a four line lower section of the screen (Kontos, Mizell, & Hesser, 1995). The newest computer based technique is interactive computer-based video conferencing (Conway, 1995). This medium provides visual and audio contact between conferees, with the rapid exchange of both sound and graphic supportive information. A major disadvantage of this technique is the cost of equipment and communication lines (Marshak, 1993; Rojas & Anderson, 1994).

Computer-mediated Communication

The term computer-mediated communication (CMC) refers to an integrated use of several computer techniques to deliver instruction. Typical applications that could be used are electronic mail, individual or group conferences, file management, simulations, tutorials, and drill and practice. A great deal of the work in CMC is text based. The dependance on text provides the advantages of allowing all to participate regardless of physical limitations or a personal reticence to speak in a group. It requires time for students to become skilled with expressing themselves in writing and the text medium is slower than speech (Berge & Collins, 1995).

One of the newest types of CMC system is the World Wide Web. Over the past two years this technology has grown rapidly (Bournellis, 1995). The Web can be used to produce a "Virtual Classroom Model" of delivery. In this model the Web is used to provide assignments, needed instruction, basic research information for the assignments, simulations, and communications. The basic tools of the Web can be used to provide an ADL environment. Assignments, configured as pages, may be printed or copied to disk by the student. Since the Web is interactive, the benefits of computer aided instruction and full hypermedia can be employed in delivery of the lesson. This is all possible in an asynchronous mode. Students can use e-mail to send questions to the instructor and receive answers. In addition to asynchronous applications, Web technology is able to provide synchronous audio and video conferencing (Saltzberg & Polyson, 1995).

Computer Hardware

To provide a computer-based educational environment requires careful consideration of the necessary computer equipment. Two topics should be examined: (a) the need for student access to a campus network and the Internet, and (b) the components of a student computer system. In addition, a review of existing computer-based distance education programs can assist in the identification of appropriate computer technology.

Networking. "In an educational or training environment, networking facilitates a more efficient learning-based environment" (Cohill, 1995, p. 46). Networked computers allow instructors to post assignments and learning activities at a single location and students can download the materials at other locations. By the use of local area networks (LANs) and Wide area networks (WANs) students have access to the materials college wide. If the LAN has an Internet connection, the student can be located anywhere in the world. Networking and the Internet can remove physical location as a factor in accomplishing work (Jones, 1995). There are several networking packages used in colleges such as Novell, Windows NT, Unix, and Windows for Workgroups. All of these systems can provide the needed support for a learning-based environment. The Department of Engineering Technology at CCAC uses a 60 station Novell system with Windows to support the curriculum. The college also has a

Novell-based WAN supporting administrative work. Plans are being made to extend the WAN to the student environment.

Computer system. The most common computer system for use by engineering technology students is a PC-based microcomputer. For multimedia and hypermedia applications a minimum of a model 486 Intel microprocessor should be used. In addition, the microcomputer should have eight megabytes of random access memory, a CD-ROM drive, a local floppy disk, a 500 megabyte hard disk drive, a sound card, and either a modem or a network interface card. If the computer is networked, a smaller hard disk can be used. At a recent conference a panel of experts described an appropriate student distance learning station. The system above would satisfy most of the needs. The CD-ROM and hard disk would be used to hold the bulk of the multimedia files that do not change from class to class. By connecting to a network and the Internet, the training can be easily changed, updated or re-sequenced. Time sensitive or rapidly changing information can be provided to the workstation through the Internet (Gillen, Neidenbach, Manganello, & Maynard, 1995).

Related projects

There are several schools involved in developing computer-based asynchronous distance learning programs in engineering topics. The Maui Community College in Kahului, Hawaii, has received a grant from the National Science Foundation (NSF) to develop multimedia materials to support electronics programs over a network using a 486 based PC (Converse, 1995; National Science Foundation, 1995). Sinclair Community College in Dayton, Ohio is developing distance learning materials for proto-type design education. Queensborough Community College is developing multimedia materials in engineering technology for use in networked laboratories. The North Carolina State Community College System is developing materials for use in a networked environment for manufacturing topics in engineering technology. The University of Georgia is working with six technical institutes to use multimedia applications in their Electronic Engineering Technology Programs (National Science Foundation, 1995). In another project the distance education division of the Northern Virgina Community College is offering a complete engineering associate degree for home based learners. At present the students connect to the network by telephone modem, but Northern Virginia plans to make the engineering program available through the Internet and the World Wide Web (Sener, 1995). The wide geographical coverage of these projects demonstrates a general interest in computer-based multimedia distance learning by the engineering technology community.

Faculty Concerns

With the increase of distance learning by the community colleges, the faculty have expressed certain concerns. Some of these concerns are (a) the effect of new technologies on the faculty as creators and users of information, (b) effects of distance learning on work loads and assignments, and (c) ownership of intellectual products such as course notes and programs. The Carnegie Foundation has related course materials developed by community college faculty as scholarship products.

The ownership of this intellectual property may need to be negotiated as part of the collective bargaining process (McKenna, 1995). The American Federation of Teachers local representing the faculty of CCAC have called for the formation of a committee to propose contract language related to distance education.

Strategic Planning

The Community College of Allegheny County has adopted the following definition of strategic planning, "A proactive process by which CCAC envisions its future and develops the necessary procedures and operations to achieve that future" (Community College of Allegheny County, 1995b, p. 5). In the Governance and Management Seminar the point was made that a better term than strategic planning is strategic thinking. The term "strategic thinking" removes the process from the management area and places the emphasis on the creation of alternative scenarios. Through strategic planning or thinking, the college can determine the relationship between itself, the environment, and the future. In the seminar on Governance and Management the collection of information on the internal and external portions of the college was used as a tool to develop a vision of the college's future. The internal audit of the college situation is completed to identify the strengths and weaknesses of the college. The external assessment will help to identify those factors that offer the college opportunities to pursue and the threats that prevent the college from meeting its mission. In Appendix F is a typical chart, called the SWOT chart, used for this process. The acronym, SWOT, stands for strengths, weaknesses, opportunities, and threats. Through an analysis of the SWOT and consideration of other documents, the planner can develop a vision statement. Once a vision is established for the college, the necessary steps to move the college toward that vision can be designed (Austin, Groff, & Scigliano, 1988).

The Community College of Allegheny County has completed an extensive internal audit in the form of a campus and college self-study. A recent Program Review of the Electronic Engineering Technology Program is also available. The Department of Institutional Research has completed and published an extensive external assessment in the form of an environmental scan of many factors affecting the college and its programs (Community College of Allegheny County, 1995a). In A Guide for New Planners, the planner is cautioned that not all planning needs to be comprehensive or college wide. "Successful, effective planning can be highly targeted and problem focused" (Norris & Poulton, 1991, p. 16-17). Further, they emphasize that the new planner should set a short, focused time line for a project. While the college is involved with an overall vision, individual departments and programs can also develop strategic plans that support and further the college vision. In a similar manner, strategic plans within the departments can impact and help to shape the continuing vision of the college. This blend of bottom-up and top-down planning can produce a more viable college vision. Norris and Poulton (1991) emphasize that the planning process needs to be flexible. "Good planning is more an art than a science in that it depends on sage assessment and careful implementation based on the uniqueness of particular situations" (Norris & Poulton, 1991, p. 4).

Summary

The literature reports growing interest in distance education by the community colleges. For today's adult student the need for distance education is not tied to the distances but rather to time constraints. Community colleges hope to serve this clientele with programs that are time independent. Accompanying this interest in distance education are developments in microcomputer hardware and software. These new technological systems, such as the World Wide Web, present the potential to offer multimedia-based instruction anywhere at anytime.

Research has shown that students working in a computer-mediated environment achieve as well as those in a traditional lecture mode. The newer advances in cognitive studies suggest we break from the lecture model of instruction and move to a new learning paradigm with more individualized learning. By including the cognitive techniques and strategies suggested by Johnson and Thomas in the application of multimedia and hypermedia technology, the microcomputer will allow information delivery in a student controlled environment. Some studies suggest that the use of multimedia systems can decrease the time required to achieve mastery. With the added use of networks, distance learning can be made interactive and collaborative. The inclusion of collaborative activities would be in agreement with the principles of cognitive studies that suggest that social interaction will assist the student to build mental models. The network brings the students and the instructor together into a virtual learning community that is independent of location or time. By also including virtual reality laboratory experiments into the electronics program, the student can apply the concepts and principles in an electrically safe and inexpensive environment. By simulating actual circuits, the students can develop mental models that will transfer to the real equipment. Many schools, including the Community College of Allegheny County, have begun to develop distance learning programs. Programs providing materials in engineering technology for use in distance education are being funded by federal granting agencies. Some of these programs are using the enabling technology of the microcomputer, the Internet, and the World Wide Web. Currently schools are offering courses in drafting, design, manufacturing, and electronics. This project has developed a strategic plan for a multisite program in Electronic Engineering Technology.

Chapter 3

METHODOLOGY AND PROCEDURES

Methodology

The development problem solving methodology was used in this project. The two primary techniques used were data analysis and plan development. The conceptual background for this project came from two practicum projects and the seminar on Governance and Management. The result of the process was a strategic plan for offering the Electronic Engineering Technology (EET) Program at all four campuses of CCAC using the Internet for distance learning. An additional benefit was the establishment of a revitalized advisory committee for the EET program.

Procedures

The procedures followed in the conduct of this project were, for purposes of project management, divided into three phases. Phase one was involved with information gathering and analysis. Phase two involved development of the plan. Phase three involved the analysis, critical review, and revision of the plan. Good project management is facilitated by advance planning. A Gantt chart is a graphical tool to provide guidance to the sequence of events in a project. The chart displays the sequence of events and the anticipated duration. Those events that depend on previous actions, and those events that can be accomplished simultaneously are clearly shown. Gantt charts are intended to contribute to the efficient completion of projects (Computer Associates, 1991). A Gantt chart used in this project may be found in Appendix G.

Phase One

Conduction of Literature Review

Phase one began with the conduction of an extensive literature review. A search of CD-ROM data-bases from Wilson holding the complete listing of ERIC documents, the Education Index, and Science and Technology Index, and Internet accessible databases, resulted in a list of references. Topics of specific interest were applications of cognitive studies to computer-aided instruction, applications of computers to distance learning, and applications of computer-mediated communication to instruction. The interlibrary loan program was able to provide nearly all the desired article and text references. All ERIC documents were obtained on microfiche.

Interviews of Other Schools

The Internet list serve, etd-l@frank.mtsu.edu, consists of over 600 faculty from two and four year engineering technology programs. A request for information on schools involved with distance learning in engineering technology was made on this list serve. From the response, a list of schools and contacts was developed to be interviewed by telephone. To assure that common information was acquired from each interview, an interview form was prepared (See Appendix H). Since some individuals could not be reached by telephone for an interview, their responses to the interview form were obtained by email and the postal service.

Interviews of Computer Center Directors

A second telephone interview form was prepared to use with the Computer Center Directors at each of the four campuses.

This form is located in Appendix I. One of these directors also preferred to respond by email. The purpose of these local interviews was to determine how receptive the computer center would be to have a distance learning workstation in their facility. These interviews suggest that an interview with the person in charge of the college's World Wide Web equipment would also be helpful. He was provided with a copy of the initial strategic plan prior to the interview. The interview focused on the ability of the college system to provide the Web and network facilities required by the project.

Phase Two

The Advisory Groups

A meeting was held with the director of business and industry programs at South Campus to discuss suitable industrial contacts for the advisory committee. These individuals were selected on the basis of two factors, their interest in the school, and their association with electronic training within their respective companies.

An educational advisory group was formed of individuals involved with engineering technology education. This educational group consisted of two representatives from the South Campus Department of Engineering Technology; two high school representatives; and two representatives of Point Park College and two from California University of Pennsylvania, the two schools with articulation agreements in EET with the college. In addition an engineering technology faculty member from the North Campus of CCAC was a member of the group. Separate initial meetings of the industrial and education segments of the advisory group were held. This was done to focus the discussion of each meeting on the interests of each group. The list of individuals in each group is shown in Appendix J.

At the meeting of the industrial group on June 11, 1996, a presentation was given to establish the conceptual framework of the proposed distance learning project. One emphasis at the meeting was on assuring the content of the on-line courses would meet the job requirements of the industries. In addition to the subject content of courses, the skills that could be provided by computer simulation and the skills expected of high performance workers was discussed. On June 19, 1996, a second meeting was held with the educational representatives. The concept of the project was presented to this group. At that meeting the emphasis was on coordination of the EET program with other areas within the college and with its educational partners. The impact of a computer intensive distance learning program on transfers to baccalaureate programs was covered with the two transfer institutions. Also, the ways in which the secondary programs could better interface to the CCAC program was discussed. The technology instructor at the local vocational school reviewed the proposal for compatibility of college enrty skills and high school exit skills. The coordinator of the Tech Prep program met separately because of scheduling conflicts. The newly proposed curriculum for a high school program in Tech Prep was reviewed to determine how well students would be prepared for the post-secondary program in EET and the distance learning options.

Student Workstation Requirements

To prepare a set of computer system specifications for an appropriate student workstation, a review of software and hardware needs to support the project was done. A list of all software to be used in the project and its system requirements was developed. In some cases, it was necessary to install and operate the software to assure it would perform the tasks desired. Using this list of software requirements, the hardware system specifications were developed. A cost estimate for each workstation was developed based on these specifications.

Plan Development

Using the information gathered through the literature review, the advisory group meetings, and the interview process an initial strategic plan was prepared. This plan included a schedule for development of courses, a curriculum design plan including evaluation, a proposed budget for necessary course development and implementation, and the student workstation and software requirements.

Phase Three

Plan Review

The initial strategic plan was mailed to all members of the advisory group. On September 23, 1996 a meeting was held to review the document. The suggestions from that meeting provided feedback for the final plan.

Final Review and Writing of Report

Following the meetings of the advisory groups the plan was revised to include their suggestions. This plan was provided to the campus executive dean, the dean of the technology division, the director of business and industry programs, and one non-technology faculty member Following their review, the final strategic plan was written.

Assumptions

It was assumed that the literature search was comprehensive and reliable. It was assumed that the positive results recorded in the literature for applications of computer-based education can be replicated in the local environment. A further assumption was made that the individuals selected to serve on the advisory groups were knowledgeable and representative of the educational and industrial communities. It was also assumed that these individuals could accurately judge the quality and practicality of the strategic plan. Another assumption is made that the use of multimedia based course work will appeal to students by meeting their different learning styles.

Limitations

Limitations of this project are that the strategic plan developed by this project has features unique to a four campus system and may not apply to other schools. The implementation of the strategic plan developed requires some time for operational implementation and is beyond the scope of this project. Because of current budget restrictions at the college, external funding sources will be necessary to implement this project, and they may not be available.

Chapter 4

RESULTS

This project resulted in a strategic plan to offer the key portions of the associate in science degree in Electronic Engineering Technology through a distance learning delivery mode. The plan, shown in Appendix M, provides for a student to access required electronics courses through the Internet from any campus of the Community College of Allegheny County. In addition, by connection to the Internet through any of the many Internet service providers (ISP), student access to the program can be made from off campus locations. These locations could include business sites, high schools, or the student's home. The plan details the necessary software and hardware to access the program, cost estimates, and a budget for course modification to the Internet based option. This was accomplished through two primary procedures: (a) data analysis and (b) plan development. A Gantt chart (See Appendix G) was used to divide the project into three phases. Nine major activities were scheduled into these three phases. This chapter details the results from the completion of these nine major activities presented on the Gantt chart and in Chapter Three, how these results influenced the development of the final plan, and how the results answered the stated research questions.

Data Analysis

Results of the Literature Review

The preliminary literature review at the proposal stage suggested that additional information should be acquired on

(a) applications of computers to distance learning, (b) applications of cognitive theory to computer-assisted instruction, and (c) computer-mediated communications. This research also suggested that some consideration be given to computer-based simulations and how the new technology of virtual reality software could apply to distance learning. The results of this research are included in the literature review presented in Chapter 2 of this report.

Interviews of Schools with Related Programs

A request was made to the Internet list serve supported by the members of the Engineering Technology Division of the American Society for Engineering Education that resulted in a list of schools believed to be involved in similar activities. Those schools were contacted by email, phone, or the postal service. Contact with some of these schools resulted in no information useful to this project. Those schools with programs related to this project are detailed below.

Northern Virginia Community College

The Northern Virginia Community College (NOVA) has a long history of distance learning. A division at NOVA called the Extended Learning Institute (ELI) offers large numbers of courses by various distance modes. A new initiative is a complete associate degree in engineering science to be offered through the use of the computer. Some information was presented on this program in the literature section. To obtain more current information, John Sener, Project Director, in a phone interview on July 17, 1996, reported that the project was currently using a local bulletin board system, or BBS, for computer access. This results in some students paying long distance charges. Sener and his colleagues hope to move to the Internet, but no date has been set for that change. The software used for connection is called First Class, and a second program, Expressionist, is used for representation of mathematical equations. Both programs offer a Windows type interface. The major problem the program has is the offering of laboratories. At present all students must travel to campus to perform necessary laboratory experiments. At this time, the program is using no simulation software. However, the engineering courses, in which simulations might apply, have not yet been developed. Enrollment in the initial offerings has been good. During the spring term, the project offered three courses with a total enrollment of 75 students. Normally courses will have a maximum enrollment of 30 students per section. Sener expects enrollment to grow to at least 300 students. The effect of the distance option on the enrollment in the regular class schedule is unknown. However, Sener said that offering expanded options was adequate justification.

The development of the computer-based course activities is supported by grant funds. The courses are being developed by the faculty of the college. The faculty involved in this curriculum development work receive a course load reduction plus stipend for each course they develop for the project. For example, the development of a four-credit course will provide the participating faculty member with four credits toward the required teaching load plus a $500 stipend. Sener stated that this was not enough compensation or time to complete the necessary job, but because of the enthusiasm of the faculty, it was being done. He stated that, to be successful, any project of this type needs "maximum buy-in" from the faculty.

Old Dominion University

At Old Dominion University, the upper division of the engineering technology programs are available by distance learning. The primary mode of delivery is with one-way video and two-way audio connectivity. Old Dominion is connected to 17 community colleges throughout Virginia by a state wide interactive cable system. This allows the lectures to be delivered from the campus to the other sites. Video tapes are prepared for those unable to attend the scheduled sessions. Professor Alok K. Verma, Mechanical Engineering Technology Program Coordinator, was interviewed by phone on July 23, 1996 to determine details of the program. Verma stated that, in addition to the lecture, an 800 phone number was available to students to contact the instructor. Some students used fax and email as well, but no emphasis was placed, at this time, on networked communication. The program offers junior and senior level courses in mechanical, civil, and electrical engineering technology. Verma stated that there were over 100 students in each major with about half in the distance learning classes. Currently, all laboratories are offered on the week-ends and students travel to the campus each week for the laboratory. A new initiative is being developed through support from the National Science Foundation for a mobile laboratory in fluid mechanics and programmable logic controllers. When the course is offered, this laboratory will travel to the local site to provide the laboratory component. Verma expressed that one of the program's biggest problems is the logistics of distribution, collection, and administration of tests. It takes three to four days to collect the test from each site for grading, and an equal amount of time to distribute the results to the students after grading. Many of the faculty have been involved in the program. If a section exceeds more than 60 students, faculty are paid an additional stipend based on the enrollment. Each faculty is assigned a helper, and each site has a full-time monitor as additional support. Typical enrollments are 30 students on campus and 30 to 40 at the remote sites. A minimum of 10 students are necessary for a course to be offered. As an additional incentive for program development and participation, faculty are given three credits of release time for preparation either prior to or during the first course offering.

Sinclair Community College

At Sinclair Community College in Ohio, 75 to 80 courses are run each term in a distance learning mode. Currently, the college offers an associate in arts degree completely by distance learning with a major in liberal arts. The majority of the courses are provided by broadcast television through the local public broadcast station. Video taped lectures are also used through the library and the postal service. Some courses are offered through an interactive connection. As of the Spring of 1996, only two courses are available in the engineering area, one in quality control and another in drafting. Both of these courses are provided on video tape. Peggy Falkenstein, Program Coordinator at Sinclair, in a telephone interview on July 23, 1996, stated that the live interactive courses were not cost effective as they required a facilitator at each site. The most cost effective courses were those provided by video and CD-ROM. Although Sinclair is not offering courses on the Internet this year, the college has plans for 14 course to be provided through the Internet by January of 1997. Falkenstein indicated that one major problem facing this distance learning program is that of testing. All students are required to come to the campus to take exams. For courses with laboratories it is also necessary to come to the Sinclair campus. To facilitate access, an open lab is maintained with regularly scheduled hours of operation.

The faculty at Sinclair are compensated for instruction based on the number enrolled in each course. A factor of 0.1 times the course enrollment is used for up to 40 students in a section. For example, 30 students equates to 3.0 credits of course load. Above a total of 40 in the section, a multiplier of 0.075 is used. Approximately 75% of the courses are taught by the full time faculty. In developing a new course, the faculty are given a one time five-credit release or overage pay to prepare materials. For those programs that are purchased, this stipend is reduced in half. The distance learning option has been very successful at Sinclair, and through the distance learning option, the enrollment in some course has increased.

University of Houston

The College of Technology, at the University of Houston in Texas, offers an extensive distance learning program for engineering technology students by one-way video and two-way audio. The areas of mechanical engineering technology and computer-aided drafting and electrical engineering technology are offered. For lectures, a specially designed classroom/TV studio broadcasts to a maximum of six sites in the Houston area. The lectures are also taped and rebroadcast on three cable networks in the Houston area. Students unable to participate in the above broadcasts may obtain tapes from the library. Students must come to the campus on Saturdays and Sundays for laboratory work. Professor Ron Pare, Associate Professor of Mechanical Engineering Technology, reported in a telephone interview on July 23, 1996 that from 20% to 25% of the College of Technology enrollment is from remote delivery classes. This has, however, not increased the overall enrollment. Students are selecting the distance option instead of coming to campus. All courses offered are at the junior and senior level. These are the only courses offered in the college. Pare stated that based on final grades, students appear to be doing as well in the remote locations as the on-campus students. However, the remote students are more likely to drop out of a class. Although using video for lectures, students are able to contact the instructor by email, fax, and the telephone. The College of Technology is working toward a goal of offering the complete baccalaureate technology degree by distance learning in the near future.

Aims Community College

In Greeley, Colorado, the Aims Community College has developed a certificate program in basic electronics in a multimedia distance learning mode. The program was developed for the employees of US West, a telecommunications company. These employees are located over a 14-state area. Linda Scott, Program Director, in a telephone interview on July 23, 1996, stated that during the spring term 150 employees were involved in the first course of the six course sequence. The expectation for Fall, 1996 was over 400 involved with the program. Courses in the program cover AC/DC circuits, telephony, advanced electronics, data communications, and LAN/WAN concepts. The courses use standard text books and computer software to deliver and pace the course. The project uses the computer program Electronic Workbench to simulate circuits discussed in the course. Some laboratories are conducted using the software program. A special kit of parts is also included in the course fees. This kit contains a power supply, calculator, digital meter, and electronic components. Using these materials, the student may complete all laboratory experiments without coming to the campus. Students are encouraged to use an 800 number or electronic mail to contact instructors for assistance. Each course is provided as a non-credit offering by Aims Community College. However, the student may receive five credits by passing an exam. The courses and laboratory work were developed by the Aims faculty. The faculty work under the non-credit continuing education division, and the classes do not apply to the normal teaching load.

George Brown College

At George Brown College in Toronto, Canada a program has been developed to offer an Electronics Technician Certificate as a CD-ROM based home study course. The CD-ROM contains 23 course units comprising the content of the first year of a two-year associates degree program. Students may complete the CD-ROM course at home and then continue in either a two-year Electronic Engineering Technician or a three-year Electronic Engineering Technologist Program. Dr. Colin Simpson, Director of Learning Innovations at George Brown College, stated that presently there are over 500 students enrolled in the home study course. The CD-ROM uses the program Electronic Workbench to simulate some 400 laboratory projects used in the course. The CD was developed in partnership with a private vendor. The faculty involved with development were paid on a contract basis for specific work performed. Since the CD-ROM course is considered home study by the college, no faculty support is provided beyond administering and grading of tests and assignments (C. Simpson, private communication, July 17, 1996).

Other Schools

Other schools contacted were only beginning to offer distance courses or had no offerings in the engineering technology related areas. For example, John Wood Community College in Illinois uses the techniques of video conferencing over high speed communication lines. J. Thomson, Assistant Dean of Instruction, in a phone interview on July 23, 1996, stated that the college is linked to one other community college and a local university through this video system. This consortium has offered the lecture component of several courses through this medium. No electronics courses have been offered, but the lecture section of a welding course has been offered. A law enforcement program has all the courses coming to John Wood Community College from the partner school. Thomson said that the use of the video conferencing delivery mode was very cost effective. Some courses would never be able to run without pooling the enrollment from the three sites. He expressed the desire to expand the use of the technology beyond the three schools in the future.

Two other schools just beginning programs are Onandaga College in New York and Northern Iowa Area Community College in Iowa. The significant feature of both of these new programs is the use of the computer simulation program called Electronics Workbench ("Electronic Workbench Enhances Distance Education," 1995-96).

Interviews with Computer Center Directors

This project would require the assistance of the computer center directors located at each campus of CCAC. Therefore, a short phone interview was conducted (See Appendix I).

The results show that the directors can provide space and internet access at each campus. One concern expressed by two directors was the level of audio that would be involved at each station. The space to be provided is shared with other users. If the student is talking through the computer, it could distract others. Equipment for the project was less certain. Two campuses would be able to provide a computer, and two would not be able to provide the necessary computer. In all cases, the directors stated that specialized software for the computers would need to be provided by the EET program. At CCAC, each campus also operates a number of remote sites around the community. Three of the directors were confident that they could provide access from one or more of their remote sites. Since the remote sites are not on the college wide area network, it would require the use of a modem card to make contact to the Internet. Only the North Campus did not expect to be able to support the off-campus sites. A summary of the results of those interviews will be found in Table 1.

Table 1

Results of Computer Center Director Interviews

	Campus			
Major Concern	A	B	N	S
Computer Center Space	yes	yes	yes	yes
Internet Access	yes	yes	yes	yes
Available Computers	yes	no	no	yes
Usable remote sites	yes	yes	no	yes

Note. The campus designations are A for Allegheny, B for Boyce, N for North and S for South. A map of the geographic locations of these campuses is in Appendix B.

All four directors were interested in the project and were willing to support it at their sites. The only problems expressed were those of initial start-up, equipment setup, and other logistics.

In addition to these directors, the person who manages the student email accounts and all external World Wide Web connections was interviewed regarding the proposed project. He was very enthusiastic about the use of the Internet connection. He described the project as "... interesting, feasible, and encouraging ... a great vision ..." (D. Broderick, personal communication, September 23, 1996). Also, he suggested that it would be more cost effective in the long run to use digitized video. The distribution of the digitized videos could be done quickly over the college network. This would save the time necessary to copy video tapes in a sequential manner, and distribute the tapes by campus mail.

Departmental SWOT Analysis

The members of the engineering technology faculty at South Campus engaged in a SWOT Analysis process to identify the strengths, weaknesses, opportunities and threats to the engineering technology curriculum at South Campus. The completed chart produced by the process is in Appendix K. The chart consists of four columns labeled strengths, weaknesses, opportunities, and threats. Several items were identified in each column, but some had more direct application to this project. Two items of project related strengths are (a) the department computer network and (b) the willingness of the faculty to change and adopt new technology. Weaknesses that impact the project are (a) declining enrollments, (b) reduced funding, and (c) larger class size requirements. The most significant external opportunity is the interest of local companies in new training. The major threat identified is competition from other schools.

Plan Development

Meetings of Advisory Groups

Prior to the meetings of the advisory groups, the electronics faculty reviewed the syllabus for each course to be offered by distance education. The content and objectives were revised to reflect modern practice in electronics. The faculty prepared each course syllabus on the college's newly adopted curriculum forms. In addition, an outline of the proposed distance learning environment that the project hoped to create was prepared to give the advisory group the background for review and comment.

Industrial Advisory Group

The advisory group members met on three different occasions. Appendix J presents the membership of the advisory groups. The first group to meet consisted of individuals from business and industry. The meeting occurred on June 11, 1996. At this meeting the industrial group reviewed the course syllabi. This review was directed at answering research question three which states "What changes in the existing objectives of the Electronic Engineering Technology program will a multisite networked program require to achieve the knowledge and skill levels expected by industry?" Because many of the courses have been offered at the Adtranz factory site, the Adtranz representative was very familiar with the syllabi. All industrial representatives agreed that the prime objective should be to assure that the quality of the distance learning and the on-campus course should be the same. The final course syllabi approved by the advisory group will be found in Appendix L. Changes in actual course content requested by the industrial group were small. The industrial group did stress that students have computer skills. A balance between simulation and hands-on with actual equipment was considered important. The format for these syllabi is required by the college for state certification.

In addition to course content suggestions, this group had several suggestions related to the on-line nature of the project. First, a short course or workshop should be made available to orient the student to the techniques and skills necessary for the distance delivery mode. This orientation should include a study guide to help the student navigate the course and deal with equipment problems. A part of that guide should be estimates of the time needed to complete each lesson. Second, the group felt that interactivity was important. Several of the companies were using various types of interactive training. The advisory group suggested the use of audio to reinforce the material. The industrial group had experience with video conferencing and whiteboard conferencing and felt it could provide helpful "real-time" contact. Some members expressed concern about the use of video tape. They suggested that the video be placed on disk.

The industrial advisory members were excited about the potential of the project, and two of the group asked that consideration be given to making the program available from their factory sites. They expressed that a telephone line and modem connection would not be a problem at their companies. A final concern of the industrial group was that the course development should be completed in a year or less. They suggested that economic development training funds may be available to support the development of distance learning.

Educational Advisory Group

The Educational Advisory Group met on June 19, 1996. The education group is listed in Appendix J. Those who could not attend provided feedback by telephone. Part of the second research question related to establishing the needed coordination between the high school programs, the community college, and the transfer institutions. The educational group consisted of representatives of the two schools to which the majority of the EET students transfer. Their main concern was the same as the industrial group, that the same syllabi should be used in any delivery mode. Course objectives should be the same for both distance learning and on-campus learning. As long as this is true, transfer of the courses to upper level would not be affected. Both of the colleges have begun to explore their own ability to offer distance learning options in some courses. The Tech Prep coordinator and one of the high school teachers were interested in the possibility of high school students participating in the electronics courses from their high schools.

They suggested that some means be made available to use sites other than the four campuses to access the program.

The Tech Prep coordinator provided copies of the new Engineering Technology Tech Prep Curriculum and the Electronics Technology Tech Prep Curriculum for review in terms of the existing curriculum. These new high school curriculum were considered adequate to allow students to enter either the on-campus or a distance learning electronics program. These students can receive a waiver for EET103, Introduction to Electronics, and enter at an advanced level. However, the Tech Prep program is new and has yet to have graduates.

Combined Meeting

The preliminary strategic plan was mailed to all members of the advisory groups. A combined advisory meeting, held on September 23, 1996, had only the educational representatives in attendance. However, all the industrial representatives responded by telephone to the plan. Both the educational and the industrial groups were supportive of the plan presented. One college representative expressed concern about the faculty load the plan might produce and asked that more clarification be presented. The use of the scanner for homework and testing was well received by all advisory members. The potential for quick response was considered a strong feature.

Development of Hardware and Software Needs

The distance learning environment that the project desires to create dictates the necessary hardware. The strategic plan calls for the use of the simulation program Electronic Workbench, the mathematics program, Mathcad, the World Wide Web Browser Netscape, and the whiteboard program CU-SEE-ME. In addition, the program Microsoft Office Professional provides word processing, spreadsheet, and database tools used in the EET program. All of these programs use a similar graphical user interface based on the visual operating system of Windows.

Table 2 shows that for one program to run at least eight Megabytes of memory are required. Since two or more of these programs may need to run simultaneously for multimedia, more memory will be required. Most computer systems require memory to be increased in doubles, such as four, eight or 16 Megabyte increments. Based on these figures, at least 16 Megabytes should be installed in each student workstation. Currently, the

Table 2

Project Software

Software Program	System Requirements: Hard Disk Storage in Megabytes	System Requirements: Active Memory in Megabytes
Netscape (with email)	4	8
Mathcad	32	8
Electronic Workbench	5	6
CU-SEE-ME	10	8
Microsoft Office Pro	82	8

minimum size hard disk drive the college is installing is 1,020 Megabytes. Since the total of the application programs is 131 Megabytes, this is sufficient for any of the proposed software.

Following the review of the memory requirements of these programs, the hardware for the computer system and the peripheral equipment was specified. Table 3 shows a listing of this equipment and each piece of equipment's primary specification.

Table 3

Student Workstation for Distance Learning

Hardware Requirements	
Computer System	
Memory (RAM)	16 Megabytes
CPU	100 Megahertz (Pentium)
CD-ROM Drive	4X Speed
Display	S-VGA Color
Sound	16 Bit Sound Blaster Compatible
Hard Disk	1,020 Megabytes
Local Drive	1.44 Megabyte Floppy disk
Communication	10BaseT network card (on-campus) 14.4 KPS modem (off-campus)
Support Hardware	
Scanner	Sheet fed, 300dpi resolution
Printer	Inkjet, 300 dpi resolution
Video Monitor	12 inch diagonal measure
Video player	1/2 inch, VHS

Local newspapers, mail order catalogs, and local computer stores were reviewed to determine the approximate cost of the computer system and support hardware needed to support all activities called for in the strategic plan. Table 4 shows an estimate of the cost for one station. Because the necessary network interface card and the modem card and phone installation are approximately the same expense, the on-campus and off-campus cost of the system are the same. The total hardware and software costs for each station will be $3,720. The Internet connection on-campus is provided by the college to all students. There is no charge made to the individual program. The costs to the college for Internet access are fixed. In an off-campus

Table 4

Expense of Necessary Distance Learning Computer

	Expense	
Item	On-campus	Off-campus
Computer System	$2,000	$2,000
Software	$ 870	$ 870
Support Hardware	$ 850	$ 850
Internet Access Charges	NA	$48/month
Total	$3,720	$3,720+ $48/Month

Note. The on-campus Internet connection is provided by the college as a general cost and not billed to a specific program.

situation, such as a college off-campus site or a factory location, the costs of an Internet service provider and telephone line must be included. These charges would be for a single station. At the campus eight to 12 students should be able to use each student workstation. This estimate is based on at least one hour of computer time per week per credit for each student. The table also assumes a one time offering to an in-county student. The expense of the equipment falls directly proportional to the number of students. The computer centers are open over 40 hours each week. At the industrial sites, or the off-campus centers a figure of four students per system would be the maximum. Table 5 presents a cost estimate for the distance learning portion of the EET program at an off-campus site for one to four students. At the industrial site, because of the normal working hours, approximately three hours per day could be available. For a one time, one student offering the

Table 5

Cost Estimate of Off-campus Program Access

	Per Student Cost			
Students/ station	System Cost	Tuition	Communication	Total
1	$3,770	$2,146	$ 804	$6,720
2	$1,885	$2,146	$ 587	$4,618
3	$1,257	$2,146	$ 528	$3,931
4	$ 942	$2,146	$ 486	$3,574

cost estimate is $6,720 for the 29 credits of the program. With four students at the same site sharing the equipment, the cost estimate per student drops to $3,574.

Writing of the Strategic Plan

The second research question of the project asks in part "What is the appropriate strategic plan: (a) to offer a multisite Electronic Engineering Technology Program by network communication ...." Any strategic plan should begin with a clear vision statement of what the project will accomplish. This vision statement is intended to describe the preferred future the project will create. The vision statement for this project is found on page four of the strategic plan in Appendix M.

In developing the strategic plan to offer the EET program in a distance learning mode, the following topics from the literature were considered.

1. Implement a Barr and Tagg (1995) type Learning Paradigm.

2. Utilize the World Wide Web (WWW), CD-ROM, and video tape as the delivery vehicle.

3. Emphasize visualization of subject content by applying a user controlled interactive multimedia environment using hypertext, graphics, audio, and simulations.

4. Build courses around the constructivist model using touchstone problems (Redish, 1994) and the instructional strategies of Johnson and Thomas (1994).

Each major feature of the plan will be presented and the rationale for the specific structure of that feature will be reviewed from both the literature and the interview results.

<u>Curriculum Design Model</u>

As the strategic plan was being developed, interested faculty and administrators ask what overall process would be used to develop each course. These individuals suggested that this process should provide a framework into which the unique features of the distance learning paradigm could fit. In the seminar on Curriculum and Program Planning, a six step curriculum design model was developed (Cunningham, 1990). This model has been used in the past for development of engineering technology courses and programs. After a review of the model, a decision was made to incorporate it as the design framework for the distance learning project. This curriculum design model has six steps and provides for student mastery. The six steps of this model are

1. Analysis
2. Objectives
3. Instruction
4. Performance Evaluation
   A. Advancement
   B. Recycle
5. Program Evaluation
6. Revision

<u>Analysis and objectives.</u> Steps one and two above are directed to the course developer. In these steps, the normal activities required to develop a syllabus are carried out.

<u>Instruction and program evaluation.</u> In steps three and four, the actual delivery of the instruction and the testing, as outlined in other parts of the strategic plan, is completed. By

using a hypertext and multimedia environment, the student will have a great deal of control of both the pace and the path taken through the instruction. Through the recycle operation, the student's satisfactory performance will be assured. This will allow improvement in the quality of the learning experience and the quality of the student's performance.

Program evaluation. A portion of research question two asks "What is the strategic plan: ... (c) to develop an evaluation plan." The fifth step of the curriculum design model relates to this evaluation process. The purpose of this evaluation is to provide feedback information to improve the program. Gagne', Briggs, and Wager (1988) define two types of evaluation. Formative evaluation is done to revise the program as it is operating. Summative evaluation is intended to draw conclusions related to how well the program met its goals. Summative evaluation is done at the conclusion of a program or major phase of a program.

The college requires a yearly review of each program. The review consists of two sections. The first involves numerical information on course enrollments, program costs per student, and any responses from the college wide graduate survey. The second part of the yearly review involves qualitative program information related to staffing needs, adequacy of on-campus and off-campus facilities, equipment and furniture needs, availability of grant funds, future program directions and resource needs. This college program review is concerned with summative information.

The evaluation phase of this project is concerned with detailed formative information that can lead to improving the course as it is being offered. A formative process allows the instructor to identify course gaps or unanticipated problems that can be remedied immediately (University of Alaska, 1990). In a traditional classroom, the feedback on student performance is usually the results of quizzes and of student comments. The quizzes and exams can indicate if the students are reaching the objectives, but these scores do not provide feedback on how the student perceives the instructional materials. The distance learning environment in this project poses new classroom paradigms with which the student and instructor are unfamiliar. The instructor needs to know if the materials are too easy or too hard, frustrating or helpful, and too fast or too slow. In the traditional classroom this information is informally gathered during and after class from student verbal and non-verbal reactions. This contact is missing in a distance learning environment. However, with the on-line facilities in this project, the student can respond to these concerns on a regular basis. To assure a consistent feedback, the same series of questions will be used at the end of each unit. This will provide between four and eight formal student feedback opportunities in each course. By including the evaluation as a Web page at the end of each unit, students must respond to continue. This full participation will improve accuracy of the data. To allow a quantitative analysis of the results, most questions will have a short ranking response. Each evaluation page will also have an open-ended question to provide qualitative depth to the evaluation (University of Alaska, 1990). When the evaluation is submitted by the student, the data will automatically be placed in a file for the instructor to review.

The five evaluation questions will consist of statements requiring a response from one to five. A one represents a low level of agreement with the statement, and a five indicates a high level of agreement with the statement. The five statements for each unit of study are as follows:

1. The level of difficulty of this unit was acceptable.

2. The computer based activities and simulations were helpful in mastering the material in this unit.

3. The computer network and learning environment performed all required functions needed for efficient learning.

4. This unit of study has increased my confidence level as an electronic engineering technician.

5. Assistance from the instructor, by email and phone, was available when needed.

A sixth question will allow the student to respond in an open-ended manner using their own words.

6. In the space provided, please write any suggestions for improvement, criticism of the unit of study or course, and any other feedback on the program you wish.

Placing the evaluation on the Web page (a) allows the students to complete the material as they are ready; (b) assures consistent, timely input; and (c) provides instructor-independent feedback on the course. In addition, to helping the instructor know how the course is being received, the feedback can be used as part of the year-end summative evaluation. Since the same information is being requested of all students in all courses, the ranking information can be easily summarized. The department head and program faculty will use these summaries, class grades, and college statistics to prepare the yearly summative review.

Revision. In step six, the feedback on course operation, and other changes is made a regular part of the program operation. In most courses steps one and two are done reasonably well. However, steps three and four often are done on a weekly or daily basis. Each instructor interprets what is and is not important. The consequence is that material may not always be of the same quality. This model will assure that the distance learning experience is of a consistent quality. By having program evaluation and revision an integral part of the course design, the EET faculty can assure that the program quality is at an acceptable level.

Creation of Virtual Learning Community

One research question posed by the project was "How can the newer electronic communication technologies be used to provide a virtual learning community in the EET program?" The strategic plan developed proposes to use the World Wide Web, email, digital scanners, computer-based conferences, and computer simulation to provide a virtual learning community.

World Wide Web Course Delivery. The plan offers all required electronics courses and two of the general requirements for the major in EET. These courses represent 29 of the 60 credits required for an associate degree. The college maintains a World Wide Web site, and space on that site is assigned to the engineering technology programs. This site, located at http://www.acd.ccac.edu/eng-tech/, will contain all the syllabi for each course. Each term the assignments and lessons for the courses being offered will be posted on the Web.

Student Assignments. Several of the schools contacted about their current programs in distance learning indicated that distribution and collection of tests was a problem. This plan will use the Internet to distribute and collect tests and also written homework assignments. One feature of the WWW site is the ability to have a password protected area. When ready to take a unit test, the student will enter a password and a test will be delivered and printed on paper. The time will be automatically printed on the test. All unit tests will be given in an open book format. When completed, usually within an hour, the student will use the scanner to input the test and return it to the instructor as an attached graphic file. This entire input process can be done with a single click on a "submit assignment screen." When returned, the email process will date stamp the file. Therefore, the time required to complete the exam can be determined. If this time appears excessive, the instructor can contact the student. Since the file is in an electronic form, the instructor can score and comment on the test directly on the screen. This modified file can be returned to the student as an email attachment. By reducing delivery time to seconds instead of days, the student will receive rapid feedback. This activity was considered by the advisory committee as a very unique and innovative addition to the distance learning program.

Student-Teacher Contact. In the typical offering of a course, the student would expect to be able to contact the instructor before class or during office hours for assistance on specific problems. With the use of technology, this contact is possible in a distance learning environment. The strategic plan will provide for contact by email which is time independent or asynchronous. Also, the student can contact the instructor by telephone during office hours. In addition, a whiteboard video conferencing program will be available to allow the student and the instructor to work on the same file together. Both the telephone and the whiteboard conference program are synchronous methods of communication. The student and teacher must be available at the same time. The industrial advisory group stated that this technique is used in industry and would be useful in the distance learning environment. The department has had experience with the program CU-SEE-ME. This program will allow whiteboard graphics and spoken audio to be sent over the Internet connection. By limiting the media to graphics, a modem-based Internet connection from a remote site can also use the conferencing program. Although the video conferencing software would allow a real-time video picture to be exchanged, the additional costs of the required higher speed communication lines is not practical.

Laboratory Component. As the course materials are developed for the distance learning program, the use of virtual reality based laboratories (VRL) will be examined. The experience of George Brown College and Aims Community College suggest that the program Electronic Workbench can provide a full spectrum of simulated laboratory experiments. Using a VRL the student could conduct many experiments off-campus. Experiments could, also, be closely tied to the assignments. However, one problem with a virtual laboratory, as proposed, is that the mechanical skills expected of an EET graduate can not be simulated. Key experiments will be carried out in the campus laboratory to gain experience with actual equipment. Special laboratory sections will be scheduled for Fridays and Saturdays. During these sections, students can be in any of the distance learning courses. However, the use of virtual technology, will reduce the travel requirements for students in the program. These on-campus times will also offer an opportunity for the student to take any proctored exams necessary. The actual development of these virtual laboratories is beyond the scope of this project.

Faculty Teaching Load

The schools contacted treated the number in a distance education section in the same manner as an on-campus course. The strategic plan, for CCAC, proposes that each section should have a limit of 24 students. A laboratory section has a corresponding limit of 12 students. As the project begins, both on-campus and off-campus students will be scheduled in the same section. This will address the desires of the administration to increase the enrollment in each section. To develop the course materials into a distance learning paradigm, the strategic plan proposes that faculty be given a course reduction or overage equal to the number of credits in the course. The faculty will develop the course activities, materials and laboratories necessary for steps three and four of the six step curriculum model. These faculty will be responsible for taping the video segments. These video segments will cover specific topics that need additional exposition. Problems will be done on the computer using a graphic environment and the Mathcad Program.

One faculty member will be designated as program coordinator. This coordinator will guide the overall project. The coordinator will assure course materials adhere to the adult principles and cognitive strategies established in the distance learning paradigm. The coordinator will also assure the program evaluation Web pages are providing information on student response, problem areas, and suggested improvements to the courses. The coordinator will provide summaries of these pages to the department head for the summative review.

Review of Final Plan

The strategic plan was presented to the dean of the engineering technology division, the vice-president of academic affairs, and the director of business and industry programs for the campus. These individuals all were supportive of the plan. The dean recommended a grant proposal be submitted. The director of business and industry requested permission to seek support from the local industries and economic development agencies.

Chapter 5

DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Discussion

This project began with a set of connected problems. First, the need to prepare electronics engineering technicians to work in a rapidly changing world; second, the decline in the local enrollment in EET; and third, the problem of county-wide student access to the single campus offering the EET program. The strategic plan developed is intended to address these three problems areas with an innovative distance learning initiative. The strategic plan provides the means to deliver training for high performance workers and learners at either campus sites or off-campus locations.

Distance Learning in the Engineering Technology Community

A large number of schools, both two-year and four-year, are involved with distance learning in engineering technology. The request sent out on the Engineering Technology Division list serve generated a number of responses and considerable discussion. In conversations with the program leaders at several of the schools, their enthusiasm for distance learning was very clear. Many of the distance learning program directors believed that distance learning was the only way their programs could reach the students. The strategic plan developed by this project has drawn upon the experience of these programs.

A major means of providing class content for these programs has been real time video-based lectures. Old Dominion

University, and University of Houston both depend on video delivered to remote sites. Sinclair Community College and Aims Community College use video tape as the means of delivering lecture material. All program directors agreed that the video taped lectures offered a cost effective way to reach distance learners. Since, the South Campus engineering technology faculty have experience in using video taped lectures, it is reasonable to include taped lecture segments in the strategic plan as part of the distance learning paradigm. The strategic plan proposes to use the video taped lectures only for key concepts. If the taped segments are sufficiently short, they can be converted to a digital format as suggested by the college computer systems administrator in charge of the Internet activity.

Most schools contacted about distance learning had a common problem with the time delay in collection and distribution of written work. The use of the postal service added a week or more to the typical on-campus turnaround time. This strategic plan addresses this problem by utilization of the digital technology of the network. By providing a page scanner at each student workstation, all written assignments will be scanned to a digital format. These scanned documents will be sent by email to the instructor. This will reduce the collection process to minutes instead of days. This application of the scanner is in the spirit of Negroponte's (1995) admonition to move bits not atoms. The alternative to a scanner was the use of a fax machine. The scanner was selected over a fax machine for several reasons. First, the page scanner hardware is much less expensive. Second, once the written work is in digital form, it can be graded on screen, comment marks can be added, and the assignment returned by email to the student. The technology to accomplish this rapid exchange of assignments has been demonstrated on the engineering technology local area network. The industry advisory members were very enthusiastic over this feature. Many of the advisory members routinely transfer documents between sites through their own corporate networks.

A study of computer use in 1995 (Cunningham, 1995) did not uncover the extensive use of computer simulation of circuits shown by some schools. In the 1995 survey, the program pSpice was dominate. However, the schools involved with distance learning were using a program called Electronics Workbench (EWB). Since the characteristics of the program were so highly recommended by two of the program directors, the program EWB was acquired and evaluated in the laboratory at CCAC. Because of the ease of use of the program, EWB has been included as part of the laboratory component of the strategic plan.

No new curriculum plan would be complete unless the impact on the faculty is considered. As Sener of Northern Virginia Community College stated, any project needs maximum buy-in from the faculty. The information from other schools was used to provide a recommendation for faculty compensation for participation in distance learning courses. If college funds are used for project development, the suggestions in the plan for faculty compensation will need to be approved by both the college and the local bargaining unit. However, if non-college grant money is obtained, the proposals as outlined can be followed for the life of the grant. In addition to faculty participation as subject matter experts, the assistance of Web programmers and graphic specialists will be needed to produce the computer based materials. Because of the college's current financial constraints, the one-year implementation budget included in the strategic plan will require external funds.

Departmental SWOT Analysis

The strategic plan related to the SWOT analysis completed by the members of the engineering technology faculty through expanded use of the engineering technology computer network. The network was identified as a major strength of the engineering technology program. By providing modem-based connectivity, the plan will address the opportunity of offering training to local companies at the company site. If these students can be accommodated as part of the regular sessions, two of the weaknesses, declining enrollments and the need for larger class sizes, will be addressed.

Curriculum Design

The strategic plan details a new distance learning paradigm that encompasses current computer technology, and applications of cognitive science and adult learning. The six step curriculum design model presented has been used at South Campus to develop engineering technology courses. However, the strategic plan for distance learning places increased emphasis on instruction and performance evaluation aspects than the typical classroom model. Barr and Tagg (1995) call for the learning paradigm to "...

create environments and experiences that bring students to discover and construct knowledge themselves ...." (p. 15). To place the learning activities on the network will require that the faculty have all details of the content delivery prepared before the course is offered. Faculty time, during the course, should be spent more on guiding and coaching the student in how best to use the material. This is a new, challenging role for the faculty. The faculty will require some training in application of the cognitive learning strategies of Johnson and Thomas (1994). The college has a new faculty development program in teaching improvement and the process can be utilized to provide the necessary changes in teaching skills. However, the faculty, themselves, in the SWOT analysis listed willingness to change as a major strength.

The Johnson and Thomas (1994) strategies call for all activities having real world applications with increasing complexity as the students progress. The industry advisory members should be helpful with suggestions and examples of real world applications.

The six step model also calls for evaluation and revision. This is an area of curriculum that is often neglected in the community college. The college has a program and course review process. The strategic plan proposes to collect, by network, the information for this process. An electronic feedback form will appear in the lesson at strategic places to obtain student opinions on all areas of the course. These feedback screens will collect information in a timely manner on problems and successes.

These screens can also provide the information for formative evaluation to improve the quality of the program.

Hardware and Software

The strategic plan lists a minimum hardware system to carry out the activities proposed. The software listed consists of those programs used at present in the program such as Mathcad and Microsoft Office. Also listed are the new programs selected for use as a result of this project such as Electronics Workbench and Cu-See-Me. The combination of hardware and software proposed is representative of the state of the art in the Fall of 1996. That will change with time. Grove (1995), CEO of Intel corporation, states that the complexity of computer chips doubles every 18 months. Although, the needs of this program are not expected to change at that rate, the expectations of students and faculty may require upgrading equipment every two years.

With the exception of the CD-ROM drive and support hardware, the engineering technology laboratories hold 15 computers that meet the requirements of the plan. An additional 15 computers are scheduled to be installed in early 1997. The computer center has 45 computers available that meet the systems specifications of the plan. However, the support hardware is not in place. The 4X CD-ROM drive was selected to be compatible with the CD-ROM writer that is connected to the engineering technology network. This will allow CD-ROMs to be made for the program that will be compatible with the project systems.

All software programs and hardware configurations proposed by the plan have been tested in the engineering technology laboratory to confirm that the specifications are realistic, and that the tasks required can be performed on the network.

Laboratory Component

The most difficult portion of electronics engineering technology to deliver in a distance learning model is the hands-on laboratory. All of the schools contacted stated that providing laboratory experience was a major problem of their programs. The equipment used by engineering technicians is expensive. A typical experiment in the South Campus electronics laboratory can involve over $3,000 worth of equipment and circuity. In addition, the industry advisory group expressed that hands-on skills with high-tech measurement equipment was important. The strategic plan takes this factor into consideration by proposing open laboratory times for distance learning students. One afternoon during the week, for full time students at other campuses, and a saturday laboratory, for evening and off-campus students, will be scheduled. This could require one trip per week to the South Campus. If simulation experiments can be developed the number of trips can be reduced. As part of the course development, the question of what can be simulated with EWB and what activities must be done with the actual equipment must be answered. The ratio of simulation to actual experiments may be different for different courses. The use of simulation will help the student to develop the mental models necessary to understand the real world (Andaloro, Donzelli, & Sperandeo-Mineo, 1991). By including these simulations in the project, through EWB, the student will have a virtual reality laboratory (VRL) on each site. The VRL can be used to practice concepts. In addition to laboratory applications of EWB, the software can be used to assist learning of the course material. With the VRL available to each student at all times, EWB will be used to provide the important touchstone problems (Redish, 1994). By using the VRL, the student will be able to expand and modify the mental model of circuit behavior more easily than in the actual laboratory.

Relationship of the Strategic Plan to the Research Questions

Research Question 1. How can the newer electronic communication technologies be used to provide a virtual learning community in the Electronic Engineering Technology Program?

The hardware and software proposed in the plan demonstrate it is possible to assemble at reasonable cost, a student workstation with the capability to support a virtual learning community. Support for such an activity is available from the campus computer center directors and from the college Internet systems administrator. It is even possible to provide the virtual learning community to off-campus sites. What remains is for the faculty to add the subject matter content to the technical infrastructure.

Research Question 2. What is the appropriate strategic plan (a) to offer a multisite Electronic Engineering Technology Program by network communication; (b) to establish the needed coordination between high school programs, the community college, and transfer institutions; and (c) to develop an evaluation plan?

This research question has three parts. First, the strategic plan outlined in Appendix N, provides a full spectrum of learning activities including reading, problem solving, simulation, audio and video presentations. This activity is done in a digital environment where information is exchanged in a matter of seconds and collaboration with the students and instructor can be both synchronous and asynchronous.

Second, the advisory group has established the needed coordination of the EET program with both the high schools and the four year colleges. The entry skills for the distance learning program are no different than for a traditional lecture-laboratory course. Necessary initial computer skills can be obtained within the program through the proposed orientation process. Students could attend full or part-time, and the quality and content of the on-line material will be equal to or better than the traditional classroom (Kulik & Kulik, 1987). Since the content and quality will be maintained, the transfer relationships with four-year schools will remain unchanged. Also, the high school students can, through the Internet and a modem based computer, participate in all or part of the program. This will allow the high school student to experience first hand the level of work expected in the college program.
In addition, students completing the Tech Prep sequence in electronics, as part of a high school program, will be given advanced placement in the EET program.

The third portion of research question two is related to evaluation. A formative program evaluation process will regularly collect student feedback. This feedback will be collected through the virtual learning environment established through the World Wide Web technology. This feedback will gage student perceptions of program difficulty and problem areas. Students must respond to the evaluation questionnaire to continue. This required response will increase the chance of uncovering problem areas. In addition to using this information for formative evaluation, by collecting the same information from many students, the data can be summarized and used as input to the required summative evaluation at the end of each year. This student feedback will provide information that the numerical information related to student numbers, graduates, costs and placement does not now contain.

Research Question 3. What changes in the existing objectives of the Electronic Engineering Technology Program will a multisite networked program require to achieve the knowledge and skill levels expected by industry?

From the perspective of the advisory group, the content of the courses should be the same for distance learning courses as for the traditional course. The principles of electronics are the same no matter how these principles are presented. Because hands-on activities are important to the electronic engineering technician and because it is not financially practical to ship electronic equipment all over the county, some on-campus laboratory time will be necessary in the program. Some simulation and use of virtual reality laboratory experiments will, however, ease the travel requirements of the program.

The incorporation of computer simulation, email, and computer conferencing will help the student develop strong computer skills. This was considered an important skill by the industrial representatives on the advisory group. Even without the distance learning influence, advances in technology would lead to increased use of simulation experiments.

Conclusions

The results of this project and the development of the strategic plan for a distance learning initiative in EET has led to several conclusions. Eleven conclusions are grouped into four categories: (a) classroom model (3), (b) faculty (3), (c) hardware and software (3), and (d) laboratory component (2).

Classroom Model

1. Modern computer networks can be used to provide a classroom model based on active student involvement instead of the more passive lecture model.

2. The Internet and the World Wide Web can provide a distance learning opportunity to all members of the county.

3. Adult learners will respond well to a constructivist approach based on real world applications.

Faculty

1. The faculty of the engineering technology division have computer and network skills and are open to the process of change.

2. When provided a reasonable incentive and time, faculty can adapt college curriculum to distance learning formats.

3. Reasonable time to develop a course into the distance learning mode is equal to the time required to offer the course.

Hardware and Software

1. Multimedia based computer systems and support software are readily available that will provide both asynchronous and synchronous distance learning capabilities.

2. The Community College of Allegheny County has an installed infrastructure that can support a computer based distance learning initiative.

3. By going to a digital information exchange for assignments, homework, and quizzes, delays in feedback to the student can be minimized.

Laboratory Component

1. The program Electronic Workbench (EWB) is a useful learning aid to provide touchstone learning experiences. Using EWB the student can practice concepts that normally require thousands of dollars worth of equipment and direct supervision.

2. There is no agreement on the specific skill set that can be taught by VRL. The appropriate mix of simulation and actual hand-on remains a question for study.

Implications

There are several implications this project has for technical education at CCAC. First, when the vision of this project to have key technical courses available at all campus sites through computer-based distance learning is accomplished, there will be increased opportunities for electronics training for the people of Allegheny county. As the students begin to be successful in the distance learning mode of delivery, they will ask for the same delivery mode to be used in other courses outside of the electronics engineering technology area. The faculty, seeing that the necessary computer infrastructure is in place and functioning, will be encouraged to participate in distance learning courses. The successful implementation of this project will cause the college administration and the faculty to recognize distance learning as a viable and important part of the CCAC program. This recognition will provide for distance learning activities to be a regular part of the college schedule.

For the industrial partners of CCAC, who have expressed a need for on-site training, the availability of a distance learning program in electronics will provide their employees new training opportunities at the corporate site.

Recommendations

As a result of this study, several recommendations have been made. These recommendations have been grouped into the areas of implementation, dissemination and research.

Implementation

Recommendation 1. The vision statement in the strategic plan for a distance learning initiative in EET should be adopted by the college.

Recommendation 2. The faculty of the engineering technology division and the administration should work together to secure the necessary external funding to support the development of the course material and student workstations.

Recommendation 3. The office of Institutional Research of CCAC assist in using the networked environment of the program to enhance the program review and evaluation process leading to regular formative evaluation in addition to the summative evaluation that Institutional Research now uses.

Dissemination

To secure the support of the wider college community, and to encourage change across the college, the following recommendations relate to dissemination of the plan.

Recommendation 4. The plan be provided to all department heads to encourage them to consider the distance learning paradigm in their discipline.

Recommendation 5. The plan be provided to the educational technology committee as an informational item for consideration with negotiations on faculty load within the collective bargaining agreement.

Recommendation 6. A copy of the strategic plan be provided to the ERIC Clearinghouse for Community Colleges to share the ideas with the wider two-year college community.

Research

Recommendation 7. The role of simulation software packages and virtual reality laboratories should have in the training of technicians should be explored further. Because distance learning can reach beyond the local area, and because many schools have shown interest in this technology, this research should be done as a regional or national project with national grant based support.

Recommendation 8. The effectiveness of off-site exams and feedback, as proposed in the plan, should be studied. For the digital scanner technology to succeed in the distance learning environment, it should be determined that students will perform on quizzes and assignments in an unsupervised environment equal to those in a supervised environment.

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APPENDIXES

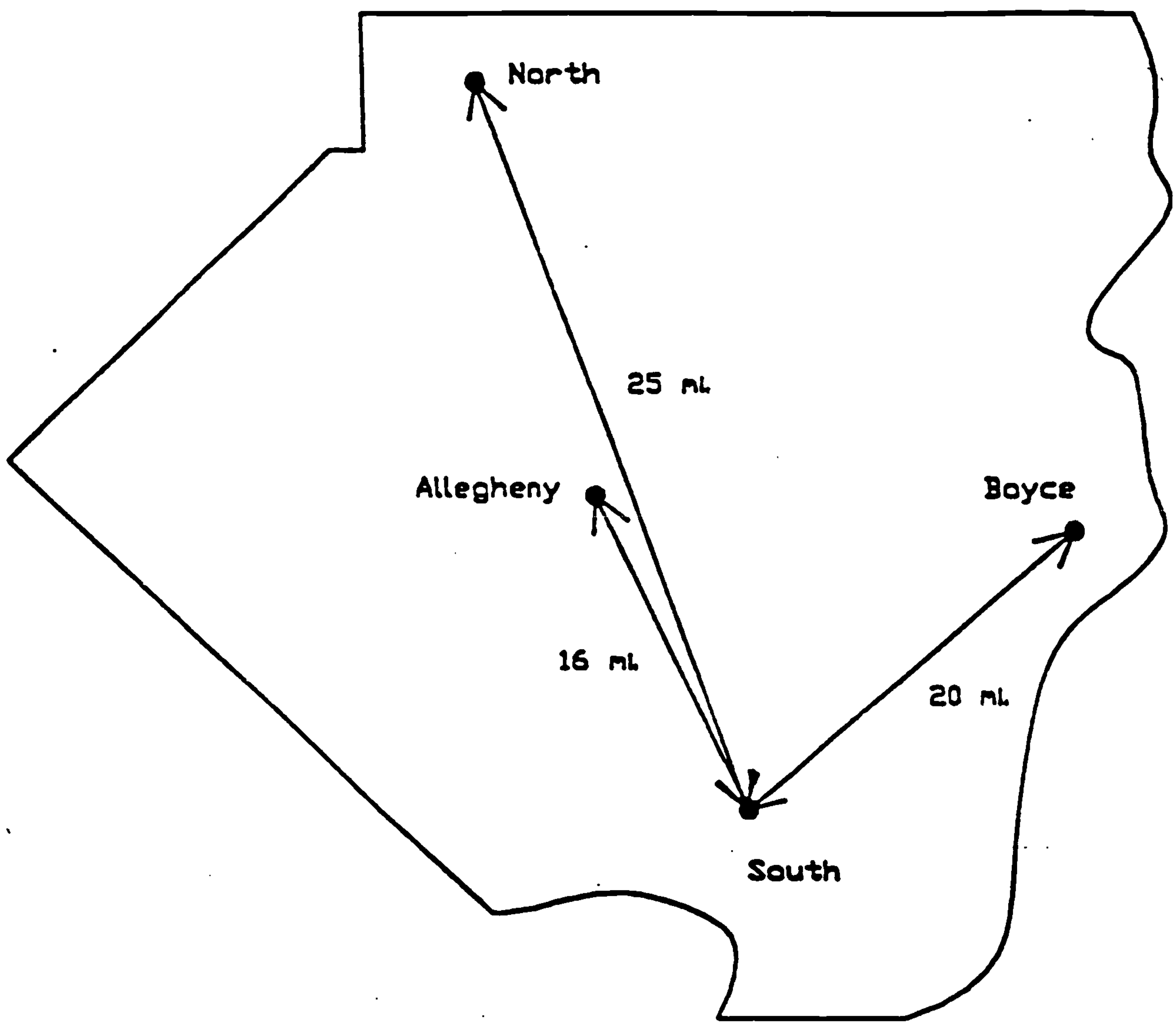
Appendix A

Mission Statement

The Community College is committed to providing an accessible and affordable college education, greater educational opportunity, comprehensive college programming and quality instruction in its classrooms. Its mission is to provide a high quality comprehensive community college program for the residents of Allegheny County. This program will include vocational-technical and career education, community services, developmental education, college transfer programs, as well as general education to enrich and enhance the student's life. The Community College of Allegheny County will seek to carry out its program with the most innovative and effective educational methods available, as economically as possible, at the lowest possible cost to its students and with full accountability to its constituents. The College will maintain an open door admissions policy and will conduct its programs at multiple locations convenient to its students (Community College of Allegheny County, 1994a, p. 2).

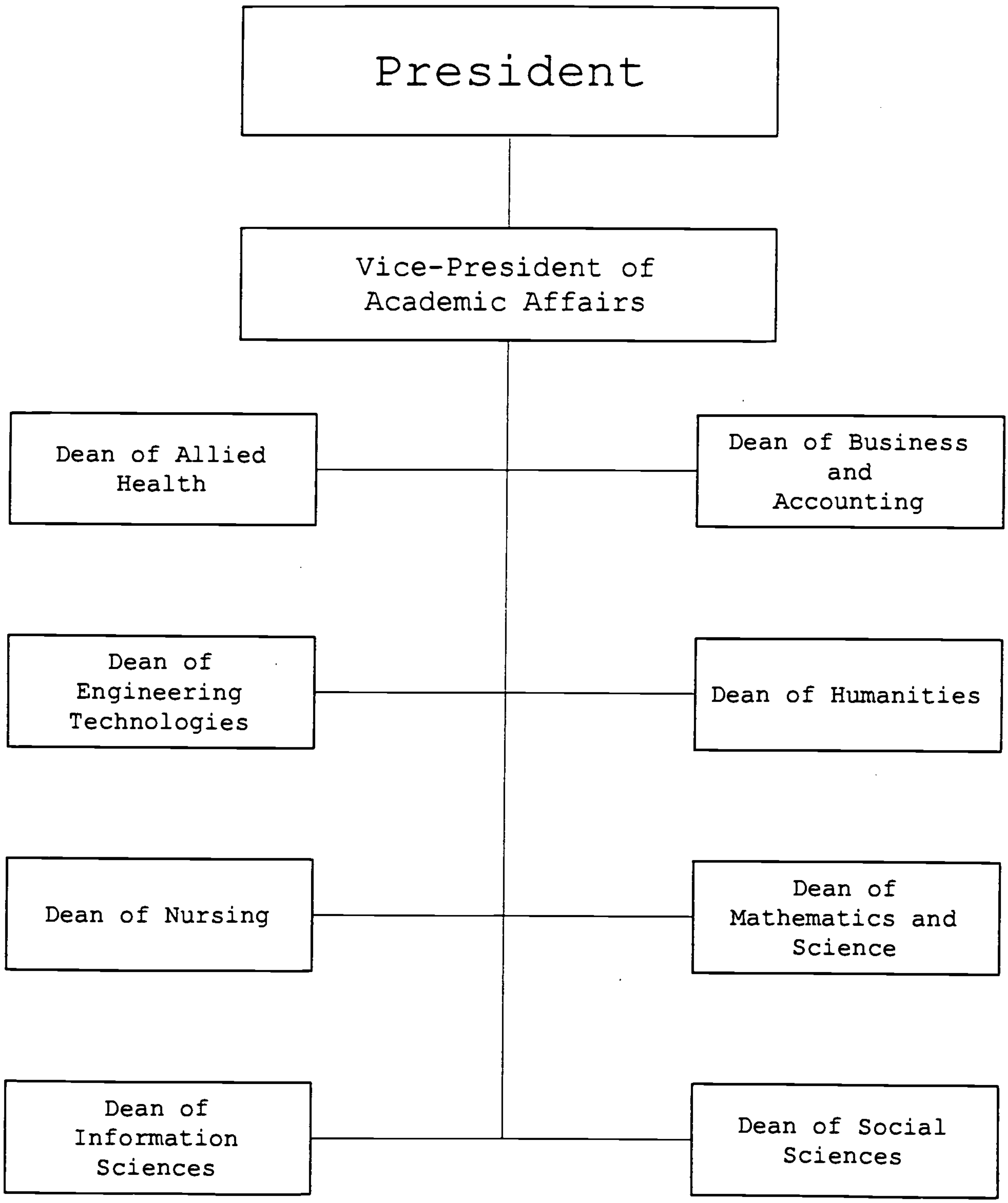
Appendix B

College Location Map



Appendix C

New Division Structure



Appendix D

Engineering Technology Related Programs

Architectural Drafting and Design

Civil Engineering Technology

Computer Aided Drafting and Design Technology

Electronic Engineering Technology

Environmental Technology

Mechanical Drafting and Design Technology

Mechanical Engineering Technology

Microcomputer Electronics Technology

Robotics and Automated Systems Technology

Science and Engineering Technology

Telecommunications Technology

Appendix E

Electronic Engineering Technology Curriculum

Required Core:

Course Number	Description	Credits
MAT114	Technical Mathematics 1	3
MAT116	Technical Mathematics 2	3
SET105*	Technical Computing	3
PHY113	Technical Physics 1	3
PHY114	Technical Physics 2	3
EGR100*	Engineering Seminar	1
ENG101	English Composition 1	3
ENG106	Report Writing	3
Required Major Courses:		
EET103*	Introduction to Electronics	3
EET201*	Electronics 1	4
EET202*	Electronics 2	4
MIT208*	Digital Electronics	3
MIT110*	Electrical Engineering Circuits 1	4
MIT210*	Electrical Engineering Circuits 2	4
MIT240*	Scientific and Industrial Instrumentation	3
Electives:		
Social Science and Humanities		6
Technical Electives		12-16
Total credits for graduation		60-65

* Indicates course to be offered by distance learning.

Appendix F

SWOT Chart

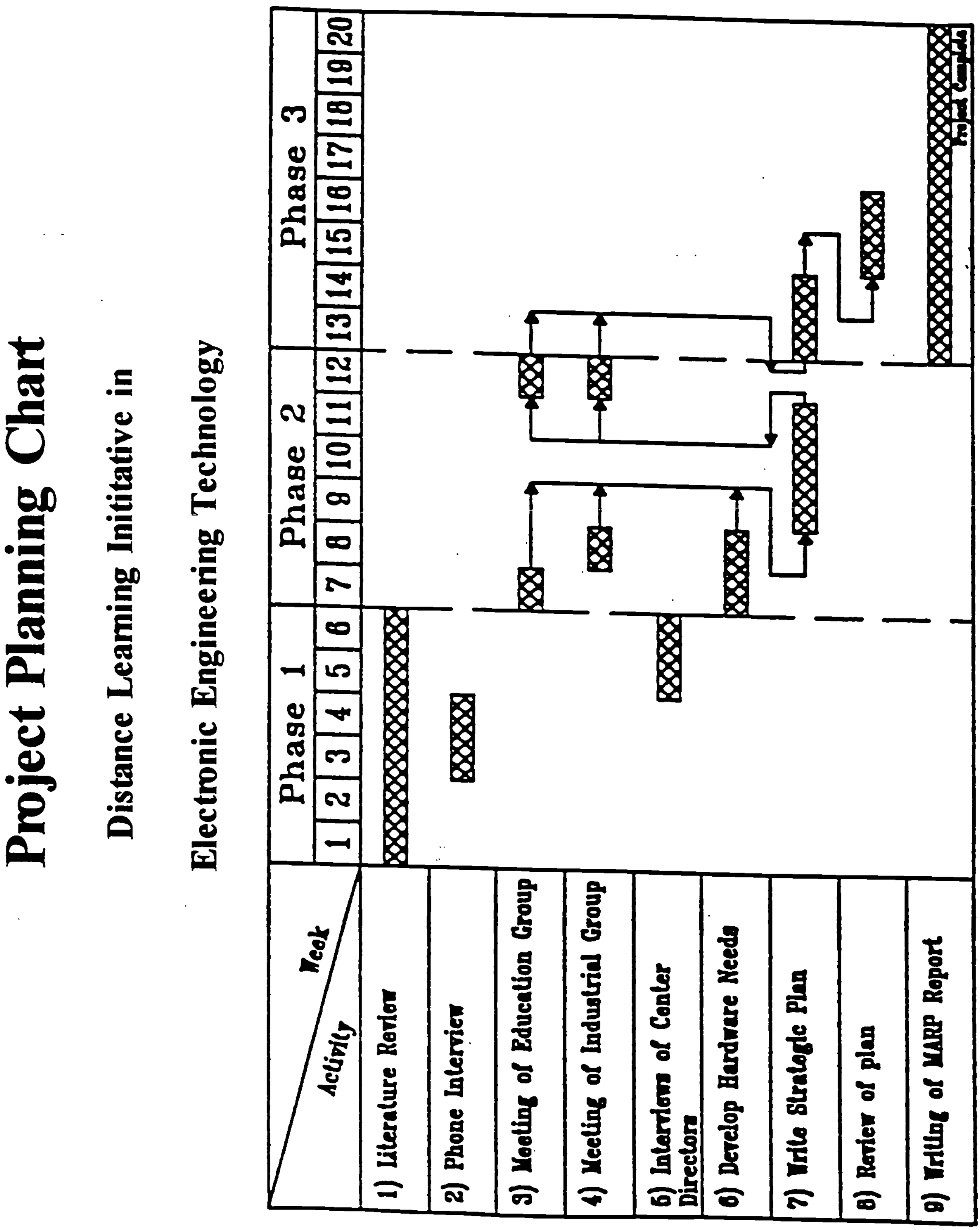
SWOT Analysis
for
Department of Engineering Technology
Community College of Allegheny County
SOUTH CAMPUS

Name: ____________________ Date: ______________

Internal Audit		External Assessment	
Strengths	Weaknesses	Opportunities	Threats
1.	1.	1.	1.
2.	2.	2.	2.
3.	3.	3.	3.
4.	4.	4.	4.
5.	5.	5.	5.

Appendix G

Gantt Chart



Appendix H

Distance Learning Program Interview Form

Question form for phone interviews of distance learning program directors.

Person Interviewed:______________________

School:________________________________

1. What forms of distance learning are you using? (are you using the Internet for any courses?)

2. How successful has the enrollment been?

3. What are the two major problems your program has?

4. How are lab components of the course handled?

5. Do you "feel" it has been cost effective?

6. How are faculty compensated:

   (a) for development?

   (b) for teaching load?

Notes:

Appendix I

Computer Center Director Interview Form

Questions for phone interview of computer center directors.

Campus:

South ____ North ____ Boyce ____ Allegheny ____

1. The EET Distance Learning proposal calls for a student workstation to be located at each site. Could that station be located in the Computer Center at your campus?

2. This student workstation would need Internet access either through the LAN or by modem. What special problem would that pose for your site? Are student email accounts going to be available at your site?

3. Do you have or will you have Pentium based systems within your Computer Center that could be dedicated to the EET students as first priority?

4. What sites beyond the campus do you support? Would it be possible to use those sites for this project?

5. As a Computer Center Director, what questions do you have or what problems do you see with a computer-based distance learning project? Would you welcome such a program?

Appendix J

List of Advisory Members

Industry Members:

Keith Davis, Adtranz

Robin Taylor, Port Authority Transit of Allegheny County

Robert Percival, AEG Automation

John Fibbi, USS Clairton Works

Education Members:

Charles Schuler, Professor, California University of Pennsylvania

John Loney, Professor, California University of Pennsylvania

David Daly, Technology Instructor, Brentwood High School

Leslie Smith, Electronics Instructor, Steel Center Area Vocational Technical School

Douglas Cunningham, Point Park College

Michael Kurth, Point Park College

CCAC Members:

James Kushner, Dean, Division of Engineering Technologies

Patrick Gerity, Director of Business and Industry

Pearley Cunningham, Professor, Engineering Technology

Reza Chitsaz, Professor, Engineering Technology

Appendix K

Completed Engineering Technology SWOT

SWOT Analysis for Department of Engineering Technology

Community College of Allegheny County

SOUTH CAMPUS

Internal Audit		External Assessment	
Strengths	Weaknesses	Opportunities	Threats
1. Department computer network 2. Comprehensive program offerings 3. Quality of faculty 4. Willingness of faculty to change and adopt new technology 5. Special technology advisor 6. Strong reputation with business and transfer schools	1. Declining enrollment 2. New reduced state funding formula 3. Poor recruitment process 4. Administrative push for larger classes than the Engineering Technology labs will hold 5. Weak Co-op program	1. Mon-Fayette Expressway improving transportation to southern counties with no community college 2. Interest of local industries in credit and non-credit technical education 3. Diverse new industries in the Mon Valley	1. Competition from aggressive technical/ trade schools 2. Poor state funding 3. Penn State branch re-organization

Appendix L

Course Syllabi

COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS:South__CREDIT COURSE SYLLABUS

COURSE NUMBER: EET103 COURSE TITLE: Intro. To Electronics

SEM CRDTS: 3 HOURS:LECTURE 2 LAB 2 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES:______COREQUISITES:_Mat108 or equivalent

CATALOG COURSE DESCRIPTION:

A course in the basic principles of electronics. Beginning with a survey of modern electronics, amplifiers power sources and selected integrated circuit elements are studied. Theory is applied to laboratory work concentrating on construction and testing of actual circuits and the use of modern measurement techniques. No previous experience in electronics or science is required.

LEARNING OUTCOMES:

1. To be familiar with the basic DC and AC circuit analysis.
2. To develope the student ability in unit conversions, logical thinking, and engineering problem solving.
3. To be familiar with the charging of a capacitor with a constant voltage source and the transient charging current in a series RC network.
4. To introduce popular modern linear integrated circuits and regulated power supplies.
5. To increase the student's use and application of electronic vocabulary to communicate within the manufacturing community both with the engineer/designer and technicians.
6. To stimulate the student's interest in life-long, self-learning.

LISTED TOPICS:

I. **Current and Voltage**
   A. Electrical Charge
   B. Electrical Current
   C. Electrical Voltage
   D. Electrical Power

II. Ohm's Law
- A. Applications of the Ohm's Law
- B. Power Relations
- C. V-I Characteristics

III. Series and Parallel Network
- A. Kirchhoff's Current Law
- B. Kirchhoff's Voltage Law
- C. Voltage Divider Rule
- D. Current Divider Rule

IV. Complex Circuit Analysis
- A. General Strategy
- B. Three and Four Resistor combinations
- C. Wheatstone Bridge

V. Time Varying Signals
- A. Describing Time Varying signals
- B. Generating Time Varying Signals
- C. Average and rms Values

VI. Capacitors
- A. Principles of Operation
- B. Parallel and series Connection
- C. Typical applications
- D. Charging a Capacitor with a Constant Voltage source
- E. Dischrging a Capacitor

VII. Operational Amplifier
- A. Integrated Circuits
- B. Op-Amp as a Voltage Comparator
- C. Op-Amp as a Voltage Amplifier
- D. Negative Feedback
- E. Voltage Follower
- F. Apllications

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT: (May be unique for each campus)

Introduction To Electronics Technology by John McWane
Course Handouts
Introduction To Electronics Laboratory Manual by P. Cunningham.

SYSTEM APPROVAL:

S T A R T
YR/TERM:______ DATE:______ SIGNATURE____________________

COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS: South CREDIT COURSE SYLLABUS

COURSE NUMBER: EET201 COURSE TITLE: Electronics I

SEM CRDTS: 4 HOURS: LECTURE 3 LAB 2 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES: EET103 COREQUISITES: None

CATALOG COURSE DESCRIPTION:

A course in the principles and use of discrete electronic devices such as bipolar and field effect transistors,triac and silicon controlled rectifiers and the application of these devices to basic circuits such as small signal and power amplifiers and power control systems.

LEARNING OUTCOMES:

1. To be familiar with semiconductor theory and solid-state devices.
2. To develop student ability to analyze and design rectifiers.
3. To provide a basic knowledge of the operation of diodes and transistors in electronic circuits.
4. To be familiar with the PSpice Design Center software package.
5. To be able to plot the frequency response graphs of voltage amplifiers.
6. To increase the student ability in troubleshooting and design of the electronic circuits.

LISTED TOPICS:

I. **Introduction**
   A. Voltage And Current Sources
   B. Thevenin's Theorem
   C. Norton's Theorem

II. **Semiconductors**
   A. Conductors and semiconductors
   B. Silicon Crystals
   C. The unbiased Diode
   D. Forward and reverse Biased

III. Diode Theory
- A. The diode Curve
- B. The Ideal Diode
- C. The second and third Approximation
- D. Load Lines

IV. Diode Circuits
- A. The Input Transformer
- B. The Half-Wave and Full-Wave Rectifier
- C. The Bridge Rectifier
- D. The Capacitor Input Filter
- E. Surge Current
- F. Design Guidelines
- G. Diode Applications

V. Special Purpose Diode
- A. The Zener Diode
- B. The Loaded Zener Regulator
- C. Optoelectronic Devices
- D. The Varactor
- E. LED Design Guidelines

VI. Bipolar Transistor
- A. The Unbiased Transistor
- B. Transistor Currents
- C. The Base and Collector Curve
- D. Cutoff and Breakdown
- E. The Transistor Model

VII. Transistor Fundamentals
- A. The load line and the Operating Point
- B. The Transistor Switch
- C. Emitter Bias
- D. LED Drivers
- E. Transistor Current Source

VIII. Transistor Biasing
- A. Voltage divider Bias
- B. VDB Analysis
- C. Two Supply Emitter Bias
- D. PNP Transistors

IX. AC Models
- A. Coupling Capacitor
- B. Bypass Capacitor
- C. Small Signal Operation
- D. AC Resistance of the Emitter Diode
- E. CE Amplifier
- F. Ac Model of the CE Amplifier

X. Voltage Amplifiers
- A. Highlights of a CE Amplifier
- B. Voltage Gain
- C. Predicting Voltage Gain
- D. Swamped amplifier

E. Cascaded Stages
F. Output Impedance
G. Cascaded Stages (Thevenin Method)
H. The common Base Amplifier

XI. Power Amplifiers

A. The AC Load Line
B. Limits on Signal Swing
C. Class A Operation
D. Transistor Power Rating
E. Ac Saturation and Cutoff
F. AC output Compliance
G. Thermal Resistance

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT: (May be unique for each campus)

Electronics Principles by Albert Malvino
Experiments for Electronics Principles By A. Malvino
Electronics Principles 5th Ed. (EP5) Tutorial Electronic - Devices Software.
Course Handouts
PSpice FOR WINDOWS "A Circuit Simulation Primer" by Roy Goody
Laboratory Handouts

SYSTEM APPROVAL:

S T A R T
YR/TERM:______DATE:______SIGNATURE____________________

COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS:South CREDIT COURSE SYLLABUS

COURSE NUMBER: EET202 COURSE TITLE: Electronics II

SEM CRDTS: 4 HOURS:LECTURE 2 LAB 3 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES: EET201 COREQUISITES: none

CATALOG COURSE DESCRIPTION:

A course in the analysis and design of diodes, triodes and multi-element vacuum tubes. Attention is given to low frequency models of transistors.

LEARNING OUTCOMES:

1. Develop student ability to analyze and design power amplifiers.

2. To be familiar with JFET and CMOS Transistors.

3. Provide a basic knowledge of the thyristors and their operations.

4. Increase the student ability in troubleshooting and design of the electronic circuits.

5. To be familiar with the design of active filters, oscillators, and timers.

6. To familiarize the student with the Design Center software package (PSpice FOR WINDOWS) to use three major interactive programs: Schematics, PSpice, and Probe.

LISTED TOPICS:

I. **Emitter Follower**
   - A. CC Amplifier
   - B. Voltage Gain
   - C. Maximum Unclipped output
   - D. Cascading CE and CC
   - E. Cascading CE and CC
   - F. Class B Operation
   - G. Improved Voltage Regulation

II. **Power Amplifiers**
   - A. The AC Load Line
   - B. Class A Operation
   - C. Transistor Power Rating
   - D. AC Output Compliance
   - E. Thermal Resistance

III. Field-Effect Transistors
- A. The Biased JFET
- B. Drain Curves
- C. The Transconductance

IV. FET Circuits
- A. Self-Bias Circuit
- B. Graphical Solution of Self-Bias
- C. JFET Amplifiers
- D. JFET Analog Switch
- E. Other JFET Applications

V. Thyristors
- A. The four-layer Diode
- B. The Silicon Controlled Rectifier
- C. Bidierectional SCR
- D. The Unijunction Transistor

VI. Frequency
- A. Frequency Response of an Amplifier
- B. Input and Output Coupling Capacitor
- C. Emittter Bypass Capacitor
- D. High-Frequency Bipolar Analysis
- F. Decibels and dBm
- G. Power and Voltage Gain
- H. Bode Plot

VII. OP-Amp Theory
- A. Integrated Circuits Making IC
- B. The Differential Amplifier
- C. Common-Mode Gain
- D. The Current Mirror

VIII. More Op-Amp Theory
- A. Small and Large Signal Frequency Response
- B. Power Bandwidth
- C. Op-Amp Characteristics
- D. Popular Op-Amps
- E. Other Linear ICs

IX. Linear Op-Amp Circuits
- A. VCVS Sallen & Key Active Filters
- B. Low-Pass 1st & 2nd-order Active Filter
- C. High-Pass 1st & 2nd-order Active Filter
- D. Band-Pass 2nd-order Active Filters
- E. Multiple-Feedback Active Filter Design

X. Oscillators
- A. Therory of Sinusoidal Oscillation
- B. The Wien-Bridge Oscillator
- C. Other RC Oscillator
- D. The Colpitts Oscillator
- E. The 555 Timer

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT: (May be unique for each campus)

- Electronics Principles by Albert Malvino
- Experiments for Electronics Principles By A Malvino
- Electronics Principles 5th Edition (EP5) Tutorial Electronic Devices Software
- Course Handouts
- Laboratory Handouts
- PSpice FOR WINDOWS " A Circuit Simulation Primer" by Roy Goody

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Community College Allegheny County #CRS10/9

COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS: South CREDIT COURSE SYLLABUS

COURSE NUMBER: MIT110 COURSE TITLE: Elect. Engineering Circuits I

SEM CRDTS: 4 HOURS: LECTURE 3 LAB 2 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES: EET103 or equivalent COREQUISITES:

CATALOG COURSE DESCRIPTION:

A course in electrical circuits analysis. Emphasis is on direct current systems. Topics include Kirchoff's Laws, Thevinin and Norton's Theorem, network equations, induction, capacitance and R-C transients.

LEARNING OUTCOMES:

1. To acquaint the student with the Design Center software package(PSpice FOR WINDOWS)to use three major interactive programs: Schematics, PSpice, and Probe.

2. To develop the student's ability to solve multi-loop Circuits by applying the Network Theorems.

3. To provide the student with the skills necessary to Thevenize any complex dc circuit and to determine the Maximum Power delivered to a load.

4. To understand the behavior of the RC circuits for both transient and the steady-state analysis.

5. To provide the student a working knowledge of the computer spreadsheet (Microsoft Excel) and obtaining the computer plot of the functions.

6. To provide back-up material for subsequent electrical engineering courses employing dc circuit analysis in design.

LISTED TOPICS:

I. **Introduction**
   A. Units of Measurements
   B. Systems of Units
   C. Conversion Between Levels

II. **Current and Voltage**
   A. Current
   B. Voltage
   C. Conductors and Insulators
   D. Semiconductors

III. Resistance and Conductance

A. Resistance of Circular Wires
B. Wire Tables
C. Tempreature Effects
D. Superconductors
E. Color Coding
F. Conductance
G. Photo Conductive Cell

IV. Ohm's Law, Power, and Energy

A. Plotting Ohm's Law
B. Power
C. Efficiency
D. Energy

V. Series Circuits

A. Voltage Source in Series
B. Kirichhoff's Voltage Law
C. Voltage Divider Rule
D. Voltage Regulation

VI. Parallel and Series-Parallel Circuits

A. Parallel Network
B. Kirichhoff's Current Law
C. Current Divider Rule
D. Open and Short Circuits
E. Series-Parallel Network
F. Ladder Network

VII. Methods of analysis

A. Voltage and Current Sources
B. Source Conversions
C. Determinants, Minor and Cofactors
D. Mesh Analysis
E. Bride Network
F. Delta-Wye and Wye-Delta Transformations

VII. Network Theorems

A. Thevenin's Theorem
B. Norton's Theorem
C. Maximum Power Transfer

IX. Capacitors

A. The Electric Field
B. Capacitance
C. Transient in Capacitive Networks
D. Time Constant
E. Energy Stored by a Capacitor
F. Stray Capacitance

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT: (May be unique for each campus)

I. TEXT BOOKS
- A. TEXT: Introductory Circuit Analysis by Robert Boylestad
- B. LAB Manual: DC Circuit Analysis with Computer Applications by R. Chitsaz
- C. PSpice FOR WINDOWS "A Circuit Simulation Primer" by Roy Goody

II. Software Packages to Support Class
- A. PSpice FOR WINDOWS
- B. Microsoft Excel for Windows
- C. Microsoft Word for Windows
- D. Micro-Cap III

III. Materials
- A. Scientific Calculator
- B. Four 3.5" High Density Disk
- C. One Package of Engineer's Pad
- D. A Two Pocket Folder

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Community College Allegheny County #CRS10/9

COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS:South CREDIT COURSE SYLLABUS

COURSE NUMBER: MIT208 COURSE TITLE: Digital Electronics

SEM CRDTS: 3 HOURS:LECTURE 2 LAB 2 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES: EET103 COREQUISITES:

CATALOG COURSE DESCRIPTION:

Beginning with the simple definition of the truth tables for the AND and OR, the course proceeds through more complicated logic elements such as flip flops, adders, counters, random access, and field programmable memories.

LEARNING OUTCOMES:

1. The student will have troubleshooting techniques and skills to repair digital circuits at the component level.
2. The student will be proficient in the use of logic probes, comparators, and logic pulsers in troubleshooting.
3. The student will be able to operate multichannel oscilloscopes to analyze timing in digital circuits.
4. The student will use computer simulation programs to check the operation of systems before they are constructed.

LISTED TOPICS:
1. Logic Types
2. Gates
3. Boolean Algebra
4. Combinational Logic
5. Multivibrators
6. Flip flops
7. Applications

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT:
(May be unique for each campus)
Digital Technology, by Williams

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COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS:South CREDIT COURSE SYLLABUS

COURSE NUMBER:MIT210 **COURSE TITLE: Elect.Engineering Circuits II**

SEM CRDTS: 4 HOURS:LECTURE 3 LAB 2 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES: MIT110 COREQUISITES:

CATALOG COURSE DESCRIPTION:

A continuation of basic circuit analysis. Emphasis is on alternating current circuits. Topics include effective values, power factors, RL, RLC circuit filters, multisource mesh and nodal analysis, transformer action, resonance and inductance. Computer analysis of circuit problems is covered.

LEARNING OUTCOMES:

1. To familiarize the student with the Design Center software package (PSpice FOR WINDOWS) to use three major interactive programs: Schematics, PSpice, and Probe
2. To develop the student ability to solve multi-loop circuits by applying the network theorems.
3. To provide the student with the skills necessary to thevenize any complex ac circuit to determine the maximum power delivered to a load
4. To provide the student a working knowledge of the computer spreadsheet (Microsoft Excel)
5. To provide back-up material for subsequent electrical engineering courses employing ac circuit analysis in design.

LISTED TOPICS:

I. **Inductors**
   A. Self-Inductance
   B. Induced Voltage
   C. R-L Transient analysis
   D. R-L Transient analysis by PSpice Design Center

II. **Sinusoidal Alternating Waveforms**
   A. The Sine-wave
   B. General Form for Sinusoidal V and I
   C. Average and Effective Values
   D. Phase Relations

III. Review of Complex Numbers

A. Rectangular Form
B. Polar Form
C. Trigonometric Form
D. Conversion Between Forms

IV. The Basic Elements and Phasors
A. The derivative
B. Average Power and Power factor
C. Phasors
D. R-C Response to Square-Wave Inputs

V. Series, Parallel, and Series/Parallel Circuits
A. Impedance and Phasor Diagram
B. Voltage Divider Rule
C. Admittance and Suseptance
D. RL, RC, and RLC Series and Parallel Circuits
E. Current Divider Rule

VI. Method of Analysis
A. Source Conversions
B. Mesh Analysis
C. Bridge Networks

VII. Network Theorems
A. Thevenin's Theorem
B. Maximum Power Transfer
C. Equivalent Circuit
D. Example Problems (Handouts)

VIII. Resonance
A. Series Resonance
B. The Quality Factor
C. Selectivity
D. Parallel Resonance

IX. Decibel. Filters, and Bode Plot
A. Logarithms
B. Decibels
C. Filters
D. Bode Plots

X. Magnetic Circuits
A. Magnetic Field
B. Flux Density
C. Permeability
D. Reluctance
E. Ohm's Law for Magnetic Circuits
F. Hysteresis
G. Ampere's Circuital Law
H. Air Gaps
I. Series Magnetic Circuits

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT: (May be unique for each campus)

I. TEXT BOOKS

A. TEXT: Introductory Circuit Analysis by Robert Boylstad
B. LAB Manual: Experiments in Circuit Analysis by Boylstad
C. PSpice FOR WINDOWS "A Circuit Simulation Primer" by Roy Goody

II. Software Packages to Support Class

A. PSpice FOR WINDOWS
B. Microsoft Excel for Windows
C. Microsoft Word for Windows
D. Micro-Cap III

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C. One Package of Engineer's Pad
D. A two Pocket Folder

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COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS:South CREDIT COURSE SYLLABUS

COURSE NUMBER: MIT240 COURSE TITLE: Scientific and Industrial Instrumentation

SEM CRDTS: 3 HOURS:LECTURE 2 LAB 2 CLINICAL STUDIO PRACTICUM

PREREQUISITES: MIT208 and PHY113 COREQUISITES:

CATALOG COURSE DESCRIPTION:

A course in the techniques of measuring physical quantities through electronic transducers. Electronic circuits used to convert these signals to appropriate voltages are presented. Techniques for these electronic signals to control physical systems through both analog and digital computers are covered.

LEARNING OUTCOMES:

1. The student will apply the principles of both physics and basic electronics to explain the representation of physical quantities as a voltage.

2. The student will explain and troubleshoot the baisc process control loop, identifing dynamic variable, measurement process, the controller, the final control elemet, and the process.

3. The student will select and apply the correct thermal sensor for a defined situation.

4. The student will develop transfer function equations for signal input or output and draw electronic circuits to accomplish the needed event.

5. The student will apply the appropriate computer tools to calculate, graph and report process information as appropriate.

LISTED TOPICS:

1. **Process Control Principles**
   a. Process Block diagram
   b. Evaluation
   c. Analog and Digital Processing
   d. Units and Standards
2. **Analog Signal Conditioning**
   a. Passive Circuits
   b. Operational Amplifiers
   c. Industrial components
3. **Digital Signal Conditioning**
   a. ADC

b. DAC
c. Resolution
d. Confersion Time

4. **Thermal Sensors**
   a. Thermocouples
   b. Thermisters
   c. Resistance/Temperature Detectors
   d. Mechanical Systems
5. **Final Control Elements**
   a. Acuators
   b. converters
   c. Power sources
6. **Controler Principles**
   a. Proportional
   b. Reset
   c. Rate
   d. PID Units

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT:
(May be unique for each campus)

Process control Instrumentation Technology - 4 th Edition, by Curtis Johnson, Printice Hall

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COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS:South CREDIT COURSE SYLLABUS

COURSE NUMBER: SET105 COURSE TITLE: Technical Computing

SEM CRDTS: 3 HOURS:LECTURE 2 LAB 2 CLINICAL___STUDIO___PRACTICUM

PREREQUISITES: MAT108 or higher COREQUISITES:

CATALOG COURSE DESCRIPTION:

A course in the programming and use of computers for engineering and engineering technology majors. Algorithm development for solution of engineering equations and problems is stressed. Although the majority of the programming will be in the BASIC language, an orientation to other languages is presented. Engineering applications of computer aided drafting, graphics, spreadsheets, wordprocessors, and databases are covered.

LEARNING OUTCOMES:

1. The student will demonstrate the ability to solve simple engineering equations by using a variety of computer tools to prepare a printed report on a given problem.
2. The student will use a spreadsheet to calculate the solution to a simple linear and quadratic algebraic equations.
3. The student will use a word processor to prepare a document containing one graphic selected from the file server.
4. The student will demonstrate the ability to move, rename, save, and create text and graphic files using Windows, DOS, and the Network.
5. The studnet will demonstrate the ability to send and receive electronic mail following guidelines set forth in the laboratory handouts.
6. The student will use Mathcad program to solve given engineering equations containing both powers and transendentals. The solution will provide both specific numerical answers and graphical presentations.
7. The student will at all times practice professional and ethical behavior as outlined in the class handouts. this includes, but is not limited to, owership of files, backup procedures, use of resources provided, and use of the Internet and team contributions.

LISTED TOPICS:

1. **Orientation to Lab and the network**
   a. Local Area Network
   b. Internet
   c. Browser Software
   d. E-mail
2. **MS DOS**
3. **Dos Edit**
   a. HTML files
   b. Text files
   c. Batch files
4. **Windows 3.1**
   a. Write
   b. Paintbrush
   c. Program Manager
   d. File Manager
   e. Notepad
5. **Use of Graphics**
   a. Clip Art
   b. Formats
   c. Conversion Techniques
6. **Mathcad**
7. **Excel**
8. **QBasic**

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT:
(May be unique for each campus)
Windows 3.1, by Hutchison, Sawyer, Coulhard.
Dos 5.0, by Above authors
Excel for Windows, by above authors
Mathcad for ET, by P. Cunningham
Each student needs two 3-1/2 inch disks(1.44Mb)

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COMMUNITY COLLEGE OF ALLEGHENY COUNTY

CAMPUS: South CREDIT COURSE SYLLABUS

COURSE NUMBER: EGR100 COURSE TITLE: Engineering Seminar

SEM CRDTS: 1 HOURS: LECTURE 1

PREREQUISITES: none **COREQUISITES: none**

CATALOG COURSE DESCRIPTION:

This course prepares students for careers in Engineering and Technology. Assigned problems acquaint the student with methods for solving practical engineering problems. Films and guest lectures delineate the work of graduate engineers in each of several professions.

LEARNING OUTCOMES:

1. The student will demonstrate a knowledge of the chosen field by selecting the appropriate courses for the time at CCAC.

2. The student will develop an understanding and appreciation of engineering and technology as a people driven profession based in practice.

3. The student will demonstrate the use of the engineering method in problem solving.

4. The student will develop their skills in calculator operations and construction of engineering graphs.

5. The student will demonstrate team work in their classroom participation.

LISTED TOPICS:

I. Orientation to Engineering and Engineering Technology

II. The Calculator in Engineering
- A. X-keys
- B. Trig operations
- C. Power of 10 notation
  1. Engineering Notation
  2. Scientific Notation
- D. Programmable Calculators

III. Career Exploration

IV. Problem Solving Reporting

III. The Engineering Method

V. Engineering Graphics

REFERENCE, RESOURCE, OR LEARNING MATERIAL TO BE USED BY STUDENT:
(May be unique for each campus)

There is no text book for the course. Work is done through a series of class hand-out materials. Attendance is mandatory.

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Appendix M

Strategic Plan for Distance Learning Program

A STRATEGIC PLAN FOR A DISTANCE LEARNING INITIATIVE IN ELECTRONIC ENGINEERING TECHNOLOGY

Pearley Cunningham

Community College of Allegheny County

December, 1996

TABLE OF CONTENTS

INTRODUCTION

The Electronic Engineering Technology (EET) Program is offered only at the South Campus of the Community College of Allegheny County (CCAC). Because of the size of the county, some students spend more time traveling than in class. The recent efforts to provide a single college syllabus for each course should allow more program and course consistency between campuses. However, the belief that students will move between campuses has not proven out in practice. Because of the geography and transportation problems, students are reluctant to travel between campuses. This is aggravated by each campus preparing a unique schedule without consideration of the activities of the other campuses. The result is increased student travel or withdrawal from the specialized programs. This project proposes that the solution to this time and space problem is a network based distance learning program.

COLLEGE PLANNING

The Community College of Allegheny County has adopted the following definition of strategic planning, "A proactive process by which CCAC envisions its future and develops the necessary procedures and operations to achieve that future" (Community College of Allegheny County, 1995, p. 5). In A Guide for New Planners, the planner is cautioned that not all planning needs to be comprehensive or college wide. "Successful, effective planning can be highly targeted and problem focused" (Norris & Poulton, 1991, p. 16-17). Further, they emphasize that the new planner should set a short, focused time line for a project. While the college is involved with an overall vision, individual departments and programs can also develop strategic plans that support and further the college vision. In a similar manner, strategic plans within the departments can impact and help to shape the continuing vision of the college. This blend of bottom-up and top-down planning can produce a more viable college vision.

College Mission

> The Community College is committed to providing an accessible and affordable college education, greater educational opportunity, comprehensive college programming and quality instruction in its classrooms. Its mission is to provide a high quality comprehensive community college program for the residents of Allegheny County. This program will include vocational-technical and career education, community services, developmental education, college transfer programs, as well as general education to enrich and enhance the student's life. The Community College of Allegheny County will seek to carry out its program with the most innovative and effective educational methods available, as economically as possible, at the lowest possible cost to its students and with full accountability to its constituents. The College will maintain an open door admissions policy and will conduct its programs at multiple locations convenient to its students (Community College of Allegheny County, 1994, p. 2).

The college's mission statement commits the college to "... providing an accessible and affordable college education, greater educational opportunity ... and quality instruction in its classrooms" (Community College of Allegheny County, 1994, p. 2). The college offers a comprehensive program including vocational, technical, career, developmental and transfer education programs. However, time and geography constraints can prevent a student from attending these programs.

This strategic plan proposes a method of achieving the college mission through a networked distance learning delivery mode in the Electronic Engineering Technology Program. This plan discusses the course mechanics such as type of computer system, techniques for delivery to and from the students and instructor, operation of the laboratory component of the courses, interaction with educational partners, necessary budget for a one year implementation, and comments of the advisory committee.

PROJECT VISION STATEMENT

Vision of Distance Learning in Electronic Engineering Technology

The Community College of Allegheny County, in meeting its commitment to provide a quality, accessible, technical education to all students, offers key technical courses necessary for an associate degree in Electronic Engineering Technology at the four campuses of the college through a distance learning delivery mode using the college network, the Internet and the World Wide Web.

THE STRATEGIC PLAN

Students involved with the Distance Learning EET Program will enroll at the campus closest to their home. At that campus the student will take support courses from the regular schedule. A student workstation at each campus allows the student to take the electronics courses. Of the 65 credits required for the associate degree in EET, this plan provides 29 credits through the network. The courses required for the degree are listed in Appendix A. Those to be taken on the network are identified by an asterisk. Because this delivery mode may be unfamiliar to the student, each person enrolling in an EET distance learning course for the first time will receive an orientation video tape. This tape will demonstrate how each feature of the distance learning system will work. Also a hands-on laboratory activity will be designed to allow them to practice the needed computer skills. After completion of the laboratory activity, the student will have mastered enough of the distance learning system to begin.

Curriculum Design

In addition to using the Internet for delivery of much of the course material, the engineering technology faculty will use a specific curriculum model in the distance learning based EET program. The EET program will use a Learning Paradigm model. Under this paradigm "... a college's purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge themselves ..." (Barr & Tagg, 1995, p. 15). This new classroom model, to be called the Distance Learning Paradigm, will be built on the principles of adult education, suggested learning strategies from cognitive studies research, and a six-point curriculum design process.

First, since the average age of students at CCAC is 28 years old, the participants in the program are adult learners. Adults respond best to education when it (a) is related to their work, (b) includes prior learning, and (c) allows immediate feedback through hands-on activities using the new knowledge (Knowles, 1984).

Second, the course activities for the distance learning option of the EET program will apply the principles of cognitive studies. The literature suggests specific techniques and strategies to assist the instructor to design efficient learning environments. Cognitive learning theory states that students construct learning through social interactions and experiences based on what they currently know. Johnson and Thomas (1994) hold that "... the cognitive view requires a stimulating learning environment in which students are active participants in planning, implementing, and evaluating teaching and learning" (p. 39-40). Key to this approach is the use of flexible, active, discovery activities to develop complex thinking skills. Johnson and Thomas (1994) provide six instructional principles and strategies below to promote cognitive learning.

1. Reduce memory load. The student must be taught how to use notes, outlines, and concept maps to promote organizing information into chunks.

2. Activate existing knowledge structures. New information must build on the existing knowledge of students. The use of analogies and metaphors help to place information in existing context.

3. Representation of new knowledge. Place new knowledge to be learned into a purposeful context and encourage the use of contrast, multiple representations, and mnemonic clues.

4. Encourage deep thinking. Use activities that allow the student to reflect on the new material by communicating with

others, or working with laboratory experiments and computer-based simulations that demonstrate the key information.

5. Enhance Cognitive control processes. It is important that the student learn to learn. The direct teaching of cognitive skills such as reciprocal teaching or thinking aloud will allow students to apply these techniques in less structured situations after formal schooling is complete.

6. Support the use and transfer of knowledge and skills. All activities should have real world applications with increasing complexity as the students progress. Each activity should lead the student toward more autonomy and less dependence on external support.

In addition to these strategies, Redish (1994) has shown that in problem-based courses the use of "touchstone" problems can assist the student in relating old and new information. In mythology, the touchstone was an object that turned the ordinary into gold. By providing touchstone problems, the teacher has identified those situations that are critical to the understanding of the subject. The touchstone problem provides an example problem or situation that illustrates the basic principles involved so well that it can be used as a reference. The touchstone problem allows the student to turn any problem into something they can accomplish.

Third, a curriculum design model that breaks the course into manageable units will be followed. This model is a modified Six Step Model. Developed for engineering technology courses, this model allows students to recycle through instruction until an acceptable mastery is achieved (Cunningham, 1990). The six steps of this model are

1. Analysis
2. Objectives
3. Instruction
4. Performance Evaluation
   A. Advancement
   B. Recycle
5. Program Evaluation
6. Revision

Steps one and two above are directed to the course developer. In these steps, the normal activities required to develop a syllabus are carried out. In steps three and four, the actual delivery of the instruction and the testing as outline in other parts of this document is completed. By using a hypertext and multimedia environment, the student will have a great deal of control of both the pace and the path taken through the instruction. Through the recycle operation, the student's satisfactory performance will be assured. This will allow improvement in the quality of the learning experience and the quality of the student's performance. In step five, information on how well the material was received, what problem areas exist, and possible improvements is collected from the students. This formative evaluation will allow the instructor to remedy immediately any unanticipated problems that may occur. With the networked infrastructure supporting these courses, the information will be collected at the conclusion of each unit of study by providing an interactive feedback Web page at the conclusion of each unit of study. This data will automatically be placed in a file for the instructor to review. The data will also be available to assist the faculty and department head in preparing the yearly summative program review. In step six, the feedback on course operation, and other changes is made a regular part of the program operation. In most courses steps one and two are done reasonably well. However, steps three and four often are done on a weekly or daily basis. Each instructor interprets what is and is not important. The consequence is that material may not always be of the same quality. This model will assure that the distance learning experience is of a consistent quality. By having program evaluation and revision an integral part of the course design, the EET faculty can assure that the program quality is at an acceptable level.

Computer Access

Each campus Computer Center will provide a student workstation with full Internet access and meeting the specification set forth by the South Campus EET Program. The minimum necessary system specifications are shown in Appendix B. The computer workstation will be setup by the staff of the EET Program. The directors of each campus computer center have agreed to provide space and some equipment to support the program. These network based courses will be available for enrollment according to the schedule in Appendix C. Course materials will be provided by access to the EET World Wide Web site at http://www.acd.ccac.edu/eng-tech/. The Web pages will contain text references, assignments, and suggested other computer activities designed to assist the student in mastering the course material. The use of the Web allows for easy changes to be made in pacing and content as necessary.

Student Assignments

Each student workstation is equipped for remote submission of written work. A page scanner allows students to submit homework electronically as an email attachment. The instructor can also read, annotate and return the assignment electronically. Also, through the use of new secure identification techniques, students will receive formative quizzes, print them, and return these quizzes to the instructor through the scanner interface. In addition to email, students and instructor can meet through an electronic conferencing system. This system allows the instructor and student to work on the same information at the same time. This provides a shared blackboard that multiple people can view at the same time, but at different locations. At this time, real time video pictures will not be provided. It has not been established that the expense of this data intensive feature would significantly improve the communication process. Real time audio will be provided. This will allow the instructor and student to discuss the work on screen. Because the Computer

Center Directors are concerned that having students talking to the screen will be distracting to others in the center, real time audio will be used sparingly.

The EET program has considerable experience with in-class video recording. Video taped lectures are used currently to provide "make-up" work for students who are absent. In one course every topic covered has been video taped. Also, video tapes are prepared on special topics or problem sets that students can view outside of class. The electronics laboratory contains four video playback systems for student use. Also a video library of over 100 commercial and campus prepared tapes are used for topic assignments and review outside of class. As part of the preparation of the distance learning materials, key lectures will be taped. These tapes will be made available at each site to provide the distance student, in an audio-visual mode, the insights provided by the professor. Currently, much of the in-class time in electronics courses is spent on sample problems. These examples will not be provided on the videos. The video is too passive an environment. Problem sets will be detailed on the Web pages. The multimedia computer system will allow visual display of the problem, key questions for student response, student-instructor feedback with email, and select audio explanations. The materials will be provided through a combined use of the Web, the network and the CD-ROM. Because of the ease of editing video tape, video tape was selected for the lectures. During the development process the video tapes may be changed several times. The intention is to modify and improve the taped lectures each term. However, once these videos are sufficiently developed, the video material could be transferred to the CD-ROM with the sample problems.

Laboratory Component of Course Work

Because of the specialized, expensive equipment such as oscilloscopes, function generators, or logic analyzers, students will need to attend laboratory sessions at the South Campus location. A specialized laboratory section will be established for friday afternoon and saturday morning. In these sections, students may carry out any laboratory experiment from any of the distance learning classes. For example, students in Digital Electronics, MIT208, and Introduction to Electronics, EET103, could work in the same laboratory session. This process will not require any change in laboratory activities. The current activities are well defined and self contained. Multiple activity laboratory sections have been done at South Campus in the past. Although this will require the student to travel to the South Campus site, it will reduce that travel to once a week. As the course materials are developed for the distance learning program, the use of virtual reality based laboratories (VRL) will be examined. The use of such programs as Electronic Workbench (EWB), pSpice, and Logic Designer have been shown to be effective. Aims Community College in Colorado and George Brown College in Canada have successfully provided part of the laboratory work in electronic circuits for distance learning in electronics through the use of EWB. This simulation program will be incorporated, as possible, to modify several of the lab projects to a distance mode. However, one problem with the virtual laboratory, as proposed, is that the mechanical skills expected of an EET graduate can not be simulated. Key experiments will be carried out in the campus laboratory to provide experience with actual equipment. The use of this virtual technology, however, will reduce the travel requirements.

Faculty

In determining a suggested policy on faculty teaching load and compensation, several schools with distance learning programs in engineering technology were contacted. In most cases the number of students in a distance learning class was the same as for a traditional on-campus course, usually 24 students per section. To develop and adapt materials to the distance mode, faculty were usually given release time or equivalent overage payments. This project proposes that the load for a class remain at 24 students per section with 12 in each laboratory section. At the beginning, both on-campus and distance learning students will be registered in the same class. To develop the materials needed for the distance classes, faculty will be given a course reduction or overage equivalent to the credits in the course being developed. The faculty assigned this task must have taught the course in a previous term. These faculty can then assure that the same quality standards are met as in the traditional course. These faculty will develop the materials needed for steps three and four of the six step curriculum design model. Video taped lectures will be prepared during the on-campus section of the class. Included in the project budget is assistance with graphic design and network applications.

Budget for the Strategic Plan

Any new initiative will undoubtedly require some initial start-up costs. At the request of the advisory group, a time line of one year has been set to develop the on-line versions of the courses. The budget necessary to accomplish these 29 credits and the orientation module is shown in Appendix D. These funds will need to come from outside the college. There are several foundations and industrial development groups that have expressed interest in the concept of a distance learning version of the EET program. With the assistance of the division dean, a formal proposal will be made to these groups.

Comments of the Advisory Committee

The advisory group for this project consisted of both industrial and educational personnel. The complete list and their affiliation can be found in Appendix E. The advisory group was supportive of the plan as presented. Their concerns and suggestions have been included in the plan. For example, several of the group felt some orientation to the distance learning environment would be needed. These concerns have been addressed by the orientation video tape and the hands-on activities for the first time student. They also expressed the need for time estimates to be placed on the materials. This would allow the student to know if they had sufficient time at the moment to finish the material. Many in the advisory group had experience with distance learning in their industrial setting. Based on their experience they felt a mixture of media would help keep the student interest and concentration at a high level. This concern will be met by this project through use of video, Web and computer simulations, paper and pencil activities, and computer conferencing. Also since it would eliminate the time delays of regular mail, the use of the scanner for submission of written assignments was considered excellent. The need for "real-time" contact with the instructor would be acceptably met by the use of the telephone and computer conferencing with a whiteboard.

The two transfer schools that receive the majority of the CCAC electronics students were present. They saw no reason the distance learning mode of delivery would change the transfer status of the courses. The primary concern set forth by both the educational and industrial members of the advisory group was that the program content and quality remain at the high level currently in the on-campus courses. The EET Program staff are committed to maintaining high program quality and content.

The advisory group was enthusiastic about the potential for the distance learning project. Two of the industry representatives expressed the desire to have student workstations at their factory site. They wished to encourage the campus to develop the materials such that it would be possible to use industrial sites. This possibility was explored. If the proper equipment was placed at the factory site, most activities on the computer could be accomplished. The computer would have a modem card replacing the network interface card. The expense for the student workstation would not change. However, additional expenses would be involved in obtaining Internet access from an off-campus location. Appendix F contains an estimate of the additional expense this option would involve. This same option could be used to allow high school Tech Prep programs to connect directly to the college course work. Except for the expense, even an individual could connect to the EET Program using this option. Logistics problems of the student receiving video tapes and CD-ROMs would be handled by postal service. This option is not part of the current plan. However, the proposed materials are consistent with a modem connected workstation. Once the materials are developed, sites external to the college campuses could be developed. The need for this distance learning project is summed up by the remarks of one of the advisory committee members. When ask if he thought distance learning was a good idea, he said it was essential to the survival of the schools.

RECOMMENDATIONS

1. To seek funding for the development of network-based distance learning materials in the nine courses required in the Electrical Engineering Technology Program.

2. To offer by Fall 1997 a combined section of on-campus and off-campus students in at least one network-based distance learning course.

3. To explore the possibilities of extending the distance learning to sites outside the college.

4. To develop complete off-campus versions of as many electronics labs as possible using simulations and virtual reality laboratories as much as possible.

5. To encourage other programs and disciplines at the college to participate in the use of the distance learning system developed by this project.

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APPENDIXES

Appendix A

Electronic Engineering Technology Curriculum

Required Core:

Course Number	Description	Credits
MAT114	Technical Mathematics 1	3
MAT116	Technical Mathematics 2	3
SET105*	Technical Computing	3
PHY113	Technical Physics 1	3
PHY114	Technical Physics 2	3
EGR100*	Engineering Seminar	1
ENG101	English Composition 1	3
ENG106	Report Writing	3
Required Major Courses:		
EET103*	Introduction to Electronics	3
EET201*	Electronics 1	4
EET202*	Electronics 2	4
MIT208*	Digital Electronics	3
MIT110*	Electrical Engineering Circuits 1	4
MIT210*	Electrical Engineering Circuits 2	4
MIT240*	Scientific and Industrial Instrumentation	3
Electives:		
Social Science and Humanities		6
Technical Electives		12-16
Total credits for graduation		60-65

Appendix B

Distance Learning System Hardware

100 MHz Pentium CPU based computer
16 Megabyte random access memory
520 Megabyte hard disk drive
3 and 1/2 inch floppy disk drive (1.44 Megabyte capacity disks)
4X CD-ROM drive
Sound blaster Compatible card
Color VGA video card with 2 Megabyte video RAM
Headset and microphone
Keyboard and mouse
Network interface card

Distance Learning Software Requirements

Windows 95 Operating System
Netscape Web Browser
Email program
Mathcad 6.0
Microsoft Office Professional
Electronic Workbench
Electronic Principles Tutor
Cu-See-Me Conference Program

Peripheral Equipment

Inkjet Printer
Page scanner
Video cassette player and monitor

Appendix C

Schedule for Offering Distance Learning Options in Electronics Engineering Technology

Fall 1997

MIT 208	Digital Electronics
EGR100	Engineering Seminar
EET201	Electronics 1

Spring 1998

EET103	Introduction to Electronics
MIT110	Electrical Engineering Circuits 1
SET105	Technical Computing

Fall 1998

MIT210	Electrical Engineering Circuits 2
EET202	Electronics 2
MIT240	Scientific and Industrial Instrumentation

Appendix D

Budget for Strategic Plan

for distance learning project

Personnel:			
2	Faculty subject matter experts (release time and/or overage)	$16,800	
	Summer course reduction	$ 9,600	
2	Student programmers		
	School year: (10 hr/wk x 2 x 15 wk x 2 semester=600 hr)	$ 3,200	
	Summer: (30 hr/wk x 2 x 12 wk=720 hr)	$ 3,780	
1	Graphic designer (300 HRS)	$ 3,000	
1	Network consultant	$ 3,000	
Personnel Total		$39,380	$39,380
Software Tools:			
	Web server software	$ 500	
	Reflector site server	$ 1,500	
	Multimedia Developer Program	$ 1,500	
	Web Editing Software	$ 1,000	
	Software total	$ 4,500	
Course Development Cost			$43,880
Student Workstations			
	Computer System	$ 2,000	
	Software	$ 870	
	Support Hardware	$ 850	
	Workstation Total	$ 3,720	
	4 workstations @ $3,720	$14,880	$14,880
Project Total			$58,700

Appendix E

Advisory Group Membership

Industrial Representatives:

Keith Davis, Adtranz

Robin Taylor, Port Authority Transit of Allegheny County

Robert Percival, AEG Automation

John Fibbi, USS Clairton Works

Educational Representatives:

Patrick Gerity, Director, Business and Industry, CCAC

James Kushner, Dean, Division of Engineering Technologies, CCAC

Charles Schuler, Professor, Technology Education, California University of Pennsylvania

John Loney, Electronics Engineering Technology, California University of Pennsylvania

David Daly, Technology Instructor, Brentwood High School

Leslie Smith, Electronics Instructor, Steel Center Area Vocational Technical School

Douglas Cunningham, Civil and Mechanical Engineering Technology, Point Park College

Michael Kurth, Electrical Engineering Technology, Point Park College

Reza Chitsaz, Associate Professor, Electronic Engineering Technology, CCAC

Pearley Cunningham, Professor, Electronic Engineering Technology, CCAC

Appendix F

Estimate of Modem Based System Costs

Fixed Cost:	
Workstation Cost	$3,720
Phone line Installation	$ 50
Fixed Cost per Station	$3,770
Monthly costs:	
Phone Line charge	$ 28
Internet Service Provider	
needed for each student	$ 20
Total Monthly Cost per student	$ 48

Estimate of One time Cost of Program Delivery by Modem for 29 Credits of the Electronic Engineering Technology Program by Distance Learning

No. of Students Using Workstation	Cost for Each Student
1	$6,720
2	$4,618
3	$3,931
4	$3,574

BIOGRAPHICAL SKETCH OF STUDENT

Pearley Cunningham

Having taught science and technology in high schools, universities and community colleges, Pearley Cunningham has extensive experience in the science, mathematics, and technology classroom. From the beginning of his teaching career in 1962, he has been involved with innovative curriculum in physics and electronics technology. Trained as a solid state physicist, he has always believed in the importance of applied science in the training of technicians. This belief brought him to the Community College of Allegheny County to develop innovative technical programs with a strong applied science background. He has participated in many national and local curriculum development projects in technical physics and engineering technology. These projects have received funding from both national and local agencies. Cunningham holds the rank of Professor at the Community College of Allegheny County. He has also served as a director of vocational studies and as acting dean of the Division of Science, Mathematics and Technology. In 1990, he was named Outstanding Faculty Member in the Northeast Region by the Association of Community College Trustees.

He earned a bachelor's degree from Ball State University with a major in mathematics and a minor in physics. After several summers of graduate work at Rutgers and Purdue Universities, he attended Ohio University. In 1968, he received a masters degree in physics from Ohio University with a specialization in solid state physics. He stayed at Ohio University for four years as a senior research associate.

He, and his wife Ruth, have lived in Pittsburgh for 25 years. They are both active in their local church and in fraternal organizations. They have three grown children, all with active careers, and two grandchildren.

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