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A study to identify selected factors affecting the implementation of computer-aided design and drafting in industrial technology baccalaureate programs

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A STUDY TO IDENTIFY SELECTED FACTORS AFFECTING THE IMPLEMENTATION OF COMPUTER-AIDED DESIGN AND DRAFTING IN INDUSTRIAL TECHNOLOGY BACCALAUREATE PROGRAMS

A Dissertation

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Industrial Technology

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May 1993

A STUDY TO IDENTIFY SELECTED FACTORS AFFECTING THE IMPLEMENTATION OF COMPUTER-AIDED DESIGN AND DRAFTING IN INDUSTRIAL TECHNOLOGY BACCALAUREATE PROGRAMS

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Approved:

Dr. John T. Fecik, Faculty Advisor

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ABSTRACT

The purpose of the study was to identify and analyze selected factors affecting the present status of Computer Aided Drafting and Design (CADD) and those factors which were needed to reach a desired level of CADD implementation in Industrial Technology Baccalaureate Programs (ITBPs) in the United States. The intent of this study was to identify and analyze selected factors which facilitate the implementation of CADD in ITBPs within the United States.

One hundred and sixty four ITBPs institutions from the 1992 National Association of Industrial Technology (NAIT) Directory were used for participation in this study. A questionnaire identifying both current and ideal status was constructed and validated through the pilot-test. The instruments were distributed, collected, and the data analyzed.

Descriptive statistics were used to analyze the data. A frequency distribution was used for all variables. A mean rank was computed for the selected factors which inhibited the implementation or continuation of CADD in ITBPs.

Selected Findings and Conclusions were: (1) A majority of respondents (91%) reported that they offered one or more CADD courses in their departments; (2) The majority of respondents (52%) indicated that for the current status, CADD was required of all majors in their departments. At

the perceived ideal level, an overwhelming majority of respondents (92%) believe that CADD should be required for all majors in their departments; (3) a combination of separate CADD courses and CADD integrated into all design and drafting courses was recommended regarding CADD instruction by a majority of the respondents (67%); (5) "Funding" was the most inhibiting factor in the implementation or continuation of CADD in ITBPs, receiving the highest mean (4.34 on a 5-point scale).

Based on the information collected in the survey, selected Recommendations were: (1) Industrial Technology Programs should hire more faculty who have expertise in the area of CADD in order to facilitate the implementation of CADD in their departments. (2) Vendor workshops and in-house training programs should be provided to faculty who need assistance to enhance their CADD knowledge so as to facilitate the implementation of CADD in their departments. (3) All industrial technology instructors should be encouraged to integrate CADD into their design and drafting programs. (4) Industrial technology instructors should be encouraged to develop their own instructional materials to suit their particular curriculum needs.

DEDICATION

Dedicated to

My wife KUEI-HSIANG and son Kevin

for without their support and understanding

this study would have been possible

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CHAPTER I

INTRODUCTION

As our society moves away from its 20th century automation-based past and continues to move toward its 21st century information-based system future, education must change at a faster pace (Merickel, 1990). The rapid influx of computers and other technological innovations has had a pronounced effect on almost every part of society including industry and education. One of these, the technology of Computer-Aided Design (CAD), is undergoing rapid growth and change (Goss, 1990). The use of Computer-Aided Design and Drafting (CADD) in drafting and design technology with increased competitiveness and improved quality and efficiency has proliferated. To adequately prepare the industrial work force of tomorrow, education must identify the factors which influence the implementation of CADD in four-year baccalaureate degree industrial technology programs. This effort is vital to prepare technical core competencies needed by students entering the work force.

Technical drawing is a fundamental communication technique used extensively in manuscripts and presentations to visually demonstrate, exemplify, or elucidate industrial projects (Hales, 1991). Competitive companies and institutions are watching the growing field of CADD research and development looking for a CADD system that will best fulfill their operation needs (Foger & Rhea, 1990). During the last decade many changes have taken place in the industrial work place because of the increasing use of Computer-Aided Design and Drafting (CADD) in place of traditional technical drawing methods (Bertoline & Resetarits, 1991). Gow (1991) added that CADD is replacing traditional drafting in many types of industries and the changeover from traditional drafting to CADD will reach the 90% to 100% level. This fact raises many questions for education. The time has come, but are the educators ready? Do we have adequate equipment and curriculum in place? Do we have the knowledge and skills necessary to face the more challenges of teaching in a changing society? Are we able to teach our students the skills needed to find jobs in industry? DeVore (1980) emphasized the necessity for change.

> Technology is a critical variable with respect to the human condition, a variable which becomes more complex with the creation of new tool, material, machine, process of technical system. This variable must be understood if human beings are to comprehend their past and create a more human future. (p. 7)

Emphasis on CADD use in industry means that university/college programs should utilize computer graphics and computer applications if they wish to keep pace with advancing technology. Technology education must adjust the curriculum to encompass the new developments (Diez, 1990; Pedras & Hoggard, 1985). CADD instruction is a new instructional problem for the innovative and concerned educator of technology. It is, however, a problem that needs to be approached wisely. Sakr (1991) stated that CADD systems can be implemented more effectively in the practice of graphic design only if educators' unique capabilities are successfully integrated in the design process.

Effective CADD education is becoming more important as the demand for CADD operators is increasing. While a vast amount of literature exists to inform the administrator or instructor about the capabilities of CADD and its varying degrees of effectiveness, there have been few unbiased references available in professional journals or research studies. Educators need information that will help them to improve the implementation of CADD education in accordance with their instructional needs. As in any new technology, there are certain problems that are inherent in teaching CADD. For example, Holloway (1987) and Laird (1985) indicated that a lack of appropriate applied experience, technical expertise, adequate facilities, adequate funding, and qualified instructors are the most common problems. According to Sakr (1991), despite a wealth of exciting predictions and reports of successes in the literature, educators still do not know the best ways to apply computers to teaching design and drafting. What seems to be lacking is a single source in which one can find a number of descriptive studies of various CADD programs intended to identify variables which will aid educators with CADD curriculum development.

Statement of the Problem

Because the factors affecting the success of Computer-Aided Design and Drafting (CADD) programs in colleges and universities have not been systematically identified and described, administrators and instructors lack much of the information needed to make decisions about CADD utilization. The intent of this study was to identify and analyze factors facilitating the implementation of CADD in Industrial Technology Baccalaureate Programs within the United States.

Statement of the Purpose

The purpose of this study was to provide data for Industrial Technology Baccalaureate Programs within the United States. Specifically, this study was to identify and analyze those factors affecting the present status of CADD and those factors which were needed to reach a desired level of CADD instructional implementation in Industrial Technology Baccalaureate Programs in the United States institutions.

Significance of the Study

If certain factors were identified that expedite the implementation of CADD in Industrial Technology Baccalaureate Programs, then this could have important implications for Industrial Technology Baccalaureate Programs in Computer-Aided Design and Drafting (CADD). This study could also make important contributions to curriculum leaders regarding valuable needs and plans. As Addison (1988) stated:

> For the drafting instructor, it is an exciting and challenging time of new theory and new techniques which must be continually woven into the course of instruction. While embracing these changes, those responsible for the curriculum must develop appropriate curriculum goals and objectives, must continue to focus on the real competencies required by their graduates in industry, and must choose those instructional processes which will best help students reach their goals. (p. 20)

The following factors more significantly focus on this study:

1. During the past five years, there has been rapid development in CADD implementation. With this latest insurgence of CADD in education, there seems to be much confusion regarding the use of CADD instruction in Industrial Technology Baccalaureate Programs (Merickel, 1992). The popularity of CADD has made its instruction in engineering/technology schools a high priority. Unfortunately, very few schools have cohesive CADD curricula. Students who graduate from these schools without a good background in this fast-growing technology may find

themselves disadvantaged in the job market (Hsu & Sinha, 1992). A better understanding of CADD instruction is necessary for Industrial Technology Baccalaureate Programs teachers and administrators.

2. Most of the recent research indicated that a successful CADD program has to avoid "Murphy's Continuum" which states "No matter what electronic device is purchased, by the time it is set up, it is outdated" (Hammer & Murphy, 1986). With this in mind, people purchasing a CADD system should decide the "what," "who," and "how" of his/her program. What do I plan to use the system for? Who is going to operate and learn the system? and finally, How can this or any system benefit my program (Hammer & Murphy, 1986)? A better understanding of the above questions would be beneficial if the Industrial Technology Baccalaureate Programs teachers and administrators are to select CADD systems wisely.

3. The demand for accountability in education has focused on the quality of teaching. Educational policymakers increasingly consider better teachers the key to better education (Resetarits, 1989). Today, the effectiveness of CADD in education appears to be determined by a very important factor: the ability of the instructor. According to Muller (1986, p. 18), "The educator should ask; Am I as current as I could be? Are my courses sharply focused on those content areas which really relate to the

student's needs? How can I catch up?" In-services, seminars, sabbatical leaves, or extended leaves of absence of one or two semesters for work study are all key factors to improve CADD instruction. It is inappropriate for students to receive CADD education from an instructor who has had no CADD experience and who learned how to use the software just
days ahead of the students. Therefore, the CADD educator should stay current with advancing technology.

4. Kicklighter (1985) believed that Industrial Technology programs can grow and improve in the midst of declining university enrollments by constantly revising and updating the curriculum. A research study conducted by Owens (1988) ranked CADD as the highest used technology within manufacturing. A further national survey conducted by Dugger, French, Peckham, and Starkweather (1992) indicated that computer use in architectural design, engineering drawing and mechanical drawing were the top three courses in technology education (TE) and trade and industrial (T & I) education programs. Diez's (1990) research indicated that CADD courses were more frequent than any offered subject in accredited and non-accredited Industrial Technology Baccalaureate Programs in 1988 and those planned for in 1993. Therefore, a better understanding of CADD for Industrial Technology

Baccalaureate Program teachers and administrators is appropriate.

Research Questions

A descriptive research study was done to identify what factors facilitate CADD implementation in Industrial Technology Baccalaureate Programs. Each question was used in an attempt to identify various factors which facilitate the implementation of CADD in Industrial Technology Baccalaureate Programs. Questions that were related to similar areas were grouped into one of three categories and used to guide this study:

1. What is the current status of CADD implementation in Industrial Technology Baccalaureate Programs?

2. What is the perceived ideal level of CADD implementation in Industrial Technology Baccalaureate Programs?

3. What factors inhibit the implementation and continuation of CADD in Industrial Technology Baccalaureate Programs?

Assumptions

The following assumptions were made in pursuit of this study:

1. The questionnaire was appropriately designed to elicit the information needed to answer all of the research questions.

2. The respondents to the instrument were responding to the questionnaire appropriately.

3. CAD & CADD were essentially the same subjects in the programs involved in this study.

4. All Four Year Baccalaureate Accredited and Non-accredited Programs listed in the University Division of the National Association of Industrial Technology--1992 Directory were representative of the population of Four Year Industrial Technology Baccalaureate Programs.

Limitations

The following limitations were applied to guide this study in completion of the investigation:

1. This study was limited to four-year colleges with industrial technology accredited and non-accredited programs as listed in the University Division of The National Association of Industrial Technology 1992 Directory.

2. The questionnaire depended upon self-reported data as well as subjective opinions.

3. The study was limited to the implementation of CADD in Industrial Technology Baccalaureate Programs.

4. The respondents to the questionnaire were those who had primary responsibility for the area of CADD in Industrial Technology Baccalaureate Programs.

Definition of Terms

The following terms were defined to clarify their use in the context of this study:

Accredited--Programs that have received accreditation from an accrediting agency or association that has standards developed for technology programs. These included the National Association of Industrial Technology (NAIT) and Accreditation Board for Engineering and Technology (ABET) (Diez, 1990).

Computer-Aided Design and Drafting (CADD)--A combination of computer science, design methodology, drafting technology and field of application.

Computer-Aided Drafting (CAD)--Synonymous with CADD.

CAD--An acronym for Computer-Aided Drafting or Computer-Aided Design, which was defined as computer hardware, software and peripheral devices used to produce graphic images (Hsu & Sinha, 1992).

CADD System--The combination of a computer, software, scanners, 3-D sensors, and related peripheral equipment used for computer-aided design and drafting (Resetarits, 1989).

Industrial Technology (IT)--Four-year baccalaureate programs designed to prepare management-oriented technical curricula built upon on a balanced program of studies drawn from a variety of disciplines related to industry. (Anderson, 1983; NAIT, 1984).

National Association of Industrial Technology (NAIT)--An accrediting agency for the program areas of industrial technology.

Non-accredited--Programs that have not received accreditation from an accrediting agency or association that had standards developed for technology programs such as the National Association of Industrial Technology (NAIT) and Accreditation Board for Engineering and Technology (ABET) (Diez, 1990).

Procedure of Research Activity

The focus of this study was to identify and analyze factors which facilitate the implementation of CADD in Industrial Technology Baccalaureate Programs within the United States. Specifically, this study attempted to identify and analyze those factors ascertaining the present status of CADD and those factors which were needed to reach a desired level of implementation of CADD in Industrial Technology Baccalaureate Programs in United States institutions. Fraenkel and Wallen (1990) stated that survey research had the potential of providing us with a great deal of information from a large sample of individuals. This was the primary method used. The procedure used to conduct this study entailed the steps which are described in the following section.

Population

The population was composed of 164 accredited and non-accredited industrial technology programs whose names were listed in the University Division of The National Association of Industrial Technology 1992 Directory (NAIT, 1992).

Instrument

The decision to use a mailed questionnaire was based on (a) the advantage of the use of a questionnaire as a data gathering technique, (b) the source from which the data was to be gathered, and (c) the requirements associated with the data to be gathered.

When compared to other data gathering techniques, such as interviews, questionnaires:

1. Are economical.
2. Provide wide geographic coverage.
3. Yield data which are more uniform resulting in more comparable responses.
4. Provide a degree of anonymity which results in more candid replies.
5. Provide the respondents with the opportunity to check the accuracy of their replies (Mouly, 1978; Sax, 1979).

The questionnaire began with the data collection of demographic information. The questionnaire consisted of two parts and was based on the questions identified. Part one was designed to gather information regarding the current status of CADD implementation and the perceived ideal level of CADD implementation in Industrial Technology Baccalaureate Programs.

Part two was designed to gather data regarding what factors inhibit the implementation and continuation of CADD in Industrial Technology Baccalaureate Programs.

The survey instrument consisted of questions structured from related literature, interviews with practitioners, and teachers.

Content-related validity test. Fraenkel and Wallen (1990) stated that content-related validity depended on the amount and type of evidence used to support the interpretations researchers wish to make concerning data they have collected. After the instrument was completed, it was submitted to the dissertation committee for necessary corrections.

After the committee's suggestions were compiled, the instrument was revised again, then piloted to ascertain that it was free of ambiguity and format problems. A panel of experts in the field of computer-aided design and drafting, who were selected as representative of the pilot-test group, assessed the instrument's validity. The criteria established for inclusion on the panel included full-time instructors in higher education degree programs who have taught in the area of CADD for at least 5 years or who have published books on the subject of CADD. Using these criteria, seven persons were identified as possible members. Information gained from the pilot was then analyzed and utilized in revising the instrument.

Collection of the data. The questionnaire was sent with a cover letter, postcard, and a self-addressed, stamped envelope to the population--164 industrial technology programs whose names were listed in the NAIT 1992 Directory. The target of each population was the chairman or head of the department of industrial technology. The chairman or head was asked to nominate an individual who was best qualified to respond to the questionnaire. The chairman or head of the department then forwarded the questionnaire to the chosen faculty member. The chairman then sent the enclosed postcard identifying the nominated faculty member back to the researcher.

Coding was utilized to assist in follow-up procedures. Two weeks after the initial mailing, the questionnaire and a follow-up cover letter with a self-addressed stamped envelope were forwarded to non-respondents. After a period of 2 weeks, a second follow-up was sent to the non-respondents urging them to return the completed questionnaires.

Analysis of the data. Descriptive statistics were used to analyze the data. A frequency distribution was compiled for all variables. The information presented the absolute frequency (number of responses) and the relative frequency (percentage of responses) of all data. A mean rank was computed for the selected factors which inhibited the implementation or continuation of CADD in industrial technology baccalaureate programs in order to determine their order of the most inhibition. More specifically, data analysis for each part of the questions in the questionnaire was the following:

1. Tabulation of the data generated a frequency distribution for all variables in demographic information.

2. Determination of mean scores for items in Part two, selected factors that inhibit the implementation or continuation of CADD in Industrial Technology Baccalaureate Programs, of the questionnaire.

CHAPTER II

REVIEW OF LITERATURE

This review of literature focused on Computer-Aided Drafting (CAD) technology. Specifically, information presented in this chapter concerned (a) an historical overview of CAD, (b) research on CAD competencies, (c) studies in purchasing CAD systems, and (d) training on CAD.

An Historical Overview of CAD

The review of the historical development of CAD has been further divided into four categories: (a) Origin of CAD, (b) Improvements in CAD hardware, (c) Improvements in CAD software, and (d) Implementation and growth.

Origin of CAD

Taraman (1980) stated that the first computer was created at the University of Pennsylvania in 1946, and the first commercially available computer was offered in 1951. CAD was introduced in 1964, when IBM made it commercially available. The first complete (turnkey) system was made available in 1970 by Applicon Incorporated. Only recently, however, has the dramatic impact of this new technology been felt. By the mid-1980s, CAD systems had become quite commonplace in industry and education (Besterfield & O'Hagan, 1990).

Byles (1985) indicated that the first generation of CAD was born in the mid 1950s. A consortium of aerospace companies called the Aircraft Industries Association created the automatically programmed tool, and engineers at General Motors created CAD batch language for producing loft lines for automobiles. According to Byles (1985), the second generation did not appear until the mid or late 1960s, or even early 1970s, when the CAD systems became commercially available for the first time.

Rivlin (1986) stated that in the early 1960s, General Motors Corporation used an early CAD system to produce electronic sketches of proposed automobile designs, which increased the productivity by 33%. Rivlin (1986) also indicated that in the early 1960s, a newly formed Digital Equipment Corporation (DEC) introduced its first commercially available graphics product, the DEC 30. In 1965, IBM introduced its 2250 output display system. Shortly after that, Control Data Corporation (CDC) came out with the Digigraphics display. In this time period, Rivlin (1986) declared that computer graphics was born.

Groover and Zimmers (1984) stated that Sutherland worked on a project at the Massachusetts Institute of Technology (MIT) called "sketchpad" during the early 1960s. This project allowed the user to enter data into the computer and see the results on a cathode ray tube (CRT).

Wright (1986) observed that interactive graphics commonly used in the 1980s originated in 1962, when Sutherland presented the sketchpad system for his doctoral thesis. The system ran on a minicomputer that was primitive by 1980's standards, but set forth much of the methodology now used in more sophisticated graphics systems.

Rivlin (1986) indicated that in 1962, Sutherland published his doctoral thesis "Sketchpad," which was software for interactive graphics. Rivlin (1986) remarked that this "Sketchpad" thesis had earned Sutherland the unchallenged title of "father of modern computer graphics." The sketchpad software, according to Rivlin (1986), allowed the user to enter data into the computer and then see the results on the screen almost immediately. This software was the first truly interactive CAD system. Rivlin (1986) considered Sutherland's sketchpad system to be "user friendly," since the user can receive responses from the screen when the terminal received messages from the user. The system allowed artists and engineers to draw objects such as lines, circles, triangles, and even abstract shapes on the computer screen. This system also had the capability of erasing segments, moving segments to another screen location, storing portions or all of the image in memory, rotating and mirroring objects, and rescaling larger or smaller drawing segments.

From the 1950s through 1990s, CAD systems usage had been continually increasing. Early computer application programs were run by computer experts with engineers interfacing with the programs to get their batch programs to operate. By the 1970s, the introduction of the storage tube and refreshed tube linked to computers provided the engineers with a graphic interface that was more direct and more efficient than earlier systems. This introduction of computer graphics resulted in a proliferation of graphics programs first in the aerospace industry, and then in other industries such as aerodynamics, automobiles, and structures.

Several schools (MIT, University of Pennsylvania and Iowa State University) did foresee the importance of computer graphics and CAD and moved to develop programs in these areas very early in the 1960s.

Borgerson and Johnson (1980) stated that the early CAD systems were created to enhance the drafting function. These systems provided two dimensional representations. They reported that during the early 1970s, a large number of universities and industrial groups had research and development projects to provide not only CAD systems, but also Computer Aided Engineering (CAE) systems. Richards (1985) pointed out that several schools moved to develop CAD programs in the 1970s. Thus, Rensselaer Polytechnic

Institute established its Center for Interactive Computer Graphics; Carnegie-Mellon University started both the Design Research Center and the Robotics Institute in 1974; Cornell University developed a computer graphics instructional facility; and Brigham Young, Lehigh, and Purdue Universities excelled in computer aided manufacturing education and research endeavors. Carnegie-Mellon University began offering a master's degree program in computer aided design in the late 1970s.

Rivlin (1986) claimed that in the late 1950s, the Army's Semi-Automatic Ground Environment System (SAGES) air defense system used a primitive form of interactive computer graphics to locate the position of suspected enemy aircraft and missiles. The operator sat in front of a display that looked like a radar screen and held a light pen, which was a device like a gun with a small photo-electric cell at its point. He concluded that, by using the light pen to point at symbols and identifying marks displayed on the screen, the operator indicated the position of potentially unfriendly aircraft to the computer database, which then tracked and noted special attention to the indicated marks.

Improvements in CAD Hardware

Plotter

Hard-copy devices are regarded as an important element of computer graphics and computer-aided drafting (CAD) systems. The California Computer Corporation (CalComp) 565 drum plotter was introduced in 1958. The Tektronic dry silver copier; model 4610, offering a fast, dry, hard-copy was introduced in about 1970. It was a major contribution to the growth of computer graphics. In the early 1970's, the user input devices such as graphic tablets, digitizers, and touch-sensitive devices were developed.

Puckett (1963) indicated that a CAD method was developed to create perspective drawings by an electronic computer equipped with a line plotter. He remarked that with this technique, the computer converted rectangular coordinates of defining points into those necessary for perspective views. This was accomplished by a rotation of axes through arbitrarily chosen angles of tilt and turn, by translation of axes to center the origin, and the computation of the shifting necessary to produce central perspective projection.

According to Puckett (1963), before the 1960s, the computer dealt with those points which were located at the ends of the line segments. Curves were approximated by many short, straight line segments. He reported that plotters were invented at that time for hard copies, and that when connected to an electronic computer, the plotter operations can be program controlled, so that the total process is automatic. He pointed out that the scale is computed automatically. According to Puckett (1963), this method was originally devised to provide drawings necessary to show idealized structures for stress analysis at the Douglas Aircraft Company.

Cathode Ray Tube

Rivlin (1986) claimed that one of the first places to explore the revolutionary idea of using a cathode-ray tube (CRT) screen, not to display an electric waveform but to graph the contents of a computer memory, was MIT's Lincoln Laboratory. This was in the middle 1950s. Before the CRT hookup the only option for getting hardcopy results was to print it out. Printouts would often consume literally reams of paper for a problem; thus, the CRT offered an exciting new option. The computer output could be formatted into a chart or graph, and the graph photographed onto ordinary 35 millimeter film, and the scientist could carry the results in a small box of slides.

Improvements in CAD Software

Groover and Zimmers (1984) indicated that a CAD program was started in the early 1970s at Lehigh University in the Industrial Engineering Department with a single interactive computer graphics terminal. They stated that one of these projects dealt with the graphics modeling of a cutting tool in machine operation. In 1975, the University formed the computer aided manufacturing (CAM) laboratory. They pointed out that the University had recognized the importance of computer graphics by 1979.

Groover and Zimmers (1984) mentioned that one of the significant initial projects in the area of computer graphics was the development of the APT language at MIT during the middle and the late 1950s. APT was an acronym for Automatically Programmed Tools, and this project was concerned with developing a convenient way to define geometry elements for numerical control part programming using the computer.

In addition to Sutherland's research, other scientific groups such as Lockheed Aircraft and International Business Machine Corporation (IBM) conducted early research projects in interactive computer graphics. Machover (1978) stated:

> The early to middle 1960s was a fertile period for computer graphics and CAD. By October 1966, even the Wall Street Journal recognized the activity and wrote about computer graphics and CAD. Major U.S. aerospace corporations like Lockheed, McDonnell Douglas, and Boeing began to explore the use of computer graphics for aircraft and missile design. IBM organized a program called Project Demand, and worked with Lockheed, McDonnell Douglas, North American Rockwell, Rolls Royce, and TRW in an effort to evolve CAD and, ultimately, CAM techniques. Project Demand may have influenced the design of McDonnell's CAD and Lockheed's CADAM (computer-aided design and manufacturing) programs.
>
> In the early 1960s, "computer graphics" was by no means the universal term for the technology. Devices were called electronic displays, computer-controlled displays, information displays, and evaluated data displays. The British called their displays VUBU (visual unit backup) and CAD was often called automatic drafting. (p. 2.6)

According to Machover (1978), through the 1960s and early 1970s, computer graphics and CAD were considered by many to be expensive toys that could be justified only by government agencies, Fortune 500 companies, and funded university research environments.

Bertoline (1985) reported that:

> Since the late '70s there has been a dramatic increase in the number of CAD systems on the market and in the number of industries using them. No one event produced this increase in CAD, but there are a number of important reasons. Contributing to the increased use of CAD by industry are the rapid development in the microcomputer due to improved microprocessor technology, the dropping cost of memory, and the increased number of vendors supplying CAD. Another major reason for the growth in CAD is competition among rival companies both in the United States and abroad. Industries are finding that CAD must be used in order to remain competitive in such fields as electronics.
>
> The decrease in turnaround time in design and increases in productivity are two ways that CAD can make a company more competitive. CAD is and will continue to be the most productive method for drafter-designers to perform their job. (p. 26-27)

According to Bertoline (1985), a growth rate of approximately 30% was expected in computer graphics through the 1980s. He predicted that the multibillion dollar industry would generate fierce competition among the manufacturers in the 1990s. This competition would produce some changes in the methods and hardware used to create graphics. On the other hand, Bertoline expected advanced computer technology to also cause many changes in computer graphics.

Rivlin (1986) indicated that the display of a three dimensional wire frame model was developed in the late 1960s. Adage Corporation produced the wire frame product in 1967. By 1970, Evans and Sutherland Computer Corporation was able to produce a skin to fit between the lines, so that the object would have a surface or surfaces. He also claimed that by 1971, computer graphics workstations began to be widely used. Everyone who had access to a minicomputer and understood Sutherland's Sketchpad thesis could create an imaging picture in a CAD system. The next development occurred when Computervision Corporation invented one of the earliest stand-alone CAD workstations.

Implementation and Growth

Groover and Zimmers (1984) reported that a number of large industrial companies merged their CAD projects into the form of commercial products such as Unigraphics by McDonnell-Douglas and CADAM by Lockheed during the 1960s. In the late 1960s, several CAD system vendors were also formed, including Calma in 1968 and Applicon and Computervision in 1969.

Rivlin (1986) reported that by 1968 there were literally dozens of intelligent computer graphics workstations on the market. These workstations had the capability to rotate a three dimensional model entered into its database. He remarked that drafters were among the first to use these products which replaced the tedium of drafting by hand with computer aided drafting (CAD). He stated that other industries were equally quick to get in on the new developments. Taraman (1980) reported that the Lucas Company had, in 1976, reduced their production lead time with CAD. CAD provided Lucas Company with accurate, to-scale drawings, a means of producing models and prototypes for customer approval, and a production of tapes for numerical control machine tools.

Taraman (1980) also reported the Altan, Billhardt and Akgerman of Battelle Columbus Laboratories claimed that they accepted the CAD system they were using in 1976, and they recommended additional research work so that CAD applications in forging would become a routine procedure. Ford Motor Company management claimed that in the late 1970s, CAD provided their designers and engineers with better tools to perform their jobs. This resulted in substantial cost savings, reduced tooling costs, and better scheduling.

Bollinger (1987) indicated that teaching CAD in colleges and universities throughout the United States has advanced significantly in this decade, especially in the four years prior to 1987. The advancement was attributed to the development of microcomputer CAD. Bollinger (1987) confirmed the results of two surveys which were taken by the

Association of Computer Aided Design in Architecture. All schools and colleges of architecture in North America were polled about their use of computer aided drafting. In 1984, only 60% of the institutions polled had CAD microcomputer capabilities, whereas in 1986, 84% of the schools had CAD microcomputers.

Burdette (1985) reported that West Virginia educational officials announced the purchase of 495 CAD programs to be used statewide in 125 occupational and vocational centers. He stated that "CAD is a powerful drawing and design tool, and if the students are going to compete in the modern job market, they are going to need CAD skills." Reskon (1986) indicated that CAD was becoming an integral part of the drafting classroom at all levels of education, and many educators were beginning to change their thinking as well as their methods of teaching CAD.

McCracken (1988) indicated that Computer Aided Drafting was a major facet of computer graphics, and certainly no exception to the widespread application of new and expanding computer graphic technologies in business and industry. Specifically, CAD has dramatically impacted traditional and non-traditional applications related to drafting/design activities.

Research on CAD Competencies

As our society integrates more computer technology, it will demand more from its educational systems to assure knowledgeable, literate citizens who can make informed decisions of a technological nature, especially in the area of computer aided design and drafting (Merickel, 1990). To accomplish this, contemporary curriculum must reflect technology while meeting the educational needs of a diverse student population (Bell & Erekson, 1991). For the past decade there has been considerable interest in organizing CAD curricula on the basis of specific competencies in the area of computer-aided design and drafting (Herschbach, 1989). There have been differing results, however, concerning the competencies for computer-aided drafting which have been reported by Owens (1988) and Hu (1988). With the rapid expansion of the use of CAD comes the need for research on what should be taught in order to achieve the competencies when students graduate from college.

Mitchell and Ligget (1986) claimed there were at least three different approaches to teaching CAD. Each approach could generate different competencies. The competencies of these three different approaches would be based on the computer-aided drafting curricula offerings. The first approach was based on a system programming viewpoint and concentrates on the data structures, graphics devices, and the design of user interfaces. The second approach was concentrated on mathematical principles and focused on matrix transformations of coordinate data and mathematical representation of curves and surfaces. The third approach was based on current CAD systems and provided appropriate training on it. According to Michell and Ligget (1986), the third approach was the most desired method for technicians in industry, CAD educators, and system vendors.

Industrial technology/education drafting programs will vary in their curriculum and especially the requirements of each competency. It is apparent that CAD is being taught at each institution with great variety. Is one institution's methods more effective than the other (Resetarits, 1989)? CAD technology has been undergoing rapid growth and challenging the way we have traditionally thought about curriculum in industrial technology/education (Goss, 1990). Thus, to progress with the changing technology, CAD curriculum must be flexible regarding student pacing (Merickel, 1992).

Panchyk, K. and Panchyk, R. (1991) analyzed competencies needed by a CAD drafter. He determined that there were two types of technical competencies. The first were specific competencies needed by all students. The second involved the ability to develop new CAD competencies. The primary competencies of the CAD drafter were identified in several research studies (Hsu & Sinha, 1992; Hu, 1988; Panchyk, K & Panchyk, R., 1991). In general the proficient CAD operator must be able to:

1. Understand basic disk operating systems.

2. Utilize and understand terminology associated with CAD.

3. Demonstrate knowledge of basic drafting principles.

4. Prepare preliminary drawings (prototype drawing).

5. Effectually use working commands and a structural library of the CAD system.

6. Edit drawings efficiently by using the Editing commands of the system.

7. Use and develop macros for increased productivity of the system.

8. Develop 3-D models.

9. Effectively perform data management, storage, and transfer of graphic data.

10. Plot drawings according to the needs and conditions of the end user.

In addition to the above primary CAD competencies, students should be able to (a) identify additional competencies, (b) develop a plan to attain the competencies, and (c) demonstrate the new competencies (Wright, 1990). We should no longer insist on which CAD systems should be integrated into the curriculum. On the contrary, we should concentrate on how to implement career education into our curriculum. The ideal CAD competencies should teach students transition skills to incorporate other CAD systems and demonstrate high competency in CAD. There does appear to be general agreement regarding the generic benefits of exposing students to a conceptually broad-based understanding of CAD software and hardware to allow easy transfer of knowledge and skills between a variety of systems (Ross, 1985). These thoughts were echoed by Bro (1983), and Bertoline (1985), who were of the opinion that CAD should be taught with flexibility in mind to assist students in adjusting to a variety of systems that they might encounter with a variety of employers. Thus, in order to become familiar with the transferability in CAD systems, it is not just the need to understand the competencies but students should also have to use relevant capstone courses offered by industrial technology/education (Cheek, 1991).

Industrial technology and industrial education play a vital role in promoting CAD education. As the subject of CAD in the industrial technology/education preparatory program must go beyond only hands-on experiences, it must become hands-on/minds-on education if it is to be effective (Bell & Erekson, 1991).

According to Addison (1988), "the continuing revolution in computer graphics technology is having a significant impact upon the technical drafting curriculum at the secondary and post-secondary level" (p. 18). The rapidly changing technology of computer graphics will have an ever-increasing impact upon the technical drafting curriculum. He stated that:

> For the drafting instructor, it is an exciting and challenging time of new theory and new techniques which must be continually woven into the course of instruction. While embracing these changes, those responsible for the curriculum must develop appropriate curriculum goals and objectives, must continue to focus on the real competencies required by their graduates in industry, and must choose those instructional processes which will best help students reach their goal. (p 20)

Many competencies that technology education teachers need in the 1990s must differ from what they needed in the 1980s (Bjorkquist, 1990). Many discussions of the skills and competencies essential for teaching in the twenty-first century must first examine program content and purposes as well as the nature of the industry that education will serve (Maley, 1990). The challenges and trends in the area of design/drafting technology is rapidly undergoing change in the development of computer-aided design and drafting (Dugger, French, Peckham, & Starkweather, 1992). Before computer-aided design and drafting can be successfully implemented into the industrial technology/education curriculum or as a separate course, it was essential to examine the perceptions of teachers regarding the importance of CAD competencies in their program curriculum in order to teach CAD effectively and to keep pace with advancing technology (Hu, 1988).

Studies in Purchasing a CAD System

Industry has purchased CAD workstations at a rate of over 10,000 per month since 1985, resulting in over 930,000 users worldwide (Haase, 1991). The CAD industry, including hardware, software, and service and consulting fees, has constituted a $7 billion market. Today most industries use CAD, and the prediction is continued growth (CAD Industry Leaders, 1991).

CAD has moved from a traditional mainframe environment and has found a new home in today's microcomputers. Because of these changes, CAD has met with immediate interest and strong demand from educators and industrialists. Within the past five years, a technology requiring well over $10,000 in investment, which only a few could afford, can now be purchased for less than $5,000. A microcomputer-based CAD system is a combination of computer hardware, software and input/output devices (Panchyk, K. & Panchyk, R., 1991). Technology teachers (technology, industrial education, and engineering) have sought to obtain this tool and to incorporate its use into their curricula. Until recently, however, its use in Technology Education was limited because of cost. In the early 1980s personal computers were introduced and low-cost CAD software programs were written. It was predicted that with the growth of low cost microcomputer CAD, more than one million systems will be running by the mid-1990s (Duelm, 1991). These CAD technology innovations have left many technology teachers wondering which CAD system to purchase (Smith, 1992).

CAD systems may be either two-dimensional, three dimensional or combination, and they may be designed to provide either special-purpose or general-purpose applications. The great majority of CAD systems in use today are general-purpose two-dimensional systems that are being applied to help drafting in any discipline: architectural, mechanical, civil, electrical, or electronic (Barr, Krimper, Lazear, & Stammen, 1985).

There were various combinations of equipment which comprised a general-purpose CAD system. This kind of CAD system was summarized as follows: (a) CAD systems were categorized as micro, mini, and mainframe. (b) Processing included programs magnetically stored on media and the means to drive them. The three types of media were cartridge, floppy disk, and hard disk. (c) Common input equipment included keyboard, digitizer/puck or light pen, and mouse. (d) Output equipment was categorized as CRT, plotter, printer (Besterfield & O'Hagan, 1990; Drushler, 1988; Ezell, 1985; Hammer & Murphy, 1986; Hsu & Sinha, 1992; Koie, 1987; Schwendau, 1987; Wright, 1992).

When purchasing a CAD system, more educators seem to agree that the curriculum should determine the type of hardware and software to purchase. According to Drushler (1988), determining how to incorporate CAD into the educational environment is the first step. Smith (1992) and Yuen (1990), however, believed that the following steps should be used when purchasing a CAD system:

1. Determine the direction of the curriculum.

2. Determine the software needs to meet curriculum objectives.

3. Determine the hardware requirements necessary to run the software.

4. Collect and study as much literature as possible from different sources to decide on a vendor.

Determining the Direction of Curriculum

No matter which CAD system is used for instruction, according to Flechsig and Seamans (1987), "the sole purpose of each class is to teach students to select, modify, and apply the computer commands necessary to draw the required assignment" (p. 5). In the area of computer literacy, selection of an appropriate CAD system that supports the targeted curriculum is strongly recommended. According to

Greenan (1992), curriculum must be evaluated to ensure that the knowledge and skills learned in school are consistent with the knowledge and skills required for employment, citizenship, and a productive life.

Before using CAD software in the classroom, the goals of curriculum and instruction must be determined (Bertoline, 1990). Bertoline (1990) added:

> If your curriculum is more vocational in nature then your instruction will focus on learning a particular type of CAD software and hardware program. If your instruction is more general in nature, then CAD is a tool used to communicate graphically. The goals of your program do not revolve around the tool but around the concepts of mechanical/architectural drawings. (p. 19)

The curriculum goal should be the instruction in industrial technology and be used when teaching graphic communications with traditional tools. Furthermore, according to Putnam and Duelm (1985), drafting curriculum can be developed in three phases once the instruction phase has been completed to develop the material as planned for the curriculum:

1. Description Phase: This phase determines for whom the instruction is designed. It is important here to set the level at which the writing is intended, what skills does the learner already have, and what is the purpose of the class.

2. Content Phase: This phase determines what instruction is being designed. What is going to be taught and with what intended results?

3. Instruction Phase: The most effective way to complete the instructional phase is to develop an instructional schedule. Instructional schedules are a schematic of the course designed. Information on an instructional schedule includes sequence, topic, content, reference, student assignments, equipment and supplies needed, and evaluation.

According to Addison (1988), one of the common mistakes when incorporating CAD into the drafting curriculum was to focus too heavily on the CAD software with the result that the overall goal of the curriculum was temporarily forgotten. Simply "teaching to the machine," or developing instruction around every major function of a CAD system was not appropriate for the typical drafting curriculum. Teachers and curriculum developers need to remember that every course or program is based, first and foremost, on the overall goals and objectives which have been established for it. In order to meet the course goals and objectives, teachers must choose among the various capabilities of the CAD system and incorporate those for which there is a corresponding goal. Thus, the same CAD system will be used differently from course to course or from program to program (Yuen, 1990).

Most current curriculum are competency-based and have strong emphasis in the technical area. Welch (1991) said, by the year 2000, education will be perceived of as too valuable to leave only to youth. This means we should not just stand in the line of traditional teaching or keep traditional curriculum. On the contrary, we should improve our traditional education, but we also need to promote our non-traditional education for people who have graduated from college. Thus, when we set up our goals for our CAD curriculum, we need to consider (a) transition between school education and employment; (b) audiences should not just be limited to traditional students but should also include non-traditional students. All students will need to be recycled periodically to keep them technologically current in a highly changing industrial society; (c) CAD as a separate course and/or incorporating CAD instruction into the drafting curriculum; (d) the gap between current curriculum and the perceived ideal level of CAD instruction.

Once the teachers are trained, they should keep the focus of the curriculum on the particular skills and competencies that are required by industry for the drafting and design function (Addison, 1988). In addition, the drafting curriculum of today must include preparation on both CAD and the basic drafting fundamentals (Addison, 1988; Burns, 1986; Goetsch, 1986; Isbell & Lovedahl, 1988). Presently, over 90% of drafting is still done manually, so manual skills are needed and likely will be in demand for some time (Burns, 1986). The amount of time devoted to manual drafting will decrease in coming years as the transition to CAD by industry becomes more complete. In the meantime, however, the curriculum will have to reflect both modes if the students are to be adequately prepared.

The rapidly changing CAD technology will have a profound impact upon the drafting curriculum. For the teacher, it is an exciting and challenging time to review new techniques which must be continually woven into the course of instruction. While embracing these changes, teachers must keep abreast of current technology, must develop appropriate curriculum goals and objectives, must continue to focus on real competencies required by the industry, and must choose those instructional processes which will best help students reach their goal (Addison, 1988).

Learning to draw with a CAD system can be difficult, and according to Bertoline (1988), one of the most important elements of a CAD software program was the user interface. This was the method used by the software program to interact with the user.

Determining the Software Needs to Meet Curriculum Objectives

Tyler's model gave special attention to the planning phases of curriculum development by using the deductive approach to learning. This model suggested identifying general objectives by gathering information from three sources: the learners, contemporary life outside the school, and the subject matter. Tyler recommended gathering data relevant to the total range of students' needs and interests such as educational, social, occupational, physical, psychological, and recreational needs. Secondly, Tyler suggested gathering data relevant to the needs of society in formulating curriculum objectives. And finally, this model used the subject matter or disciplines themselves in establishing general or broad objectives. All three sources would tend to be important in establishing objectives in a CAD curriculum (Tyler, 1949).

First, we intend to give students a general understanding of the basic principles and concepts of CAD and to give them introductory hands-on experience with activities pertinent to their specific course of study. We need to recognize that a true CAD software program is one that was developed for industrial applications and not for education. The advantage of using these software programs is the opportunity to provide students with experience using a true CAD software program. It can motivate the students while they use these powerful programs in technology education. When evaluating CAD software for classroom use it is important that curriculum materials be available and be evaluated at the same time. Fortunately, AutoCAD, Versa-CAD, and CADKey have many types of curriculum materials developed for use in the classroom (Bertoline, 1990).

Several researchers recommend that in evaluating and selecting a particular software package, the following criteria should be followed (Koie, 1987; Shirley, 1992; Smith, 1992):

1. Identify objectives
2. Ease of use
3. Cost
4. Support
5. Frequency of updates
6. Warranty
7. Documentation
8. Software specific items
9. Training

Smith (1992) recommended that before placing the order, the software vendor should be requested to supply references from several schools in the area. Take the time to contact instructors at each school. It is good to visit the school while classes are in session. Ask the students and the instructor about the strengths and weaknesses of the software. Discuss specifics such as student interest, and the tendency of the program to "crash". Ideally, you should take a one or two day training session before placing an order. Such "hands-on" experience solidifies the purchasing decision and also helps people get started using the evaluation package or the purchased software immediately (Smith, 1992).

Careful selection of the proper software that adequately meets the needs of the curriculum will insure a proper return on investment and will give the capability to increase teaching efficiency. Whichever system is ultimately selected, it should be cautioned that CAD is not a panacea, but a tool that can be used to do a wide variety of tasks more easily and productively (Ezell, 1985).

Determining the Hardware Requirements Necessary to Run the Software

After selecting the software it is necessary to select the hardware (Crist, 1985; Ezell, 1985; Smith, 1992). All CAD programs (software) should have a required list of specifications for the hardware. Software programs indicated the kind of hardware they support and identify all the requirements. However, some of the more popular CAD programs such as AutoCAD, Versa-CAD, and CADKEY can operate on various platforms. The selection of specific hardware is a complex and time consuming issue; however, only major categories are dealt with in this study.

Some major points to consider include the platform and operating system used. Platforms vary widely according to cost, memory utilization, speed, software availability, networkability, ease of learning, cross-application consistency and many other criteria. Along with the central processing unit (CPU) one will need to select the memory devices and monitor for the computer. The size and type of storage devices must be investigated. Consideration must be given to internal Random Access Memory (RAM) size, hard drive size, and floppy disk drive size. When purchasing a monitor and the graphics card to drive it, one must consider the number of colors it will support, its size, cost, resolution, image quality, adjustability, and sync-lock time (Smith, 1992).

Peripheral devices must be added to the computer to operate CAD software. Possible input devices include mouse, digitizer, light pens, track balls, and voice activated systems (Smith, 1992; Panchyk, K. & Panchyk, R., 1991). The most popular input devices are digitizers and mouse (Barr et al., 1985; Wohlers, 1991). Because of their flexibility, digitizers can have drawings or menus taped to them or just be used for point and object input. Output devices such as printers and plotters must also be purchased. Plotter types include pen plotters, ink jet plotters, electrostatic plotters, and thermal direct plotters. Usual considerations of size, cost, and supplies must be made before purchasing such equipment (Smith, 1992). The major caution in choosing from the many plotters and plotter/printer is not to over or under buy. The features to look for are number of pens, pen speed, pen color, drawing size, and price (Hammer & Murphy, 1986).

Collecting and Studying Literature

Once the software and hardware is selected, the vendor can be selected. Usually, the vendor with the lowest bid or the vendor who provided the information and the demonstrations is selected, but people should look beyond that (Smith, 1992). Vendors can be a tremendous help to technology teachers. They often provide information on new products and equipment and describe its potential impact on the curriculum, matching the schools' needs with the services provided. Investigate the background of the sales representative. If the representative has worked in education, he/she will probably be able to identify with your needs better than industrial representatives (Smith, 1992).

In selecting a CAD vendor, there are many items that should be considered. The following list gives some of the most important questions that should be answered (Ezell, 1985).

1. What are the capabilities of the system?

2. Have the basic ergonomic considerations been integrated into the design of the workstation and the interactive software?

3. Is the system database upwardly compatible to the larger systems?

4. Can the system be expanded to meet future needs?

5. Can the system be networked?

6. Will the system allow for the addition of third party software?

7. What kind of training is available?

8. What kind of vendor support services are available?

9. Is there an active users group?

10. How do present users evaluate the system?

11. What is the financial condition of the company?

12. Does the vendor have a record of product upgrades and enhancements?

The basic advice in this respect would be to (a) attain a knowledgeable consultant to guide people's decision making process and (b) to talk with companies that have already completed the process. With this advice in mind and the brief description of the twelve guidelines, one should be able to develop a more successful program for one's curriculum.

Training on CAD

Computer-aided design and drafting is an essential element of the emerging technology into industrial technology/education. It is becoming increasingly evident that the competitiveness of an industrialized society will be strongly affected by the extent to which computers are used in its design and drafting sectors (Hsu & Sinha, 1992). Increased acceptance of computer-aided design and drafting has resulted in the need for increased training programs in industry and education. Merickel (1990) stated:

> "By the year 2000, more than two-thirds of the technology we use today will be replaced by new technology." How can educators possibly keep up? They no sooner graduate from college than their skills and understanding of current technology are outdated. The problem of keeping educators abreast of current technology has been with us for many years. As the pace of the information race accelerates, many educators find it a problem too large to manage. (p.31)

Some estimate that more than 50 million people will need some kind of training or retraining between now and the end of the century (Bush, 1990). In the 1990s, CAD and related technologies will continue to expand into a variety of traditional technical disciplines (Panchyk, K. & Panchyk, R., 1991). Reflecting growth in new positions, it is estimated that 1,220,000 jobs will be created by the year 2000 in CAD and CAD-related fields (Becker, 1985). The field of computer-aided design and drafting is undergoing rapid growth and change. Education must change at a faster pace than it is currently prepared. Educators need to remain abreast of technological developments in CAD (Bertoline, 1985; Merickel, 1992). Many CAD instructors have been primarily self-taught and have not had the benefit of developing a complete perspective on the application of CAD in industry. Goetsch (1981) indicated that if educators want to keep current technology in their classrooms, they must first learn it themselves.

The shortage of teachers trained in CAD is a major obstacle for incorporating CAD into the curriculum (Anderson, 1986). There are several ways to receive CAD training. The first is pre-service training.

Pre-Service Training

Education programs traditionally have been slow to react to technological changes (Hawkins & Routh, 1988). Hawkins and Routh continued:

> When instruction is offered it is typically dependent on the personal knowledge and interest of the teacher. Since many instructors lack up-to-date on-the-job experience, their instruction is typically not in depth. Such programs not only inadequately prepare graduates but also offer few opportunities for upgrading of drafters already employed in industry. (p. 23)

If curriculum developers in educational programs in industrial technology/education institutions want to provide adequate instruction in computer-aided design and drafting, the following recommendations, from the literature, would possibly facilitate their efforts:

1. An entry-level course of computer-aided design and drafting could be offered at the freshman or sophomore levels so the relationship between technical drafting and computer-aided drafting could be learned simultaneously. CAD systems cannot produce drawings automatically. The operator must be adept in the basic concepts of design/drafting (Bro, 1983).

2. Instructors should receive adequate training in computer-aided design and drafting prior to teaching classes. It is unfair to students when the instructor has had no CAD experience and learns how to use the tool just days ahead of the students (Merickel, 1992).

In-Service Training

The second type of training program is in-service training. Tokunaga was aware that in order to achieve the education needs of 1990s and beyond, we need to teach the teachers first (Merickel, 1990). From this idea, he created the Mechanical Technologies Inservice Program. According to Presta, of the Human Resources Planning and Development Group, at Lawrence Livermore Laboratory, "There is currently not a sufficient number of students with the necessary skills and knowledge ready to meet the increasing needs of industry" (Merickel, 1990, p. 28).

The Mechanical Technologies Program (MTP) was designed to provide high school and college instructors with the resources to better prepare their students to be successful in the technical workplace. MTP was designed with the following goals (Merickel, 1990):

1. To provide the opportunity for educators to update their knowledge of current technologies and the application of those technologies in the workplace.

2. To increase awareness and develop a better understanding of the jobs themselves, the variety and scope of the jobs, and the skills required to be successful in the field of advancing technology.

Merickel (1990) reported that:

> Lawrence Livermore National Laboratory has designed, implemented and tested this model for successfully updating the knowledge and skills of technology educators. It is a model that can, and should, be implemented by other industries and schools around the country. It is through this type of industry-educator inservice effort, that we will be able to provide students with the necessary skills and knowledge to meet the increasing needs of today's High Technology Industries. (p. 31)

Hawkins and Routh (1988) recommended that (a) training should be offered in-house whenever possible; (b)sufficient lead time and information should be provided to the training consultant so that learning aides can be developed; (c) Training programs should be offered in short sessions over several weeks; and (d) training consultants should provide assistance in establishing on-going training programs.

Most CAD software manufacturers offer intensive training classes at their company headquarters. The classes usually are three to five days in length. They usually emphasize hands-on experience and problem solving (Monahan, 1987). In addition to these training classes, some CAD manufacturers offer teacher training programs to meet the needs of teachers wanting to incorporate CAD into their curricula (Yuen, 1990).

Training By CAD Vendors

The third type of training program is offered by CAD vendors which have authorized training centers spread geographically throughout the country. The training is usually conducted at dealer sites or through participating college industrial education programs. The programs cost about $150 to $400 per day per student. Many training centers also teach classes at a client's work site, although this option is more expensive (Anderson, 1986).

Training By Other Institutions

The fourth type of training program is offered by many colleges and universities to prepare teachers in CAD. Usually, these classes not only prepare teachers in how to operate a CAD system, but also cover wider ranges of topics such as system selection, cost-effective applications, curriculum development, and CAD management (Yuen, 1990).

Internship

The fifth type of training program is internship. Muller (1986) asked, "How do faculty stay current, or enter a field not previously part of their educational background?" He suggested that an internship in industry would enhance faculty hands-on work experience and update their knowledge of current technologies and the application of those technologies in the workplace. Muller (1986) added further that it is important to follow certain steps in setting up an internship:

1. Maintain participation in an area chapter of technical societies.

2. Make a tentative list of those companies in the desired geographical areas which are active in areas of interest to you.

3. Contact business and industry representatives to state your intention.

4. Formally apply for the internship in target companies.

How should an effective internship in computer-aided design and drafting be organized? The first requirement is that there is a qualified consultant in that company. The second requirement is the industry must also be willing to supply information required by the instructor. Muller (1986) commented after his internship, "Will I be able to convey a higher level of technical credibility to my students? I am confident that I will."

The rapidly changing CAD technology will have a profound impact upon the drafting curriculum. While embracing these changes, teachers must keep abreast of current technology, must develop appropriate curriculum goals and objectives, must continue to focus on real competencies required by the industry, and must choose those instructional processes which will best help students reach their goal (Anderson, 1986).

Well planned educational programs designed specifically for the persons that are intended to teach can result in effective learning experiences in both education and industry (Hawkins & Routh, 1988).

CHAPTER III

DESIGN AND PROCEDURES FOR THE RESEARCH

For the purpose of this study a descriptive research design was utilized. The primary characteristic of descriptive research is to collect information from a group of people in order to describe aspects or characteristics of that population (Fraenkel & Wallen, 1990). This study was divided into five major phases: (a) identification of the population, (b) development of the instrument, (c) validation of the instrument, (d) collection of the data, and (e) analysis of the data.

Identification of the Population

The population was comprised of current faculty at four-year baccalaureate industrial technology programs in the United States which were identified by the department head in each institution. The names and addresses of each institution were obtained from a directory supplied by the University Division of the National Association of Industrial Technology--National Association of Industrial Technology Baccalaureate Programs Directory (1992 ed.). The total number of industrial technology programs was 164.

Development of the Instrument

A survey questionnaire was designed to determine the implementation of CADD in four-year baccalaureate industrial technology programs in the United States. The questionnaire was divided into three sections and was based on the problems identified from literature sources.

The first section of the questionnaire was developed to collect demographic information pertaining to the institutions, departments, and teachers. The frequency for each item was tabulated and reported in Chapter IV.

The second section, called Part One, of the questionnaire was designed to gather data from teachers about their current and perceived ideal levels of CADD implementation in industrial technology baccalaureate programs. It was designed specifically to gather data regarding selected sources of information used by teachers for equipment, curriculum development, and for keeping technologically up-to-date. The frequency for each variable was tabulated and reported in Chapter IV.

The third section, called Part Two, of the questionnaire was designed to obtain the perceptions of teachers regarding the factors which inhibit the implementation or continuation of CADD. A Likert-type scale was used to rate inhibition. Available ratings ranged from 1, indicating that this factor was least inhibiting to the implementation of CADD, to 5, indicating an extremely inhibiting factor in the implementation of CADD. The mean and rank were computed for each variable and reported in Chapter IV.

Items for the instrument were gleaned from the literature relating to CADD. The literature included dissertations, trade magazines, journals, brochures from vendors, and research documents indexed by ERIC. The questionnaire was developed through the following procedures:

1. A first draft of the questionnaire was submitted to the researcher's dissertation advisory committee for review and recommendations.

2. A second draft of the questionnaire was made based upon the recommendations from committee members and re-submitted to the committee for further review and critique.

3. A third draft was subsequently approved by the committee for validation purposes and printed (see Appendix B).

Validation of the Instrument

According to Wiersma, a survey instrument should be pilot tested, usually with 5 to 10 individuals (1991). The purpose of the pilot test is to check for ambiguity, confusion, and poorly prepared items. The five participants in the questionnaire validation were selected from the Industrial Teacher Education Directory (29th ed.) according to the following criteria: (a) They were not in the population to be sampled in the survey, (b) Their professional responsibility was in the area of CADD, and (c)

They had been employed by their institution for a minimum of 5 years. These five participants were professors at Fairmont State College, Western Michigan University, Western State College, the University of Northern Iowa, and Middle Tennessee State University. The remaining two participants were academic administrators at Okalossa-Walton Junior College and at Clackamas Community College. Each had been active in curriculum development in CADD and had published textbooks and articles in the area of CADD.

A phone call was first made to each expert individually in order to secure his/her permission to participate in the validation procedure. The questionnaire, together with a cover letter and stamped return envelope, was then sent to each of the five validators. An evaluation form for validating the instrument was also enclosed. The participants were asked to answer the entire questionnaire and were carefully reviewing each item of the questionnaire. They were also asked to provide comments and suggestions to the content relevance, clarity, appropriateness, and coding.

The participants provided information about the survey instrument after a follow up phone call was made. Upon receiving the validation responses, the critiques and suggestions were analyzed and revisions were made in the questionnaire. The refined instrument was submitted to each member of the researcher's dissertation advisory committee for review and suggestion. Their input was again revised and re-submitted to the committee for approval. This committee approved the format with some suggested content changes. The changes were made and the instrument was approved for the final printing and mailing to the population.

Collection of the Data

Once the industrial technology program addresses were compiled, the initial mailing, November 5, 1992, was sent out with a cover letter (see Appendix B), postcard (see Appendix B), and a packet to the department head in each industrial technology program (N = 164). The department head was asked to nominate an individual from his/her program who would be best qualified to respond to the questionnaire. The department head was asked to then pass along to that individual the enclosed packet which contained a cover letter (see Appendix B), questionnaire (see Appendix B), and a stamped, addressed, return envelope. The department head was also asked to complete the postcard by identifying the individual nominated and to return it to the researcher for possible follow-up use. The cover letter was printed on the letterhead of the department of industrial technology at the University of Northern Iowa and was signed by the researcher's dissertation advisor to add authenticity and credibility to the research.

On November 24, 1992, a follow-up letter (see Appendix B) was mailed to 66 department heads who had not responded to the initial mailing by returning the postcard as requested, or had returned the unanswered questionnaire. On the same date, November 24, 1992, another follow-up letter (see Appendix B) was mailed to 9 nominees identified by their department heads to respond to the questionnaire.

On January 4, 1993, a second follow-up letter (see Appendix B) was mailed to 40 department heads who had not responded to the November 24th follow-up. On the same date, January 4, 1993, another follow-up letter (see Appendix B) was mailed to 8 nominees who had not responded to the November 24th follow-up, and who had been identified by their department heads to respond to the questionnaire passed along to them.

The subsequent follow-ups resulted in a 77.4% ($\underline{N}$ = 127) response rate. A 75% return rate was desirable for more meaningful data. Thus, no further attempts were made to increase the return rate.

Analysis of the Data

After the data were tabulated into the National Computer System (NCS), form 6703, the data were compiled and analyzed. The statistical analysis of the data was accomplished through the use of the Statistical Package for the Social Science (SPSS), a program available in the

Information Service and Computer Service (ISCS) at the University of Northern Iowa.

A frequency distribution was used for all variables. The information presented the absolute frequency (number of responses) and the relative frequency (percentage of responses) of all data. Each factor was computed for the mean and was ranked in order for the selected factors which inhibit the implementation or continuation of CADD in industrial technology baccalaureate programs in order to determine their order of the most inhibition.

CHAPTER IV

ANALYSIS OF THE DATA

The findings presented for this study were derived from an analysis of data from the questionnaire. The purpose of this chapter was to analyze those factors ascertaining the present status of Computer-aided Design and Drafting (CADD) and those factors which will be needed to reach an ideal level of implementation of CADD.

To facilitate the presentation of the findings for this study, this chapter was divided into four sections. The first section described the profile of the respondents. The second section reported the demographic data which included: (a) the number of students enrolled in an institution, (b) the number of students enrolled in the Industrial Technology programs, and (c) the number of full-time faculty associated with the Industrial Technology programs. The third section identified some factors which facilitated the current status and the perceived ideal level of CADD implementation in Industrial Technology Baccalaureate Programs. The fourth section revealed the perceptions of respondents about some factors which inhibit the implementation or continuation of CADD in Industrial Technology Baccalaureate Programs. The method of analysis used was descriptive.

Description of Respondents

The initial mailing consisted of 164 questionnaires sent to the department chairs of universities/colleges having Industrial Technology Baccalaureate Programs in the United States. The initial instruments were received from 89 instructors, representing 54.2% of the total population. About two weeks after the first mailing, a follow-up letter was mailed to 75 persons: 66 department heads who had not responded to the initial mailing by returning the postcard as requested, or who had returned the unanswered questionnaire, and nine nominees identified by their department heads to respond to the questionnaire. Twenty-seven instructors responded, for an additional 16.5% of the population.

In order to reach a high return rate on the questionnaires, a second follow-up letter was mailed to 40 department heads and eight nominees who had not responded to the first follow-up. Eleven more instructors responded for an additional 6.7% of the population. The subsequent follow-ups resulted in a total of 127 responses or a 77.4% response rate to the questionnaire. Of these 127 returns, nine returns were not usable for data analysis. These were either returned blank or were incomplete. The usable returns totaled 118, or 72% of the total population. Table 1 summarizes the distribution of the respondents to the questionnaire.

Table 1

Respondent Population

Population	Initial Mailing N = 164/%	1st Follow-up N = 75/%	2nd Follow-up N = 48/%	Total N / %	Usable N / %
ITBPs	89 54.2	27 16.5	11 6.7	127 77.4	*118 72
No Responses	75	48	37	37 22.6	

* There were 9 returns that could not be used because of non-response in certain categories. So the usable returns totaled 118 or 72% of the total population.

Demographic Information

Demographic data were collected to gain information regarding (a) the total student enrollment, (b) the total number of undergraduates majoring in Industrial Technology, (c) the total number of full-time faculty in Industrial Technology, and (d) the total number of Industrial Technology Baccalaureate Programs in CADD discipline. These results were summarized in Tables 2-4 below.

Total Student Enrolled in Institution

Table 2 summarizes the total student enrollment for the respondents' institution. The modal value for respondents (28%) indicated that their total student enrollment was 15,001 or more. There were 18.6% with an enrollment between 8,001--12,000 and 17.8% with an enrollment 5,001--8,000. Approximately 75% of respondents had a school enrollment of 5,001 or more.

Table 2

Total Students Enrollment in Institution

Student Enrolled	*N* = 118	%
0 - 1000	3	2.5
1001 - 2500	11	9.3
2501 - 5000	26	13.6
5001 - 8000	21	17.8
8001 - 12000	22	18.6
12001 - 15000	12	10.2
15001 or more	33	28.0
Total	118	100.0

Total Number of Undergraduate Majors in Industrial Technology

The respondents were asked how many undergraduate majors were in their departments. The findings are presented in Table 3. About 64% of respondents had 101 to 500 undergraduate majors in their department. There were 26.2% having 0 to 100 undergraduate majors and only 10.2% with 501 or more undergraduate majors.

Table 3

Total Undergraduates Majoring in Industrial Technology

Majored Students	N = 118	%
0 - 45	9	7.6
46 - 100	22	18.6
101 - 200	25	21.2
201 - 300	20	16.9
301 - 400	18	15.3
401 - 500	12	10.2
501 - 600	8	6.8
601 or more	4	3.4
Total	118	100.0

Full-Time Faculty in Industrial Technology

The respondents were asked to indicate the total number of full-time faculty in their departments (see Table 4). The modal value for respondents (34.5%) indicated that their full-time faculty was between 6 and 10. There were 37.1% with full-time faculty of 11 or more and 28.4% with a full-time faculty of 0 to 5.

Table 4

Total Full-Time Faculty in Industrial Technology

Full-time Faculty	N = 118	%
0 - 5	33	28.4
6 - 10	40	34.5
11 - 15	21	18.1
16 or more	22	19.0
Total	118	100.0

Total Number of Programs Offered in CADD

Table 5 indicates the total number of Industrial Technology Baccalaureate Programs that offer CADD (90.7%).

Table 5

Total Number of Programs Offered in CADD

Offered CADD	N = 118	%
Yes	107	90.7
No	11	9.3
Total	118	100.0

Factors Facilitating or Inhibiting Current Status and Perceived Ideal Level of CADD Implementation

This section of the questionnaire, Part One, was used to gain information from CADD instructors concerning both their current status and their perceived ideal level of CADD implementation in Industrial Technology Baccalaureate Programs. Tables 6 through 27 summarize the results, under these tables, not all of these respondents could or should have respondent. For example, in Table 6, under Current Status, the 11 no respondents represent those schools that didn't offer CADD courses. On the other hand, of the 13 non-represents under Perceived Ideal, two should have but did not. Thus, the relative percentage was used instead of the total percentage.

Full-time Faculty That Teach CADD Course(s)

The respondents were asked to indicate the total number of full-time faculty who teach CADD in their departments. The findings are presented in Table 6. In the Current Status, over 80.8% of respondents indicated that they have 1 to 3 full-time faculty teaching CADD courses. Correspondingly, 70.5% of respondents indicated that the ideal level should be 1 to 3 full-time faculty members teaching CADD courses. When comparing the responses from the current status and perceived ideal level, there was a certain amount of perception difference between the respondents. Approximately 42.1% of the respondents indicated they have only 1 full-time faculty member while only 10.2% reported that they have 4 or more faculty members. Correspondingly, 21% of the respondents felt that the ideal level should be 1 full-time faculty member and about 27.6% reported 4 or more faculty members.

Table 6

Number of Full-Time Faculty Teaching One or More CADD Course(s)

Full-time	Current Status N = 118	%	Perceived Ideal N = 118	%
0	1	0.9	2	1.9
1	45	42.1	22	21.0
2	34	31.8	31	29.5
3	16	15.0	21	20.0
4	7	6.5	21	20.0
5 or more	4	3.7	8	7.6
No Respondents	11[1]		13[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. No missing cases.

2. Of the 13 missing cases indicated only 2 did not respond to this item.

Full-Time Faculty Whose Full Teaching Load is CADD Courses

The respondents were asked to indicate how many full-time faculty taught CADD full-time in their departments. Table 7 contains a summary of the responses. Approximately

73.8% of respondents indicated that none of their present full-time faculty teach CADD full time. Over 94.4% of respondents indicated that presently full-time faculty whose full teaching load is CADD courses was only 0 to 1 faculty. Only 5.6% of respondents in the current status indicated that 2 or more full-time faculty members were teaching CADD full time. However, only 32.3% of respondents in their perceived ideal indicated that the full-time faculty whose full teaching load is CADD was none. Approximately 27.3% of respondents in the perceived ideal indicated the full-time faculty whose full teaching load is CADD should be 2 or more full-time faculty members.

Table 7

Full-Time Faculty Whose Full Teaching Load is CADD Courses

Full-time	Current Status N = 118	%	Perceived Ideal N = 118	%
0	79	73.8	32	32.3
1	22	20.6	38	38.4
2	2	1.9	22	22.2
3	4	3.7	5	5.1
4 or more	0	0.0	2	2.0
No Respondents	11[1]		19[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. No missing cases.

2. Of the 19 missing cases indicate only 8 did not respond to this item.

Part-Time Temporary Faculty Teaching CADD Course

The respondents were asked to indicate the total number of part-time faculty who teach CADD courses in their departments. As shown in Table 8, about 68.2% of respondents indicated that none of the part-time faculty teach CADD courses at the present time. About 12.1% of respondents indicated that only 2 or more part-time faculty members were teaching CADD at the present time. The number of respondents in the perceived ideal level appears to agree with the current status.

Table 8

Number of Part-time Faculty Teaching CADD Course(s)

Part-time Faculty	Current Status N = 118	%	Perceived Ideal N = 118	%
0	73	68.2	64	64.6
1	21	19.6	21	21.2
2	11	10.3	9	9.1
3	1	0.9	5	5.1
4 or more	1	0.9	0	0.0
No Respondents	11[1]		19[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item, no missing cases.

2. Of the 19 missing cases indicated only 8 did not respond to this item.

Graduate Assistant(s) Who Teach CADD Course(s)

The respondents were asked to indicate the total number of graduate assistants who teach CADD courses in their departments. The findings are presented in Table 9. Currently, about 85.8% of respondents indicated that they presently do not have graduate assistants teaching CADD courses. In the perceived ideal level, only about 64.3% of respondents indicated they would not want graduate assistants teaching CADD courses. Approximately 14.2% of respondents indicated that they currently have 1 to 2 graduate assistants teaching CADD. This was contrasted by 31.6% of respondents indicating that they would like to have 1 to 2 graduate assistants.

Table 9

Number of Graduate Assistants Teaching CADD Courses

Graduate Assistant	Current Status N = 118	%	Perceived Ideal N = 118	%
0	91	85.8	63	64.3
1	10	9.4	22	22.4
2	5	4.7	9	9.2
3	0	0.0	3	3.1
4 or more	0	0.0	1	1.0
No Respondents	12[1]		20[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only one did not respond to this item.

2. Of the 20 missing cases indicated only 9 did not respond to this item.

CADD Classes Offered Each Semester or Quarter

Table 10 represents the average number of CADD classes offered each semester. Approximately 53.3% of respondents indicated that currently the average number of CADD classes offered each semester or quarter was 1 to 2. About 17% of respondents indicated that they offered 5 or more, with 12.1% offering 6 or more. Correspondingly, 40% of respondents ideally wanted 1 to 2 CADD classes, and 30% of respondents wanted 5 or more classes, with 22% offering 6 or more classes.

Table 10

Average Number of CADD Classes (Sections) Offered Each Semester or Quarter

CADD Classes	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
1	26	24.3	16	16.0
2	31	29.0	24	24.0
3	17	15.9	17	17.0
4	15	14.0	13	13.0
5	5	4.7	8	8.0
6 or more	13	12.1	22	22.0
No Respondents	11[1]		18[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item, no missing cases.

2. Of the 18 missing cases indicated only 7 did not respond to this item.

Credit Hours of a Beginning CADD Course

The respondents were asked to indicate the semester credit hours of a beginning CADD course offered in their programs. Table 11 contains a summary of the responses. Approximately 77.4% of respondents indicated that the credit hours of a beginning CADD course was 3; ideally it should be higher (81.8%). There appears to be little difference between actual and perceived ideal levels.

Table 11

Credit Hours of a Beginning CADD Course

Credit Hours	Current Status		Perceived Ideal	
	N = 118	%	*N* = 118	%
1	3	2.8	2	2.0
2	12	11.3	4	4.0
3	82	77.4	81	81.8
4	5	4.7	7	7.1
5 or more	4	3.8	5	5.1
No Respondents	12[1]		19[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only 1 did not respond to this item.

2. Of the 19 missing cases indicated only 8 did not respond to this item.

Grade Level Intended to Serve as Beginning CADD Course

As shown in Table 12, the respondents were asked to indicate the grade level intended to serve as the beginning CADD course in their departments. Approximately 59.4% of respondents indicated that currently the beginning CADD course was offered during the freshman year. About 65.7% of respondents indicated that the ideal grade level was the freshman year.

Table 12

Grade Level Intended to Serve as Beginning CADD Course

Grade Level	Current Status N = 118	%	Perceived Ideal N = 118	%
Freshman	63	59.4	67	65.7
Sophomore	31	29.2	27	26.5
Junior	12	11.2	8	7.8
Senior	0	0.0	0	0.0
No Respondents	12[1]		16[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only one did not respond to this item.

2. Of the 16 missing cases indicated only 5 did not respond to this item.

Main Type of CADD Training Program

The respondents were asked to indicate the main type of CADD training program used to prepare instructors in their departments. The findings are presented in Table 13. The modal value for respondents (42.1%) indicated that the main type of CADD training program was in-house, while about 29.9% of respondents indicated they do not have a training program used to prepare instructors for CADD instruction. However, approximately 29.4% of respondents felt that the ideal training program used should be workshops by vendors. About 26.5% of respondents indicated they would like to keep in-house training. Also, approximately the same number of respondents (15%) indicated in-service and workshops by other institutions were their ideal training programs for CADD instruction.

Table 13

Main Type of CADD Training Program

Training Program	Current Status N = 118	%	Perceived Ideal N = 118	%
None	32	29.9	5	4.9
In-house	45	42.1	27	26.5
In-service	3	2.8	16	15.7
Internship	1	0.9	8	7.8
By Other institutions	7	6.5	15	14.7
By vendors	18	16.8	30	29.4
Other	1	0.9	1	1.0
No Respondents	11		16	
Total	118	100.0	118	100.0

Main Source of CADD Textbooks

The respondents were asked to indicate the major source of CADD textbooks for CADD instruction in their departments. The findings are presented in Table 14. The majority of respondents (84.1%) indicated that their major CADD textbook was from a commercial publisher. Correspondingly, 66.1% of respondents indicated that the major source of CADD textbooks should come from commercial publisher.

Table 14

Main Type of CADD Textbooks

Training Program	Current Status N = 118	%	Perceived Ideal N = 118	%
Software vendor	7	6.5	6	5.9
Instructor developed	9	8.4	17	16.8
Commercial publisher	90	84.1	78	77.2
Other	1	0.9		
No Respondents	11[1]		17[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item.

2. Of the 17 missing cases indicate only 6 did not respond to this item.

Main Source of CADD Instructional Materials

The respondents were asked to indicate the major source of CADD instructional materials for CADD instruction in their departments. The findings are presented in Table 15. The majority of respondents (60.7%) indicated that their major CADD textbook was developed by the instructor. Only 12.1% of respondents indicated their CADD instructional materials came from commercial publishers. Correspondingly, in the perceived ideal level, approximately 58.6% of respondents indicated that the major source of CADD textbooks should be developed by the instructor. About 22.2% of respondents indicated they preferred commercial publishers.

Table 15

Major Source of CADD Instructional Materials

Training Program	Current Status N = 118	%	Perceived Ideal N = 118	%
Software vendor	28	26.2	18	18.2
Instructor developed	65	60.7	58	58.6
Commercial publisher	13	12.1	22	22.2
Other	1	0.9	1	1.0
No Respondents	11[1]		19[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item, no missing cases.

2. Of the 19 missing cases indicated only 8 did not respond to this item.

Highest Level of Performance on Primary CADD System

Table 16 summarizes the responses regarding the highest level of performance on the primary CADD system in their department. Approximately 40% of respondents indicated that in the current status the highest level of performance on the CADD system is 2D, 3D and solid modeling (All of Above). Ideally, 69.9% of respondents indicated 2D, 3D, and solid modeling (All of Above) should be the highest performance of CADD systems.

Table 16

Highest Level of Performance on Primary CADD System

CADD Function	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
2D	16	15.0	7	6.8
3D (Wireframe & Surface)	8	7.5	5	4.9
2D and 3D	35	32.7	17	16.5
Solid Modeling	2	1.9	2	1.9
All of Above	46	43.0	72	69.9
No Respondents	11[1]		15[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item, no missing cases.

2. Of the 15 missing cases indicated only 4 did not respond to this item.

Main Type of CADD Software Used

As indicated in Table 17, the respondents were asked to identify the main type of CADD software used for their CADD instruction. In the Current Status, a majority (81%) indicated that the main type of CADD software was AutoCAD. AutoCAD was also the perceived ideal majority (83.2%) among other software.

Table 17

Main Type of CADD Software Used

Software	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
AutoCAD	85	81.0	79	83.2
CADKey	10	9.5	9	9.5
Design CADD	2	1.9	1	1.1
AutoSketch	0	0.0	1	1.1
Discover CADD	0	0.0	0	0.0
Generic CADD	0	0.0	0	0.0
INTERGRAPH	1	1.0	2	2.1
Personal Designer	0	0.0	0	0.0
VersaCAD	3	2.9	1	1.1
Other	4	3.8	2	2.1
No Responses	13[1]		23[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so only 2 did not answer this item.

2. Of the 23 missing cases indicated only 12 did not respond to this item.

Main Type of CADD Hardware Used

The respondents were asked to indicate the main type of CADD hardware used for their CADD instruction. The findings are presented in Table 18. Approximately 52.8% of respondents indicated that their current main type of CADD hardware used was an IBM 386 or compatible. There were about 21.7% using IBM 286 or compatible machines and 16% using IBM 486 or compatible machines. For the perceived ideal level, an overwhelming majority of respondents (81.4%) indicated IBM 486 or compatible machines should be the main type of CADD hardware used for CADD instruction.

Table 18

Main Type of CADD Hardware Used

Hardware Used	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
Macintosh Families	3	2.8	3	2.9
IBM 286 or compatible	23	21.7	2	2.0
IBM 386 or compatible	56	52.8	6	5.9
IBM 486 or compatible	17	16.0	83	81.4
VAX	1	0.9	1	1.0
AT&T Series	1	0.9	1	1.0
Apple II Families	1	0.9	0	0.0
IBM minicomputer	0	0.0	2	2.0
INTERGRAPH	1	0.9	1	1.0
Other	3	2.8	3	2.9
No Responses	12[1]		16[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only one did not respond to this item.

2. Of the 16 missing cases indicated only 5 did not respond to this item.

Type of CADD Configuration

The respondents were asked to indicate the type of CADD configuration used in their programs. Table 19 summarizes the responses. Approximately 77.6% of respondents indicated that the type of CADD configuration used was a stand-alone unit. About 22.4% of respondents indicated Network was their type of CADD configuration. For the perceived ideal level, more respondents preferred a network configuration (56.7%). Only 43.3% of respondents indicated that they preferred stand-alone CADD configuration.

Table 19

Type of CADD Configuration

CADD Configuration	Current Status N = 118	%	Perceived Ideal N = 118	%
Stand-alone	83	77.6	42	43.3
Network	24	22.4	55	56.7
No Responses	11[1]		21[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item.

2. Of the 21 missing cases indicate only 10 did not respond to this item.

Number of Workstations

The respondents were asked to indicate the number of CADD workstations in their departments. The findings are presented in Table 20. In the Current Status, about 72.5% of respondents indicated they have 6 to 25 workstations, with the model number being 11 to 15 (23.5%). Approximately 26.5% of respondents indicated the total number of CADD workstations was 26 or more. For the Perceived Ideal level, only about 53.1% of respondents indicated 6 to 25 workstations. However, the modal number of respondents was 36 or more (30.9%).

Table 20

Number of Workstations

Workstations	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
1 to 5	1	1.0	1	1.1
6 to 10	15	14.7	2	2.1
11 to 15	24	23.5	6	6.4
16 to 20	15	14.7	18	19.1
21 to 25	20	19.6	24	25.5
26 to 30	7	6.9	11	11.7
31 to 35	3	2.9	3	3.2
36 or more	17	16.7	29	30.9
No Responses	16[1]		24[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only five did not respond to this items.

2. Of the 24 missing cases indicated only 13 did not respond to this item.

Prerequisites for a Beginning CADD Course

The respondents were asked, in Table 21, to indicate the prerequisites for a beginning CADD course in their departments. In the Current Status, there are two modal values of 45.2%: orthographic drawing and none respectively. In the Perceived Ideal level, approximately 36.7% of respondents indicated orthographic drawing was their preferred prerequisite for a beginning CADD course while there were 43.3% of respondents indicated that they had no preferred prerequisites.

Table 21

Prerequisites for a Beginning CADD Course

Prerequisites	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
Geometry	1	1.4	3	5.0
Computer programming	1	1.4	1	1.7
Orthographic Drawing	33	45.2	22	36.7
Pictorial Drawing	0	0.0	1	1.7
None	33	45.2	26	43.3
Other	4	5.5	7	11.7
No Responses	45[1]		58[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. 34 did not respond to this item.

2. Of the 58 missing cases indicated 47 did not respond to this item.

CADD Required for All Majors

The respondents were asked to indicate if CADD was required for all their majors. The findings for this item are presented in Table 22. The majority of respondents (52.3%) indicated that CADD was required for all majors in their departments. About 47.7% of respondents reported that CADD was not required for all majors in their programs. However, in the Perceived Ideal level, a majority (91.9%) responded that CADD should be required for all majors. Only 8.1% of respondents indicated CADD was not necessary as a required course for all majors in their departments.

Table 22

CADD Required for All Majors in Industrial Technology

CADD Required For All Majors	Current Status N = 118	%	Perceived Ideal N = 118	%
Yes	56	52.3	91	91.9
No	51	47.7	8	8.1
No Response	11[1]		19[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item.

2. Of the 19 missing cases indicated only 8 did not respond to this item.

Scope of CADD Offering

The respondents were asked to indicate the scope of CADD offerings in their department. The findings are presented in Table 23. In the Current Status, the majority of respondents (53.8%) indicated their current CADD scope was courses only. About 44.3% of respondents indicated the CADD scope in their department was program/ major or emphasis/concentration. However, approximately 72.6% of respondents indicated that their perceived ideal of the CADD scope in their department was program/major or emphasis/concentration. Only about 25.3% of respondents indicated their CADD scope was course only.

Table 23

Scope of CADD Offering

Scope of CADD Offering	Current Status		Perceived Ideal	
	N = 118	%	N = 118	%
Program or major	24	23.1	33	34.7
Emphasis or concentration	22	21.2	36	37.9
Course(s) only	56	53.8	24	25.3
Other	2	1.9	2	2.1
No Responses	14[1]		23[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only 3 did not respond to this item.

2. Of the 23 missing cases indicate 12 did not respond to this item.

Number of Different CADD Courses Offered

Table 24 represents the number of different CADD courses offered in respondents' departments. Approximately 53.3% of respondents indicated the total of different CADD courses was 3 or more. About 46.7% of respondents indicated that they offered 1 to 2. In their Perceived Ideal level, only 20.4% of respondents indicated their total different CADD courses was 1 to 2. However, about 79.6% of respondents indicated that they preferred to offer 3 or more in their departments.

Table 24

Number of CADD Course(s) Offered

Number of CADD Courses Offered	Current Status N = 118	%	Perceived Ideal N = 118	%
1	17	16.2	6	6.1
2	32	30.5	14	14.3
3	18	17.1	26	26.5
4 or more	38	36.2	52	53.1
No Responses	13[1]		20[2]	
Total	118	100.0	118	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they did not have to answer this item. Only 2 did not respond to this item.

2. Of the 20 missing cases indicate only 9 did not respond to this item.

CADD Course(s) Offered by the Level of Difficulty

In Table 25 the respondents were asked to list the current CADD courses offered by the level of difficulty of each course. About 38% of respondents indicated their CADD courses offered by the level of difficulty was beginning CADD. There were 37.6% with intermediate and only 23.7% with advanced CADD. For additional CADD courses, approximately 64% of respondents indicated advanced CADD should be an additional course option in their departments.

Table 25

CADD Course(s) Offered by the Level of Difficulty

Level of CADD Difficulty	Current Status N = 118	%	Perceived Ideal N = 118	%
Beginning	106	38.7	13	11.2
Intermediate	103	37.6	29	25.0
Advanced	65	23.7	74	63.8
Total	274[1]	100.0	116[1]	100.0

Note. 1. The number indicates there have some instructors responding to this question and responded to more than one item.

Type of CADD Organization

The respondents were asked to indicate which type of organization was their perceived ideal with regard to CADD instruction. The findings are presented in Table 26. The majority of respondents (66.7%) indicated the type of CADD organization is a combination of separate CADD courses and CADD integrated into all design and drafting courses. About 22% of respondents indicated that the type of CADD organization was CADD integrated into all other design and drafting courses with no separate CADD courses.

Table 26

Ideal Type of Organization Regard to CADD Instruction

Type of CADD Organization	N = 118	%
CADD integrated into all other design/drafting courses; no separate CADD Courses	23	21.9
A beginning CADD course on how to use software	2	1.9
A series of CADD courses on how to use software at the Beginning, Intermediate and Advanced level	10	9.5
A combination of separate CADD courses, and CADD integrated into all design and drafting courses	70	66.7
No Responses	13[1]	
Total	118[1]	100.0

Note. 1. There were 11 returns that indicated they did not offer CADD course, so they do not have to answer this item. Only 2 did not respond to this item.

Most Needed Changes with Respect to CADD Implementations

In Table 27 the respondents were asked to list three most needed changes with respect to CADD implementation from Part 1 of the questionnaire. The highest percent of respondents indicated number of workstations with 14.3% of responses. There were 12.7% of respondents who indicated the main type of CADD hardware and 9.3% of the respondents indicated type of CADD organization as the perceived ideal with regard to CADD instruction. The respondents identified some additional changes. These included (a) keep instructor up on latest software version, (b) instruction of Disk Operation System (DOS) and Autolisp language, and (c) finite element analysis (FNA) need to be added into CADD courses etc.

Factors Inhibiting the Implementation or Continuation of CADD in Industrial Technology Baccalaureate Programs

This section of the questionnaire, Part Two, sought to gain information from the respondents about the most inhibiting factors for the implementation or continuation of CADD in industrial technology programs. The factors presented were:

Table 27

Most Needed Changes with Respect to CADD Implementation

Item		Count	%%	Rank
15.	Number of CADD workstations	34	14.3	1
13.	Main type of CADD hardware used for your CADD instruction	30	12.7	2
20.	Which type of organization is your perceived ideal with regard to CADD instruction	22	9.3	3
19-2.	List the additional CADD courses which you would like to offer and check their level of difficulty	20	8.4	4
12.	Main type of CADD software used for your CADD instruction	15	6.3	5
19.	Number of different CADD course(s) offered	15	6.3	5
8.	Main type of CADD training program used to prepare instructor in your department	14	5.9	7
1.	Number of full-time faculty who teach one or more CADD courses	13	5.5	8
14.	Type of CADD configuration	13	5.5	8
11.	Highest level of performance on your primary CADD system	10	4.2	10
18.	Scope of your CADD offering	9	3.8	11
2.	Number of full-time faculty whose full teaching load is CADD courses	8	3.4	12
5.	Average number of CADD classes offered each semester or quarter	7	3.0	13
9.	Major source of CADD textbooks for your department	7	3.0	13
17.	Is CADD a required course for all major in your department	6	2.5	15
10.	Major source of CADD instructional materials for your departments	5	2.1	16
3.	Number of part-time temporary faculty who teach CADD courses	2	0.8	17
4.	Number of graduate assistant who teach CADD courses	2	0.8	17
7.	Grade level intended to serve as your beginning CADD course	2	0.8	17
6.	Credit hours of a beginning CADD course offered in your department	1	0.4	20
16.	Your prerequisites for a beginning CADD courses	1	0.4	20
19-1.	List the current CADD courses you offer by course title and check the level of difficulty of each course	1	0.4	20
Total		237[1]	99.8[2]	

Note. 1. The total number is larger than 118 which indicated the instructors responded to 1 to 3 most needed change item(s).

2. The total percentage does not equal 100 due to rounding error.

1. Technical expertise
2. Industrial experience
3. Facilities
4. Funding
5. Qualified instructors
6. Department administration
7. Advisory committee
8. Instructional materials
9. Textbooks
10. Training programs
11. Faculty shortage
12. Other.

Technical Expertise

The respondents were asked how technical expertise will inhibit the implementation or continuation of CADD in their departments. The findings are presented in Table 28. Over 78.8% of respondents indicated technical expertise was either "least," "little," or "inhibiting" in the implementation of CADD in their programs. Only 21.3% of respondents indicated technical expertise was "strong" or "extremely" inhibiting on their CADD implementation.

Industrial Experience

The respondents were asked to rate the factor "Industrial Experience" inhibiting the CADD implementation or continuation in their departments. Table 28 contains a summary of the responses. Approximately 82.5% of respondents indicated industrial experience was "least inhibiting," "little inhibiting," or "inhibiting" on CADD implementation. Only 17.5% of respondents indicated industrial experience was either "strong inhibiting" or "extremely inhibiting."

Facilities

In Table 28 the respondents were asked how the facilities will inhibit the implementation or continuation of CADD in their departments. Approximately 70.8% of respondents indicated facilities were either "extremely inhibiting," "strong inhibiting," or "inhibiting" in the implementation or continuation of CADD. Only 29.2% of respondents indicated this factor was "least inhibiting," or "little inhibiting."

Funding

The respondents were asked how the funding will inhibit the implementation or continuation of CADD in their departments. The findings are presented in Table 28. Over 93.1% of respondents indicated funding was "extremely inhibiting," "strong inhibiting," or "inhibiting" in the implementation of CADD. Only 6.9% of respondents indicated funding was "least inhibiting" or "little inhibiting."

Table 28

Factors Inhibit the Implementation or Continuation of CADD in ITBPs

Factors		1 Technical Expertise N = 118	%	2 Industrial Experience N = 118	%	3 Facilities N = 118	%	4 Funding N = 118	%
Least Inhibiting	1	32	28.3	24	21.1	12	10.6	2	1.7
	2	28	24.8	37	32.5	21	18.6	6	5.2
	3	29	25.7	33	28.9	20	17.7	13	11.3
Inhibiting	4	15	13.3	16	14.0	33	29.2	24	20.9
Extremely	5	9	8.0	4	3.5	27	23.9	70	60.9
No Respondents		5		4		5		3	
Total		118	100.0	118	100.0	118	100.0	118	100.0

Factors		5 Qualified Instructors N = 118	%	6 Department Administration N = 118	%	7 Advisory Committee N = 118	%	8 Instructional Materials N = 118	%
Least Inhibiting	1	22	19.5	50	43.9	64	57.7	40	35.4
	2	34	30.1	36	31.6	26	23.4	38	33.6
	3	30	26.5	19	16.7	17	15.3	21	18.6
Inhibiting	4	18	15.9	4	3.5	2	1.8	11	9.7
Extremely	5	9	8.0	5	4.4	2	1.8	3	2.7
No Respondents		5		4		7		5	
Total		118	100.0	118	100.0	118	100.0	118	100.0

Factors		9 Textbooks N = 118	%	10 Training Programs N = 118	%	11 Faculty Shortage N = 118	%	12 Other N = 118	%
Least Inhibiting	1	50	44.2	25	22.7	24	21.1		
	2	28	24.8	28	25.5	24	21.1	2	13.3
	3	24	21.2	33	30.0	29	25.4		
Inhibiting	4	11	9.7	20	18.2	21	18.4	3	20.0
Extremely	5	0	0.0	4	3.6	16	14.0	10	66.7
No Respondents		5		8		4		103	
Total		118	100.0	118	100.0	118	100.0	118	100.0

Qualified Instructors

According to the data contained in Table 28, the majority (50.4%) of respondents indicated qualified instructors was either "extremely inhibiting," "strong inhibiting," or "inhibiting." About 49.6% of respondents indicated this factor was either "least inhibiting" or "little inhibiting."

Department Administration

As indicated in Table 28, a majority of respondents (92.2%) indicated department administration was either "least inhibiting," "little inhibiting," or "inhibiting." Only about 7.9% of respondents indicated this factor was either "extremely inhibiting," or "strong inhibiting."

Advisory Committee

As indicated in Table 28, a majority of respondents (96.4%) indicated advisory committees were either "least inhibiting," "little inhibiting," or "inhibiting" in the implementation of CADD. Only 3.6% of respondents indicated this factor was either "extremely inhibiting," or "strong inhibiting."

Instructional Materials

In Table 28 respondents were asked how instruction materials will inhibit the implementation or continuation of CADD in their departments. The majority of respondents

(87.6%) indicated instructional materials were either "least inhibiting," "little inhibiting," or "inhibiting." About 12.4% of respondents indicated this factor was either "extremely inhibiting," or "strong inhibiting."

Textbooks

The respondents were asked how textbooks will inhibit the implementation or continuation of CADD in their departments. The findings are presented in the Table 28. The majority of respondents (90.2%) indicated textbooks were either "least inhibiting," "little inhibiting," or "inhibiting" in the CADD implementation. About 9.7% of respondents indicated this factor was "strong inhibiting." None of the respondents indicated textbooks were "extremely inhibiting."

Training Programs

The respondents were asked how training programs will inhibit the implementation or continuation of CADD in their departments. The findings are presented in Table 28. About 51.8% of respondents indicated training programs were either "extremely inhibiting," "strong inhibiting," or "inhibiting." Approximately 48.2% of respondents indicated this factor was either "least inhibiting," or "little inhibiting."

Faculty Shortage

In Table 28 the respondents were asked how faculty shortage will inhibit the implementation or continuation of CADD in their departments. The majority of respondents (57.8%) indicated faculty shortage was either "extremely inhibiting," "strong inhibiting," or "inhibiting." About 42.2% of respondents indicated this factor was either "least inhibiting," or "little inhibiting."

Other

The respondents were asked if there were any other factors that would inhibit the implementation or continuation of CADD in their departments. The findings are presented in Table 28. It demonstrated that 66.7% of respondents indicated that (a) demand for technicians, (b) CADD taught in other department, and (c) time were "extremely inhibiting." About 20% of respondents indicated (a) technological change, (b) knowledge of instructors, (c) curriculum change, (d) software purchase, update, and (e) service contract were "strongly inhibiting." About 13.3% of responses indicated that the curriculum change was "little inhibiting."

Ranking of the Factors Inhibit the Implementation or Continuation of CADD

Table 29 provides the mean values and ranks for each of the 12 factors which inhibit the implementation of continuation of CADD in Industrial Technology Baccalaureate Programs. A Likert-type scale was used to rate inhibition and frequency. Available rankings ranged from 1, indicating least inhibiting, to 5, indicating extremely inhibiting in the implementation of CADD in four-year baccalaureate industrial technology programs.

The mean and rank were computed for each variable and reported on Table 29. The majority of respondents indicated "funding", assigning it the highest rating (4.34). The second highest rating of the responses was "facilities" (3.37). "Faculty shortage" was recognized as the third (2.83) and "Qualified instructors" was the fourth (2.63). The fifth rating was "training programs" (2.55). "Advisory committee" received the lowest rating (1.67). The mean value for these factors was 2.56.

Table 29

Ranking of the Factors Inhibit the Implementation or Continuation of CADD

Factor	Mean	SD	Rank	Valid *N*
Funding	4.34	0.99	1	115
Facilities	3.37	1.32	2	113
Faculty shortage	2.83	1.34	3	114
Qualified instructors	2.63	1.20	4	113
Training programs	2.55	1.14	5	110
Technical expertise	2.48	1.25	6	113
Industrial experience	2.46	1.08	7	114
Instructional materials	2.11	1.08	8	113
Textbooks	1.96	1.03	9	113
Department administration	1.93	1.07	10	114
Advisory committee	1.67	0.93	11	111

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to provide information on selected factors which affect the current status of Computer-aided Design and Drafting (CADD) as well as those factors which are perceived to be needed to reach a desired level in the implementation of CADD in Industrial Technology Baccalaureate Programs (ITBPs). In addition, this study provided necessary information for educators and administrators about the factors inhibiting the implementation or continuation of CADD.

The general focus of this study was to identify and analyze factors which facilitate the implementation of CADD in Industrial Technology Baccalaureate Programs in the United States. Three research questions were developed to guide the study:

1. What is the current status of CADD implementation in Industrial Technology Baccalaureate Programs?

2. What is the perceived ideal level of CADD implementation in Industrial Technology Baccalaureate Programs?

3. What factors inhibit the implementation and continuation of CADD in Industrial Technology Baccalaureate Programs?

This research was guided by several assumptions and limitations. It was assumed that (a) the questionnaire was appropriately designed to elicit the information needed to answer all of the research questions, (b) respondents were able to provide accurate data, (c) CAD and CADD were essentially the same subjects in the programs involved in this study, and (d) the population of this study was representative of the University Division of the National Association of Industrial Technology (NAIT) 1992 Directory. The research was limited to (a) industrial technology accredited and non-accredited programs as listed in the University Division of the NAIT 1992 Directory, (b) self-reported information as well as subjective opinions, (c) the implementation of CADD in Industrial Technology Baccalaureate Programs, and (d) respondents who had primary responsibility for teaching in the areas of CADD in Industrial Technology Baccalaureate Programs.

The literature review was designed to provide (a) an historical overview of CADD, (b) a background of research on CADD competencies, (c) an overview of studies in purchasing CADD systems, and (d) some information on CADD training. Related fields of study were reviewed for reference in developing the questionnaire.

Summary of Findings

The following is a summary of the findings of this study. The findings were derived from an analysis of data obtained from demographic information, as well as Part One and Part Two of the questionnaire.

Demographic

1. The modal value for respondents (28%) indicated that the total institutional student enrollment was 15,001 or more.

2. The modal value for respondents (21%) indicated that the total undergraduates majoring in industrial technology programs was 101-200.

3. The modal value for respondents (35%) indicated that the total full-time faculty in industrial technology departments was 6-10.

4. The majority of respondents (91%) reported they offered CADD in their industrial technology departments.

Research Question 1:

What is the current status of CADD implementation in Industrial Technology Baccalaureate Programs?

1. The modal value for respondents (42%) indicated that they employ 1 full-time faculty member who teaches one or more CADD course(s).

2. The majority of respondents (74%) indicated that their department head did not employ full-time faculty teaching a full-time load in CADD courses.

3. The majority of respondents (69%) indicated that there were no part-time faculty who taught CADD course(s).

4. The majority of respondents (86%) indicated that graduate assistant(s) did not teach CADD course(s).

5. The modal value for respondents (24%) indicated that the average number of CADD classes offered each semester or quarter was two.

6. The majority of respondents (77%) indicated that their beginning CADD course was equivalent to three semester hour credits.

7. The majority of respondents (59%) indicated that the grade level the beginning CADD course intended to serve was freshman level.

8. The modal value for respondents (42%) indicated that in-house faculty training was the main type of CADD training.

9. The majority of respondents (84%) indicated that a commercial publisher was the main source of CADD textbooks.

10. The majority of respondents (61%) indicated that instructor-developed materials were the major source of CADD instructional materials.

11. Fourty three percent of respondents indicated that 2D, 3D, and solid modeling (all of the above) were the highest level of performance on a primary CADD system.

12. The majority of respondents (81%) indicated that AutoCAD was the main type of CADD software used.

13. The majority of respondents (53%) indicated that the main type of CADD hardware used was an IBM 386 or compatible.

14. The majority of respondents (78%) indicated that a stand-alone unit rather than a network was the main type of CADD configuration.

15. The most frequent respondents (24%) indicated the present number of workstations at 11 to 15; however, approximately 20% had 21 to 25 workstations.

16. The majority of respondents (90%) indicated that the prerequisites for a beginning CADD course was either orthographic drawing (45%) or no prerequisite (45%).

17. The majority of respondents (52%) indicated that CADD was required for all majors in their departments.

18. The majority of respondents (54%) indicated that their scope of CADD offerings consisted of course(s) only rather than CADD as a major or concentration area.

19. The most frequent respondents (36%) indicated that 4 or more different CADD courses were currently offered.

Research Question 2:

What is the perceived ideal level of CADD implementation in Industrial Technology Baccalaureate Programs?

1. The modal value for respondents (30%) indicated the belief that the department head should employ two full-time faculty members to teach CADD course(s).

2. The modal value for respondents (38%) indicated that the department head should employ one full-time faculty member to teach a full-time load in the CADD area.

3. The majority of respondents (65%) indicated that they would not want part-time faculty teaching CADD course(s).

4. The majority of respondents (64%) indicated that they would not want graduate assistant(s) teaching CADD course(s).

5. The modal value for respondents (24%) indicated that the average number of CADD classes offered each semester or quarter should be two. There were 22% of the respondents who indicated they would like to offer 6 or more CADD classes each semester (quarter).

6. The majority of respondents (82%) indicated they preferred the beginning CADD course to have a 3 hour credit value.

7. The majority of respondents (66%) indicated that their preferred grade level for a beginning CADD course was freshman.

8. The most frequent response indicated that workshops provided by vendors (29%) and in-house training (27%) were the preferred type of CADD training program.

9. The majority of respondents (77%) indicated that a commercially published textbook was the preferred source of CADD textbooks.

10. The majority of respondents (59%) indicated that instructor developed was the preferred source of CADD instructional materials.

11. The majority of respondents (70%) indicated that the ideal highest level of performance on primary CADD system was 2D, 3D and solid modeling.

12. The majority of respondents (83%) indicated that they preferred AutoCAD as the main type of CADD software.

13. The majority of respondents (81%) indicated that the preferred type of CADD hardware was an IBM 486 or compatible.

14. The majority of respondents (57%) indicated that a network was the ideal type of CADD configuration.

15. The modal value for respondents (31%) indicated that the ideal number of workstations was 36 or more.

16. The modal value for respondents (43%) indicated that they preferred no prerequisites for a beginning CADD course.

17. The majority of respondents (92%) indicated that ideally, CADD should be required for all majors.

18. The modal value for respondents (38%) indicated that the ideal scope of CADD offerings was as a program or major.

19. The majority of respondents (53%) indicated that the ideal number of CADD course(s) offered was 4 or more.

Research Question 3:

What factors inhibit the implementation or continuation of CADD in Industrial Technology Baccalaureate Programs?

The majority of respondents indicated that "funding" was an extremely inhibiting factor for the implementation of CADD which was ranked as the highest mean among the other factors in Table 29. "Facility" was ranked second highest as an inhibiting factor (Table 29). However, while both are ranked as inhibiting, it should be noted there is a difference in the means between these two factors, of approximately one point.

"Faculty shortage" and "qualified instructors" were perceived as inhibiting factors on the implementation of CADD which were ranked as third and fourth among other factors (Table 29). On the other hand, most of the respondents indicated that an "advisory committee" was the least inhibiting factor for the implementation of CADD, ranking it the lowest (11th) in the Table 29.

Also many of respondents indicated that "department administration" and "textbook" were not actually inhibiting factors on the implementation of CADD, ranking 10th and 9th respectively. Some factors fell into the mid-range of the scale regarding the implementation of CADD. These were (a) training programs, (b) technical expertise, (c) industrial experience, and (d) instructional materials.

Conclusions

The conclusions of this study were based upon the data presented in Chapter IV. After an examination of the data, it was concluded that:

1. It appears that there is no need, nor is it appropriate to hire, part-time faculty to teach CADD courses. But the data does support the hiring of a full-time faculty member to teach CADD courses.

2. A good commercially published textbook plays an important role in CADD implementation.

3. AutoCAD software is the primary package used in CADD instruction.

4. There are typically no prerequisites required for a beginning CADD course.

5. Three semester credit hours for a beginning CADD course was used frequently by industrial technology

programs. And the data suggest that it is appropriate to retain three semester credit hours for a beginning CADD course.

6. Respondents like to use CADD instructional materials developed by the instructor. Therefore, it is important for facilitating the implementation of CADD if the CADD instructional materials are developed by the instructors.

7. Respondents indicated that one full-time faculty member was currently employed in the area of CADD implementation. However, the employment of two full-time faculty members would be better. This finding implies industrial technology programs should hire more full-time faculty in the area of CADD in order to facilitate the implementation of CADD.

8. Most of respondents indicated that they do not have full-time faculty whose full-time teaching load was in CADD. However, they think that hiring more faculty who teaching CADD area would facilitate the implementation of CADD.

9. The most common number of CADD workstations for the current status in industrial technology was identified as 11-15. However, many respondents indicated that 36 or more CADD workstations should be used in the future to facilitate the implementation of CADD. This implies more CADD workstations should be purchased in order to meet the needs of future development in CADD implementation.

10. A majority of respondents indicated that CADD was required for all majors in their departments. Moreover, an overwhelming majority of respondents (91.9%) believe CADD should be required for all majors in the future. So, there seems to be a trend for CADD to be required for all majors in industrial technology department programs in order to facilitate CADD implementation.

11. Respondents indicated they most frequently offered four or more CADD courses. Moreover, a larger number of the respondents also felt offering four or more CADD courses would be helpful to facilitate implementation. According to the data (Table 24), there may be a need to offer at least four CADD courses in industrial technology programs.

12. A majority of respondents reported IBM 386 or compatible computers were used in the implementation of CADD. However, an overwhelming majority of respondents recommended that IBM 486 or compatible machines would be best to facilitate implementation. Industrial technology educators prefer the IBM family of computers when considering new purchases of equipment. There seems to be a trend for increased growth in the use of more powerful IBM or compatible computers in CADD implementation.

13. Among the types of training programs used for this study, the one most frequently utilized currently is in-house training. However, the perceived ideal was divided

about equally between the vendor workshops and in-house training programs. It would be appropriate to pursue both avenues of training for faculty who need assistance in facilitating CADD implementation in their programs.

14. The highest level of performance on a CADD system at both the current and ideal status was a combination of 2D, 3D, and solid modeling.

15. The majority of respondents indicated that the current CADD offerings in their departments were not as a major or concentration area. This finding may be attributed to the fact that CADD acts as an individual or separate course(s) in industrial technology programs and CADD has not been integrated into a design or drafting program. However, an approximately equal number of respondents feel that CADD should be offered as a major or a concentration (Table 23). Therefore, a curriculum designer might consider the fact that a CADD offering as a major or concentration may be necessary for the implementation of CADD.

16. An overwhelming majority of respondents indicated they did not have graduate assistants teaching CADD classes. Though the perceived ideal helps to reinforce the notion that graduate assistants are not needed, there is an indication that they should be used.

17. The freshman year was the grade level used and also considered the ideal for the beginning CADD classes. Even there a larger number of respondents felt, in an ideal program, a beginning CADD classes should be introduced at the freshman level. So, it seems important to introduce beginning CADD at the freshman level, perhaps, so that students can utilize fully the CADD skills in their design and drafting courses of the junior or senior level.

18. Stand-alone microcomputers were used extensively by a majority of industrial technology programs in their CADD implementation. Although microcomputers are inexpensive and useful, most of the respondents perceived that ideally industrial technology programs should strive to change their CADD configuration into network-based systems to become more efficient and economical.

19. "Funding" was identified as the most inhibiting factor in the implementation or continuation of CADD (research question 3). Additional factors, "facilities," "faculty shortage," "qualified instructors," and "training programs" were also identified as inhibiting the implementation of CADD. Most of the respondents indicated that an "advisory committee" was the least inhibiting factor the implementation of CADD. Therefore, industrial technology programs should strive to (a) locate new space for the CADD instruction, (b) recruit more qualified instructors who have

expertise in the areas of CADD, and (c) provide more training programs for faculty who need assistance to facilitate CADD implementation in their departments.

Discussion

The purpose of this study was to identify those factors that affect the implementation of CADD and the factors needed to reach a desired level of CADD implementation in Industrial Technology Baccalaureate Programs. Because the factors affecting CADD programs in colleges and universities have not been systematically identified and described, administrators and instructors information needed to make decisions about CADD utilization. If certain factors could be identified that expedite the implementation of CADD, this could have important implications for industrial technology programs in CADD. This study could also be helpful to curriculum leaders and department heads regarding plans in CADD implementation in their industrial technology programs.

This study was limited to the Industrial Technology Programs listed in the University Division of the NAIT 1992 Directory. It would be useful to find out whether there is any significant difference in the implementation of CADD in the industrial technology programs (National Association of Industrial Technology) and engineering technology programs (Accreditation Board for Engineering

Technology). It also would be interesting to find out whether there is any significant difference in the implementation of CADD between accredited and non-accredited industrial technology programs listed in the University Division of the NAIT 1992 Directory.

In the current software market, there are over 200 software programs in the area of CADD. Even though AutoCAD was used by a majority of respondents in this study, there is a need to find out whether different CADD software for CADD instruction would generate significant differences on the implementation of CADD. Moreover, it would be interesting to explore how educators teach their students to make CADD knowledge transferable to industrial and educational environments.

Recommendations

The results of this study suggest the following recommendations. The reader should remember these recommendations were based upon those respondents who had primary responsibility for the CADD program.

1. Administrators of Industrial Technology Programs should hire more faculty who have expertise in the area of CADD in order to facilitate the implementation of CADD in their departments.

2. Vendor workshops and in-house training programs should be provided to faculty who need assistance to enhance

their CADD knowledge so as to facilitate the implementation of CADD in their departments.

3. All industrial technology instructors should be encouraged to integrate CADD into their design and drafting programs.

4. CADD should be a required course for all majors in all industrial technology programs.

5. The curriculum designer should consider the development of CADD as a major or concentration program in their departments.

6. Industrial technology instructors should be encouraged to develop their own instructional materials to suit their particular curriculum needs.

7. If funding is available, it is recommended that IBM 486 or compatible computers be purchased and be used for CADD implementation.

8. Industrial technology instructors should be encouraged to share CADD knowledge and teaching skills as a means to improve teaching skills and to maintain state-of-the-art CADD technology expertise.

Recommendations for Future Study

It is recommended, based upon the findings of this research, that further study in the following areas be conducted:

1. Determine if there is any significant statistical difference in student performance with the different CADD software package.

2. Determine if there is any significant statistical difference in CADD instruction for the students who have basic technical drawing prerequisites and those students who do not have basic technical drawing prerequisites in the implementation of CADD.

3. Determine how funding sources for the implementation of CADD are allocated. For example, funding has the effect on hiring more faculty in CADD area or for the purchase or upgrade the CADD software etc.

4. Duplicate the study of implementation of CADD in Industrial Technology Baccalaureate Programs listed in the University Division of the NAIT Directory at five year intervals to verify the results and findings of this study, and to see what changes might occur.

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APPENDIX A

Questionnaire Validation

1. Trial Run Participants
2. Cover Letter
3. Trial Run Questionnaire

Trial Run Participants

Dr. Gerald L. Bacza
Division of Technology
Fairmont State College
Fairmont, WV 26554

Dr. Michael B. Atkins
Department of Engineering Technology
Western Michigan University
Kalamazoo, MI 49008

Dr. Jerry L. Kowal
Department of Industrial Technology
Western State College
Gunnison, CO 81231

Dr. Ronald D. Bro
Department of Industrial Technology
University of Northern Iowa
Cedar Falls, Iowa 50614

Dr. Richard S. Redditt
Department of Industrial Studies
Middle Tennessee State University
Murfreesboro, TN 37132

Mr. David A. Madsen
Department of Drafting & Manufacturing Technology
Clackamas Community College
Oregon City, OR 97045

Date: October 4, 1992

Inside address

Dear Dr. :

Thank you for agreeing to participate in this doctoral study as a jury member. The attached survey instrument concerns the implementation of Computer-Aided Design and Drafting (CADD) in Industrial Technology Baccalaureate Programs within the United States.

You have been recommended as one of the few persons in the nation who has expertise in CADD in higher education. This study is concerned specifically with the current status, the perceived ideal level, and factors inhibiting the implementation or continuation of CADD in Industrial Technology Baccalaureate Programs. The result of this study will help to provide preliminary data to be considered for developing better CADD programs in Industrial Technology Baccalaureate Programs.

Your help is particularly desirable during this pilot-test to validate the instrument for use on a broader scale. Please respond to the items directly on the survey instrument. In addition, please make comments directly on the survey instrument with regard to redundancy, explicitness, understandability, readability, and in general problems you had responding to the instrument.

It will be appreciated if you will complete the enclosed form prior to **October 19th, 1992** or as soon as possible and return it in the enclosed stamped, addressed envelope. The other phase of this research cannot be conducted without your contributing response. Your responses will be held in strictest confidence.

I will be pleased to send you a summary of this study should you desire. Thank you for your cooperation.

Sincerely yours, Endorsement,

Tsung-Juang Wang,
D.I.T. Candidate
Enclosures

Dr. John T. Fecik,
Dissertation Advisor

APPENDIX B

Letter to Department Chairs for the Purpose of Identifying Prospective Survey Respondents and Research Documents

1. Letter to Department Chairs
2. Letter to Prospective Survey Respondents
3. Post-card
4. First Follow Up Letter to Department Chairs
5. First Follow Up Letter to Identifying Respondents
6. Second Follow Up Letter to Department Chairs
7. Second Follow Up Letter to Identifying Respondents
8. Questionnaire

(Phone):319-273-2561
(Fax):319-273-2893
(Internet):WANG3754@ISCSVAX.UNI.EDU

Date: November 3, 1992

1~
2~
3~
4~

Dear 5~:

Please consider this as a request for your cooperation and professional assistance in my doctoral dissertation research.

Please nominate an individual from your program who would be the best qualified to evaluated the enclosed questionnaire. This person may be either yourself or a faculty member in your department. Then, pass along to that individual the enclosed packet which contains the questionnaire and stamped, address envelope. Also, please complete the enclosed postcard by identifying the individual nominated, and returning it in the mail at once.

The attached survey instrument concerned with the implementation of Computer-Aided Design and Drafting (CADD) in Industrial Technology Baccalaureate Programs is part of this doctoral study. This study is concerned specifically with the current status, the perceived ideal level, and factors inhibit the implementation or continuation of CADD in Industrial Technology Baccalaureate Programs. The results of this study will help to provide preliminary data to be considered for developing better CADD program in Industrial Technology Baccalaureate Programs.

Thank you in advance for your assistance.

Sincerely yours, Endorsement,

Tsung-Juang Wang
D.I.T. Candidate
Enclosures

Dr. John T. Fecik
Dissertation Adviser

(Phone):319-273-2561
(Fax):319-273-2893
(Internet):WANG3754@ISCSVAX.UNI.EDU

Date: November 3, 1992

1~
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Dear Educator:

The attached survey instrument is concerned with the implementation of Computer-Aided Design and Drafting (CADD) in Industrial Technology Baccalaureate Programs part of this doctoral study. This study is concerned specifically with the current status, the perceived ideal level, and factors inhibit the implementation or continuation of CADD in Industrial Technology Baccalaureate Programs. The results of this study will help to provide preliminary data to be considered for developing better CADD program in Industrial Technology Baccalaureate Programs.

It is desirous to obtaining your responses because your experience in the implementation of CADD will contribute significantly toward the primary data needed in this important area. The enclosed instrument has been tested with a panel of experts in the area of CADD and therefore revised it in order to making it possible to obtain the necessary data while using a minimum of your time. The average time required to try out the survey instrument was 12.5 minutes.

It will be appreciated if you will complete the enclosed form prior to **November 18, 1992** and return it in the stamped, addresses envelope enclosed. Your participation and contribution to this study will be vital part of the data needed in this study. Any comments that you may have concerning that factors related to the implementation of CADD not covered in the instrument will be welcome. Your response will be held in strictest confidence. Your name will not be associated with your answers in any public or private report of the study's results. Coding will be used only for follow-up mailings.

Thank you in advance for your assistance. I will be pleased to send you a summary of the study if you desire.

Sincerely yours,

Tsung-Juang Wang
D.I.T. Candidate
Enclosures

Endorsement,

Dr. John T. Fecik
Dissertation Adviser

Dear Mr. Wang:

I nominate ________________
to response your questionnaire.

Recommended By: ________________

(Phone):319-273-2561
(Fax):319-273-2893
(Internet):WANG3754@ISCSVAX.UNI.EDU

Date: November 25, 1992
*

1~
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Dear 5~:

Two weeks ago, you were sent a letter and enclosed was a cover letter and questionnaire requesting your professional assistance to identify a qualified member in your department to participate in a study of the Implementation of Computer-aided Design and Drafting in Industrial Technology Programs. Our records indicate that we have not received your response. Would you kindly take a few minutes to complete and send the recommendation card and/or completed questionnaire to me?

If, by chance, the initial instrument forwarded to you was misplaced. Please contact me for another copy. If you do this in the immediate time period, I will be grateful for your contribution to my study. The receipt of the completed questionnaire is very important for the completion of this study. Please help! If you recently have responded to my request, I thank you for your cooperation.

Sincerely,

Tsung-Juang Wang
D.I.T. Candidate

(Phone):319-273-2561
(Fax):319-273-2893
(Internet):WANG3754@ISCSVAX.UNI.EDU

Date: November 25, 1992

1~
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Dear 5~:

As the faculty member designated as the participant from your program, you were requested to respond to a survey for the Implementation of Computer-Aided Design and Drafting in Industrial Technology Programs. The cover letter and questionnaire were mailed two weeks ago to the chair of your department and it should have been forwarded to you for a response. Our records indicate that we have not received your response. Would you kindly take a few minutes to complete questionnaire to me?

If, by chance, the initial instrument forwarded to you was misplaced. Please contact me for another copy. If you do this in the immediate time period, I will be grateful for your contribution to my study. The receipt of the completed questionnaire is very important for the completion of this study. Please help! If you recently have responded to my request, I thank you for your cooperation.

Sincerely,

Tsung-Juang Wang
D.I.T. Candidate

(Phone):319-273-2561
(Fax):319-273-2893
(Internet):WANG3754@ISCSVAX.UNI.EDU

Date: December 30, 1992

1~
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Dear 5~:

One and half months ago, you were mailed a letter requesting your professional assistance to identify a qualified member in your department to participate in a study on the Implementation of Computer-aided Design and Drafting in Industrial Technology Programs. One month ago a follow-up letter was mailed to you to encourage the return of the survey instrument. Our records indicate that we have not received your response yet. Would you kindly take a few minutes to complete and send the recommendation card and/or completed questionnaire to me?

If, by chance, the initial instrument forwarded to you was misplaced. Please contact me for another copy. If you do this immediately, I will be grateful for your contribution to my study. Every questionnaire is very important for the completion of this study. Please help! If you recently have responded to my request, I thank you for your cooperation.

Sincerely,

Tsung-Juang Wang
D.I.T. Candidate

(Phone):319-273-2561
(Fax):319-273-2893
(Internet):WANG3754@ISCSVAX.UNI.EDU

Date: December 30, 1992

1~
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Dear 5~:

Your department head/chair designed you as an expert for responding to a survey on the Implementation of Computer-Aided Design and Drafting in Industrial Technology Programs. The cover letter and questionnaire were mailed one and half months ago to the chair of your department and should have been forwarded to you for a response. Our records indicate that we have not received your response. Would you kindly take a few minutes to complete questionnaire?

If, by chance, the initial instrument forwarded to you was misplaced. Please contact me for another copy. If you do this immediately, I will be grateful for your contribution to my study. Every questionnaire is very important for the completion of this study. Please help! If you recently have responded to my request, I thank you for your cooperation.

Sincerely,

Tsung-Juang Wang
D.I.T. Candidate

Please return by **November 18, 1992**

SELECTED FACTORS RELATED TO THE IMPLEMENTATION OF COMPUTER-AIDED DESIGN AND DRAFTING IN INDUSTRIAL TECHNOLOGY BACCALAUREATE PROGRAMS

DEMOGRAPHIC INFORMATION:

INSTRUCTIONS: Please check ONE that is applicable in each of the following items.

1. How many students are enrolled in your institution?

_____ 0-1000 _____ 1001-2500 _____ 2501-5000 _____ 5001-8000
_____ 8001-12000 _____ 12001-15000 _____ 15001 or more

2. How many undergraduate students major in your department?

_____ 0-45 _____ 46-100 _____ 101-200 _____ 201-300
_____ 301-400 _____ 401-500 _____ 501-600 _____ 600 or more

3. How many full-time faculty are there in your department?

_____ 0-5 _____ 6-10 _____ 11-15 _____ 16 or more

***** Check the ONE response which best describes how you teach CADD in your department. *****

_____ 1. I teach CADD, please continue to answer PART ONE and PART TWO, Page 5.

_____ 2. I DO NOT teach CADD, please go directly to PART TWO, Page 5.

PART ONE - Current Status and Perceived Ideal Level of CADD Implementation in Industrial Technology Baccalaureate Programs.

INSTRUCTIONS: Check the ONE response, unless otherwise stated, that most accurately describes the current status and the perceived ideal level of CADD in your department.

	Current Status	Perceived Ideal Level
1. Number of full-time faculty (including yourself) who teach one or more CADD courses?	_____ 0 _____ 1 _____ 2 _____ 3 _____ 4 _____ 5 or more	_____ 0 _____ 1 _____ 2 _____ 3 _____ 4 _____ 5 or more
2. Number of full-time faculty whose full teaching load is CADD courses?	_____ 0 _____ 1 _____ 2 _____ 3 _____ 4 or more	_____ 0 _____ 1 _____ 2 _____ 3 _____ 4 or more
3. Number of part-time temporary faculty who teach CADD courses?	_____ 0 _____ 1 _____ 2 _____ 3 _____ 4 or more	_____ 0 _____ 1 _____ 2 _____ 3 _____ 4 or more

CONTINUED ON BACK

	Question	Current Status	Perceived Ideal Level
4.	Number of graduate assistant(s) who teach CADD courses?	____ 0 ____ 1 ____ 2 ____ 3 ____ 4 or more	____ 0 ____ 1 ____ 2 ____ 3 ____ 4 or more
5.	Average number of CADD classes (sections) offered each semester or quarter?	____ 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 or more	____ 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 or more
6.	Credit hours of a beginning CADD course offered in your department?	Semester ____ 0 ____ 1 ____ 2 ____ 3 ____ 4 ____ 5 or above	Semester ____ 0 ____ 1 ____ 2 ____ 3 ____ 4 ____ 5 or above
7.	Grade level intended to serve as your beginning CADD course	____ Freshman ____ Sophomore ____ Junior ____ Senior	____ Freshman ____ Sophomore ____ Junior ____ Senior
8.	The main type of CADD training program used to prepare instructor(s) in your department	____ None ____ In-house ____ In-service ____ Internship ____ Workshop by other institutions ____ Workshop by vendors ____ Other (please specify) ____________	____ None ____ In-house ____ In-service ____ Internship ____ Workshop by other institutions ____ Workshop by vendors ____ Other (please specify) ____________
9.	The major source of CADD textbooks for your department	____ Software vendor ____ Instructor developed ____ Commercial publisher ____ Other (please specify) ____________	____ Software vendor ____ Instructor developed ____ Commercial publisher ____ Other (please specify) ____________
10.	The major source of CADD instructional materials other than textbooks for your department	____ Software vendor ____ Instructor developed ____ Commercial publisher ____ Other (please specify) ____________	____ Software vendor ____ Instructor developed ____ Commercial publisher ____ Other (please specify) ____________
11.	The highest level of performance on your primary CADD system(s)	____ 2D ____ 3D (Wireframe & Surface) ____ 2D & 3D (Wireframe & Surface) ____ Solid modeling ____ All of above	____ 2D ____ 3D (Wireframe & Surface) ____ 2D & 3D (Wireframe & Surface) ____ Solid modeling ____ All of above

No.	Question	Current Status	Perceived Ideal Level
12.	Main type of CADD software used for your CADD instruction		
		____ AutoCAD	____ AutoCAD
		____ AutoSketch	____ AutoSketch
		____ CADKEY	____ CADKEY
		____ CADAM	____ CADAM
		____ CADAPPLE	____ CADAPPLE
		____ CADDRAW	____ CADDRAW
		____ Cascade	____ Cascade
		____ Design CADD	____ Design CADD
		____ DESIGNER	____ DESIGNER
		____ DiscoverCAD	____ DiscoverCAD
		____ FastCAD	____ FastCAD
		____ Generic CADD	____ Generic CADD
		____ GS-1000	____ GS-1000
		____ INTERGRAPH	____ INTERGRAPH
		____ MATC-CAD	____ MATC-CAD
		____ Medusa	____ Medusa
		____ MicroCADDS	____ MicroCADDS
		____ Personal Designer	____ Personal Designer
		____ RoboCAD	____ RoboCAD
		____ Solution3000	____ Solution3000
		____ TechniCAD	____ TechniCAD
		____ VersaCAD	____ VersaCAD
		____ Other (please specify)	____ Other (please specify)
13.	Main type of CADD hardware used for your CADD instruction		
		____ Apple II Families	____ Apple II Families
		____ Macintosh Families	____ Macintosh Families
		____ IBM 286 or compatible	____ IBM 286 or compatible
		____ IBM 386 or compatible	____ IBM 386 or compatible
		____ IBM 486 or compatible	____ IBM 486 or compatible
		____ VAX	____ VAX
		____ Prime	____ Prime
		____ AT&T Series	____ AT&T Series
		____ Tectronics Tech. Series	____ Tectronics Tech. Series
		____ IBM minicomputer	____ IBM minicomputer
		____ Cyber 760	____ Cyber 760
		____ Intergraph	____ Intergraph
		____ Auto-Trol	____ Auto-Trol
		____ Other (please specify)	____ Other (please specify)
14.	Type of CADD configuration	____ Stand-alone	____ Stand-alone
		____ Network	____ Network
15.	Number of CADD workstations	____ 1-5	____ 1-5
		____ 6-10	____ 6-10
		____ 11-15	____ 11-15
		____ 16-20	____ 16-20
		____ 21-25	____ 21-25
		____ 26-30	____ 26-30
		____ 31-35	____ 31-35
		____ 35 or more	____ 35 or more
16.	Your prerequisites for a beginning CADD course (check all that apply)		
		____ Geometry	____ Geometry
		____ Computer Programming	____ Computer Programming
		____ Orthographic Drawing	____ Orthographic Drawing
		____ Pictorial Drawing	____ Pictorial Drawing
		____ None	____ None
		____ Other (please specify)	____ Other (please specify)
17.	Is CADD a required course for all majors in your department?	____ Yes	____ Yes
		____ No	____ No

CONTINUED ON BACK

		Current Status		Perceived Ideal Level	
18.	Scope of your CADD offering	____	Program or major	____	Program or major
		____	Emphasis or concentration	____	Emphasis or concentration
		____	Course(s) only	____	Course(s) only
		____	Other (please specify) ____	____	Other (please specify) ____
19.	Number of different CADD course(s) offered?	____	1	____	1
		____	2	____	2
		____	3	____	3
		____	4 or more	____	4 or more

19.1. Please list the current CADD courses you offer by course title and check the level of difficulty of each course.

1. ____________ ____ Beginning ____ Intermediate ____ Advanced
2. ____________ ____ Beginning ____ Intermediate ____ Advanced
3. ____________ ____ Beginning ____ Intermediate ____ Advanced
4. ____________ ____ Beginning ____ Intermediate ____ Advanced

If you have more courses, please list them on the top of this sheet.

19.2. Please list the additional CADD courses which you would like to offer and check their level of difficulty.

1. ____________ ____ Beginning ____ Intermediate ____ Advanced
2. ____________ ____ Beginning ____ Intermediate ____ Advanced
3. ____________ ____ Beginning ____ Intermediate ____ Advanced
4. ____________ ____ Beginning ____ Intermediate ____ Advanced

20. Which type of organization is your perceived ideal with regard to CADD instruction?

____ CADD integrated into all other design/drafting courses; no separate CADD courses.

____ A beginning CADD course on how to use software

____ A series of CADD courses on how to use software at the Beginning, Intermediate and Advanced level.

____ A combination of separate CADD courses, and CADD integrated into all design and drafting courses.

____ No CADD, all manual drafting

21. Please select three (3) most needed changes with respect to CADD from above items 1-20 in your department. Identify these by the item number.

1. ____ 2. ____ 3. ____

PART TWO - Factors Which Inhibit the Implementation or Continuation of CADD in Industrial Technology Baccalaureate Programs.

INSTRUCTIONS: Circle on the scale the extent to which each of the factors listed will have an inhibiting influence upon CADD implementation in your department. Rate on a scale of 1 (the least inhibiting) to 5 (the extremely inhibiting).

		Least Inhibiting					Extremely Inhibiting
1.	Technical expertise	1	2	3	4	5	
2.	Industrial experience	1	2	3	4	5	
3.	Facilities	1	2	3	4	5	
4.	Funding	1	2	3	4	5	
5.	Qualified instructors	1	2	3	4	5	
6.	Department administration	1	2	3	4	5	
7.	Advisory committee	1	2	3	4	5	
8.	Instructional materials	1	2	3	4	5	
9.	Textbooks	1	2	3	4	5	
10.	Training programs	1	2	3	4	5	
11.	Faculty shortage	1	2	3	4	5	
12.	Other (please specify)						
	______________		1	2	3	4	5

Additional Comments:

Thank you for completing the questionnaire. Please check and make sure no responses are left unanswered. Return the questionnaire by **November 18, 1992** in the self-addressed stamped envelope.

If you wish to receive a summary of the results, check "**send results**" and **your name** on the bottom of this page.

Thank you!

Send Results ________

Name ______________________________

APPENDIX C

Listing of Addresses for Population

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APPENDIX D

Respondents Comments

The respondents were asked to write comments if there are other concerns which were not cover in this study. Thirty-two (32) of the responses write down their comments about this study. These comments are listed on the followings.

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1. Part Two is not applicable since we have previously implemented a key effective series of CAD courses at xxx University.

2. We treat CADD like the drafting pencil- a tool. First course required of an major is engineering graphic.

3. CADD courses are taught by the engineering technology department for the entire Campus.

4. Our program has been discontinued.

5. Georgia Board of Regents policy forbids graduate assistants from teaching. They do work in labs as assignments.

6. No changes needed.

7. Sorry it took so long. Good luck!

8. Students take CAD courses in the other department within the School of Technology at xxx University.

9. We just moved into a new technology building where our computer numbers, expertise and facility increased a tremendous amount. We have not yet caught up with these new environments. So we are setting pretty good at present.

10. All drafting and related course material are taught by our engineering school on our campus.

11. CADD is offered in our engineering technology department. We offer heavy computer application for graphic arts using MAC's. Our students use classes and facilities of the other department. We do not have funds to duplicate facilities and equipments.

Comments (Continued)

12. Need plans for software update and technicians.

13. We recently switched to CADKey from AutoCAD because of AutoCAD's cost and because practices.

14. We recently merged our computer needs, on a campus wide basis, to better serve students and faculty.

15. Our program has just undergone updating and revision. Within the constraints of our university, we are as current as we expect to be regarding hardware.

16. After a few years of abandoning the traditional board drawing format, we have returned to some drawing board instruction. We are incorporating both CAD and board instruction in our Engineering and Architectural (and Technical Illustration) courses. All CAD did not seem to fill our - or business/industry - expectations. Good luck!

17. I am sorry I overlooked the return date.

18. Most drafting and all types taught by the engineering Graphics Department.

19. Networks crash, we use networks to share data, not file serve.

20. We are one of less than 10 B.S. programs in the U.S. We run a very unified experience for our graduates at the cutting edge of Design Drafting. We (as are all Higher Education) find the short money supply to be the most factor.

21. Design & Drafting is redundant - if we design we must document the design -- drafting.

22. The computer is nothing more than a tool. As such there should not be CADD courses. We might as well create T-square and triangle courses. Good luck with your study!!!

23. CADD was just the foundation we need to expand. Based on the CADD, (1) we need to go CAD/CAM, (2) reverse engineering, rapid phototyping and document engineering, needs to filter dawn to an senior year level, (3) FEA needs to be added.

Comments (Continued)

24. I received the questionnaire on November 18 and filled it out November 19. Hope it is still useful.

25. Multiple licensing would be ideal for different software but we cannot afford it.

26. Grade level intended to serve [should] put it early [freshman] so they can apply in later classes.

27. AutoCAD used by 74% of industrial CADD application. Any other helpful to supplement for specific needs.

28. Any [hardware] use be able to deliver software.

29. Industry will favor IBM or compatible. Education will favor Apple/MAC.

30. CADD exposure at any level, on any platform, with any software is important. The degree of exposure will be determined by the program offerings and the needs and desires of the student - according to his/her goals.

31. Faculty do not have time to learn about new developments in CADD. Our teaching and committee loads are so heavy that there is no time to sit at a computer and learn. Software is out of data before we learn to use it!

32. We currently have a very sound program. However, it is increasingly difficulty to maintain equipment and software levels and find time to keep current.

33. Please accept my apology for the problems created by this late response. I hope you will not interpret my actions as reflecting disinterest in your research; the opposite is true.

34. I am conducting a study in the greater Houston area. I will share the results when completed. Survey and cover letter attached.

35. Our institution offers CADD courses at the engineering technology level, not industrial technology.

36. I am almost impossible to equip facilities with state of the art hardware and keep up with software upgrades.

37. Funding to stay current with software updates is critical.

Comment (Continued)

38. Add an intermediate/advanced CADD course. This is currently in progress and planned to be introduced next year (Sept.).

39. CADD should be required of all technology majors. Plans are underway to do this by fall 1993.

40. Add 1-2 full-time and 1 part-time CADD teachers.

41. The rapid change in the levels and complexity of AutoCAD and related auxiliary Autodesk programs required retraining on an ongoing basis. I have had to learn 5 levels already and am working on No. 6 now (Version 12). With little access to outside training (funding), this means continuous, self-training is mandatory. The ever-increasing complexity of the software requires almost constant upgrading or replacement of hardware.

42. Faculty have decided to have the CAD course taught by engineering department as an elective course. We have a communications lab, but the teacher does not like other teachers to use it for their class.

43. New developments come so fast it is difficult to maintain any level of expertise.

44. Strangely our advisory committee favors board drafting classes over computer drafting. We offer an A.A.S. in Computer-aided Design and Drafting.

Note: 1. The above comments are copied down from the return questionnaires. The research did not change any wording unless indicate by [].

2. The above number indicate the coding number which was initially used for follow-up basis.