COMPUTER AIDED DRAFTING: PERCEIVED NEEDS OF VIRGINIA'S COMMUNITY COLLEGE DRAFTING INSTRUCTORS

by

Arnold Keith Murdock

Dissertation submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

in

Vocational and Technical Education

APPROVED:

K. K. Eschenmann, Chairman

C. R. Finch **H. M. Harvey**

J. L. Hoerner **P. A. O'Reilly**

April, 1996

Blacksburg, Virginia

Key words: Drafting, Computer, Virginia, Needs, College

COMPUTER AIDED DRAFTING: PERCEIVED NEEDS OF VIRGINIA'S COMMUNITY COLLEGE DRAFTING INSTRUCTORS

by

Arnold Keith Murdock

K. Kurt Eschenmann, Chairman

Department of Vocational and Technical Education

(ABSTRACT)

Rapid changes in the drafting profession have left gaps in skills and resources which hinder the ability of community college drafting instructors to provide students with the advanced skills needed for employment. To minimize these problems and to facilitate the integration of CAD into drafting programs, local and state authorities must plan to allocate adequate resources to each program. They must also provide avenues for instructors to become proficient with CAD and to assess the instructor's perceptions about their needs.

The purpose of this study was to identify areas of perceived need of community college drafting instructors in Virginia. A survey was mailed to 36 community college drafting

instructors. For 14 categories of CAD skills, instructors were asked to indicate their (1) technical skill, (2) need for technical training, (3) level of CAD integration, (4) integration skill, and (5) need for integration training. The instructors were also asked to identify resource needs.

The findings suggest that a high level of instruction exists in CAD categories related to traditional drafting tasks. Fewer instructors have vetured into the CAD categories related to design. Many of the instructors who have attempted to teach these categories feel uncertain about their technical skills and skills in integrating advanced CAD categories into their drafting curriculum. From the instructors' responses, it is concluded that a need for resources exists to help instructors to use and integrate CAD categories related to design and customization.

DEDICATION

This work, in it’s entirety, is dedicated to my wife, Nancy, who has given me everything and asked for nothing in return. I love you more than you could ever imagine.

——Strawberries.

ACKNOWLEDGMENTS

While many have contributed to my education, and more specifically to my doctoral degree, I would like to formally recognize a few of those who have contributed the most to my success.

First, I must thank the almighty God for giving me the strength, courage, and the chance to complete this project.

Second, I would like to thank the members of my doctoral committee for their support, advice, and enthusiasm, especially Dr. Kurt Eschenmann. I have known Kurt since my undergraduate days at Virginia Tech. Since that time, he has practiced a high level of student advocacy. It is virtually impossible to summarize how Kurt has influenced me. I can only hope that I will be as professionally competent, and as personally caring as he.

I would also like to thank the Business and Vocational Education faculty at Valdosta State University for the chance to join you in Georgia. I hope that I will become a respected colleague and a trusted friend to you all.

In addition, I wish to express gratitude for the support provided by Mr. Gregg Kendrick at Republic Research Training Centers, Inc. Gregg has given much needed financial support through the many work opportunities he has offered. Further, the technical skills I developed at RRTC have proven to be extremely valuable to me. Thanks also, Gregg, for helping me to make the decision to return to graduate school.

More personally, I would like to thank Dr. Lloyd Benson for his support and enthusiasm. Lloyd, I have thoroughly enjoyed the time we have spent together. You have proven to be a valued colleague, a trusted ally, and a true friend. Your intense enthusiasm for learning has helped me tremendously.

Finally, I must thank my family. It is difficult for one to be successful without familial support. I would like to thank my parents, George and Stella Murdock, for providing a good home environment. Also, thanks go to my sister Barbara, for being a good role model, and spending time with me. I will never forget the summers I spent with you, or the many trips to your house during my years in Blacksburg. Likewise, thanks, to my niece Angela, and nephews Sam and Steve. I am proud to call you relatives, and more importantly, friends. The many hours we have spent together will never be forgotten.

I am indebted to you all for the life and experiences you have given me.

Arnold Murdock

April, 1996

Valdosta, Georgia

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I: BACKGROUND OF THE PROBLEM

Introduction

The increased capabilities of Computer Aided Drafting (CAD) software have had a profound effect on the drafting profession. Drafters using CAD equipment are more efficient and more accurate than drafters without CAD capabilities. By eliminating repetitive work, CAD frees the drafter to spend more time on design related issues. According to Wissa (1988), CAD allows drafters to take on more of the work of designers and designers to function more as engineers. These changes in the drafters work call for similar changes in the educational programs and instructional staff charged with preparing those students who will enter the profession.

Indeed, drafting technology has become an important part of industry around the world. Drafters and designers produce technical drawings in pencil or ink on a surface such as vellum or mylar. Traditionally, they use equipment such as drafting boards, dividers, triangles, pencils, erasers, and the like. Consequently, training for drafters has focused on preparing students to use this equipment.

Over the past decade, computers have emerged in the drafting profession. Using computer aided drafting (CAD) software, drafters and designers can produce technical drawings quicker, and more accurately, than ever before. Duelm (1986) stated, "As the interface between man and machine, CAD serves to integrate the maximum capabilities of each to rise above the manual drafter in applying the concepts of engineering graphics" (p. 3).

Computer aided drafting offers several advantages over traditional drafting methods. Productivity features such as the ability to copy and move entities top the list. In addition, modern CAD software is completely customizable. Complete libraries of graphic symbols can be created once and re-used as often as they are needed. Consequently, the repetitive nature of many traditional drafting tasks has disappeared. Along with powerful commands which eliminate repetition and increase productivity, modern CAD software has evolved into a powerful three dimensional modeling and analysis tool.

Changes in the drafting profession require changes in drafting education programs. According to Burns (1986), changes in the drafting profession (i.e., increased use of CAD technology and more focus on design related functions) have led to increased training requirements for drafters. Similarly, research shows that a large percentage of CAD training is obtained from community colleges (Irwin, 1992). During the past decade, considerable literature focusing on the integration of CAD technology into these programs has been produced. Indeed, many community college drafting programs now include CAD technology as part of the curriculum. Flechsig and Seamans (1987), suggested that, despite this effort, the best way to integrate CAD into the drafting curriculum was still unknown.

While community college drafting programs must change to keep pace with a dynamic drafting profession, instructors within these programs must likewise strive to maintain up-to-date CAD skills. To prepare students to enter today's drafting profession, instructors must have advanced technical (CAD) skills. Community college instructors must be skilled in the use of those CAD functions which facilitate the design process and increase productivity. Such skills include (1) use of basic drawing and editing commands, (2) scaling commands, (3) rotation commands, (4) replication functions, (5) applying dimensioning commands, (6) CAD menu customization, (7) writing custom CAD programs, (8) creating re-usable symbols, (9) using three dimensional drawing commands, (10) using three dimensional viewing commands, (11) using solids modeling, (12) applying shading and rendering functions, (13) using non-graphical database functions, and (14) using Finite Element Analysis functions. Teachers who possess these types of skills will be able to meet the needs of their students in the years ahead.

Yuen (1990) pointed out that while most teachers agree that CAD must be incorporated into the drafting curriculum, many community college teachers lack the resources needed to meet the program needs. Common problems include a limited exposure to CAD, limited budget, and a lack of curriculum materials. Holloway (1987) also stated that many teachers lack appropriate occupational experience, technical expertise, and proper funding.

The problems drafting teachers face with CAD are indicative of more broad-based concerns about the use of technology in education. The integration of computer-based technologies has been described as inefficient, poorly planned, and chaotic (Picciano, 1994). A review of literature conducted by Sormunen and Chalupa (1994) identified two primary concerns about the use of technology in education: (1) preparing teachers to use technology and (2) preparing teachers to *integrate* technology into the classroom. When using CAD in their classes, instructors must have the skills to actually use the CAD software themselves. Further, they must be able to integrate CAD into the curriculum by teaching with the technology.

A review of literature identified several other factors that influence the use of computers in the classroom. The teacher's prior training and experience are shown to be important (Kinzie and Delcourt, 1991). Teachers having more actual experience and prior training are more likely to use computer technologies in their classes. In addition, research suggests that teachers who have computers available for their use (either at home or school) more strongly support the use of computers in their programs (Yuen, 1985).

To help teachers make more effective use of technology in the classroom, Gordon (1993) recommended that teachers should be provided with opportunities to get "hands on" experience with computer technology. Additionally, Gordon recommended that training should be relative to the teachers major program area (i.e., CAD specific). An earlier study by Nelson (1984) concluded that assistance was needed by teachers to increase the effective use of computers in their classes. Specifically, Nelson listed additional funding, equipment, in-service training, and technical assistance as areas where problems are likely to exist.

Need for the Study

It would appear from earlier studies that community college drafting instructors may not be prepared, either technically or pedagogically, to provide the advanced level of training required to enter the drafting profession. Further, community college drafting programs may lack the resources necessary to offer CAD-related drafting and design education. Rapid changes in the drafting profession have created gaps in skills and resources which hinder the ability of instructors to provide students with the advanced CAD skills needed for employment. To facilitate the integration of CAD technology into the community college drafting curriculum, local and state authorities must plan to allocate adequate resources to each program. It is also necessary to plan activities that will help instructors to use CAD software and to integrate CAD into the curriculum. Before this can be done, however, it is important to assess the needs of instructors in these three areas.

To identify the CAD related needs of community college drafting instructors in Virginia, a comprehensive needs assessment must be conducted. This study takes a comprehensive approach to needs assessment in that it assesses the three categories of needs as identified through related literature. These are needs relating to: (1) technical skills of instructors, (2) the instructors skill in integration CAD into the curriculum, and (3) the availability of CAD related resources.

Purpose of the Study

The purpose of this study was to identify the perceived CAD-related instructional and non-instructional needs of community college drafting instructors in Virginia. Although this study was designed specifically to gather information to assist those involved in planning for the integration of CAD into drafting programs, it provides a model for planning the integration of related technology into educational programs. In addition, this information can be used by CAD vendors and manufacturers in their efforts to provide resource materials for teachers.

Research Questions

In the questions listed below, "selected CAD functions" refer to (1) basic drawing and editing commands, (2) scaling commands, (3) rotation commands, (4) replication functions, (5) dimensioning commands, (6) CAD menu customization, (7) user defined programs, (8) creating re-usable symbols, (9) three dimensional drawing commands, (10) three dimensional viewing commands, (11) solids modeling, (12) shading and rendering functions, (13) non-graphical database functions, and (14) finite element analysis (FEA) functions.

The following research questions were established for this study:

1. What is the perceived level of skill with regard to selected CAD functions of community college drafting instructors in Virginia?

2. What is the perceived level of need for technical training with regard to selected CAD functions of community college drafting instructors in Virginia?

3. What is the perceived level of skill of community college drafting instructors in Virginia in integrating selected CAD functions into their curriculum?

4. To what extent do community college drafting instructors in Virginia perceive that selected CAD functions have been integrated into their drafting curriculum?

5. What is the community college drafting instructors' perceived level of need for training in integrating selected CAD functions into their drafting curriculum?

6. What resources do community college drafting instructors believe are needed to further integrate CAD into their curriculum?

Delimitations

The following delimitation applies to this study:

1. The population in this study was restricted to include only faculty teaching full-time within drafting, design, or engineering programs at community colleges in Virginia.

Assumptions

The following assumption applies to this study:

1. Because it was not possible to make direct observations of skill levels and program resources, a self report needs assessment instrument was administered. Therefore, it was necessary to assume that the subjects were objective and accurate in reporting their levels of skill and program needs.

Definition of Terms

The following terms are defined to clarify their meaning within the context of this study:

1. Computer Aided Drafting and Design (CAD)—The use of a computer to perform drafting and design tasks (also referred to as CADD).

2. Hardware—The physical components of a computer system.

3. CAD Software—Computer programs that contain specific functions to facilitate drafting and design tasks.

4. Community College CAD Programs—Community college level programs that include CAD as part of a drafting, design, or engineering curriculum.

5. Finite Element Analysis (FEA)—The determination of the structural integrity of a part by mathematical simulation of the part and the forces acting on the part.

6. Database—A collection of interrelated data items organized by a consistent scheme that allows one or more applications to process the items without regard to physical storage locations.

7. Bill of Material—A computer listing of parts or items represented on an engineering design, automatically derived from the database.

8. Solids Modeling—A three dimensional object that is being constructed electronically; having solid properties such as boundaries, measurable volume, and mass.

9. Curricular Integration of Technology—the overall process of using the technology within an instructional context. It involves technical skill and knowledge of when and how the technology can be used to teach the subject matter.

CHAPTER II: REVIEW OF THE LITERATURE

Introduction

This chapter summarizes the literature reviewed as part of this research study. The literature reviewed was related to (1) planning for technology in education, (2) the benefits of using CAD, (3) use of CAD in education, (4) important CAD functions, (5) needs assessment, and (6) survey research methods.

Information presented in this review was gathered from ERIC database searches, Proquest Dissertation Abstracts database searches, and from manual searches conducted in the libraries of Virginia Tech, Valdosta State University, and the University of Virginia. The interlibrary loan service was also utilized to obtain resources from other university libraries.

This chapter is organized into the following ten sections:

1. Introduction
2. Planning for Technology in Education
3. Benefits of Using CAD
4. Use of CAD in Education

5. Important CAD functions

6. Needs Assessment

7. Purpose of Descriptive Research

8. Instrument Development

9. Data Collection

10. Summary

Planning for Technology in Education

As the use of computer technology continues to grow, we must be more aware of the processes that are used to integrate that technology into educational programs. The successful integration of technology into educational programs requires considerable planning. Picciano (1994) states that: "The major impediment to establishing successful computer-based applications in schools now is the lack of careful planning" (p. 9). While planning for vocational programs is often a function of local needs assessment, it is also important to consider information pertaining to the state level. According to Picciano (1994), external environmental scanning is an important part of planning for technology. The author defines the process as, "engaging in activities to provide information on the community, state, and society for planning purposes" (Picciano, 1994, p. 45).

Indeed, planning for the integration of computer technology involves more than a determination of hardware and software specifications. Educators must also be concerned with the curricular integration of technology and staff education. Picciano (1994) maintains that the integration of technology into a curriculum is closely tied with staff development. Further, Picciano (1994) states:

> ...while more equipment has been acquired, its effectiveness in the classroom is in question. A major reason for this is that the process of bringing technology to instruction has not been effective and in fact has been described as inefficient, poorly planned, and incredibly chaotic. While problems of hardware cost and software development and acquisition are being resolved, other problems such as curricular integration and staff development remain. Careful planning at both the district and school building levels would more clearly define these problems and provide alternatives for their resolution (p. 9).

Picciano (1994) describes the process of integration as follows:

> Curriculum Integration is a simple concept but is proving difficult to realize with instructional computer applications. Integrating computer tools into the classroom is conceptually similar to integrating other tools such as chalkboards, overhead projectors, or paints and crayons. Teachers and students have few problems using these other, more familiar tools in teaching and learning. Microcomputers, on the other hand are more sophisticated, expensive tools, and mastering them is a more complex undertaking. Integrating microcomputers into the curriculum starts with making sure that teachers and students have developed a basic understanding of and knowledge of computer use. Once this basic understanding has been achieved, mastery involves developing a knowledge about the many different ways computers can be utilized (p. 104).

Therefore, technology may be seen as an instructional tool. Curricular integration, then, may be defined as the overall process of using the technology within an instructional context. It involves, first, a high level of technical skill, and second, specific knowledge of when and how the technology can be used to teach the subject matter.

In summary, when planning for the use and integration of computer technology, educators must be concerned with building the teacher's skills in (1) how to use the computer, and (2) how to incorporate computer technology into the curriculum. Indeed, successful integration of technology into the classroom requires the development of both the technical and pedagogical skills of teachers.

Supporting the case for staff development activities, Nelson (1985) stated, "to encourage the use of technology, teacher educators must develop and provide courses, both on campus and in-service to the schools, as well as technical assistance programs to help teachers upgrade the computer content of their classes" (Nelson, 1985). Picciano (1994) believes that planning for staff development must be based on teacher input:

> ...planning requires the involvement of those who possess expertise and who ultimately may be responsible for implementing new applications. The fulcrum for curriculum integration and planning instructional applications is the teaching staff. The teachers are critical for identifying applications and evaluating software, hardware, and staff development needs (p. 105).

Tu (1991) believed that, for computer use to be maximized in education, we must consider both the human and technological side of computer usage. Unless instructors have positive attitudes toward the technology, computer use will be unproductive (Pickard, 1983). An important part of one's attitude toward computers is perceived confidence in computer use (Molla, 1987). Therefore, when planning for computer use in education, it is important to consider the technology itself as well as the perceptions and attitudes of those who will use the technology.

When planning for the use of technology in drafting programs, staff development activities must focus on content that is appropriate for the level of instruction (i.e., secondary versus postsecondary). They must increase the instructor's technical and pedagogical knowledge/skills with regard to drafting content for which the use of technology (i.e., CAD) is appropriate. It is equally important to consider the teacher's perceptions of need and competence when planning for technology. Indeed, how teachers use computers in the classroom, and their perceived competence with the technology must guide the determination of content for staff development activities (Langhorne, 1989).

Benefits of Using CAD

Engineering graphics plays a major role in American industry. Technical drawings represent a highly specialized form of language to engineers, architects, and other technical professionals. These technical drawings are a means of providing information about the size, shape, and location of features on an object. Traditionally, drafters and designers sit at drawing boards and use triangles, dividers, compasses, protractors, and other tools to produce drawings manually. This procedure is referred to as board drafting. More recently, computers are being used by drafters and designers to produce technical drawings quicker and more accurately. Duelm (1986) stated, "As the interface between man and machine, CAD serves to integrate the maximum capabilities of each to rise above the manual drafter in applying the concepts of engineering graphics" (p. 3). Figure 1 is an example of a three dimensional solid model of a tool that was drawn using the Microstation CAD software package.

Using CAD software, contemporary drafters and designers incorporate a series of programmed commands to position and manipulate graphics on a computer screen. CAD systems have many functions that contribute to increased productivity and aid the design process. Productivity increases since the user is permitted to draw and edit an object (i.e., scale, rotate, move, mirror) many times before creating a printed drawing. In addition, modern CAD systems are completely customizable, thus permitting users to create job-specific command menus and libraries of commonly used symbols. This customization ability also promotes a more user-friendly system and increased productivity. Further, modern CAD software has powerful three dimensional modeling and analysis tools. These tools allow a designer to view the

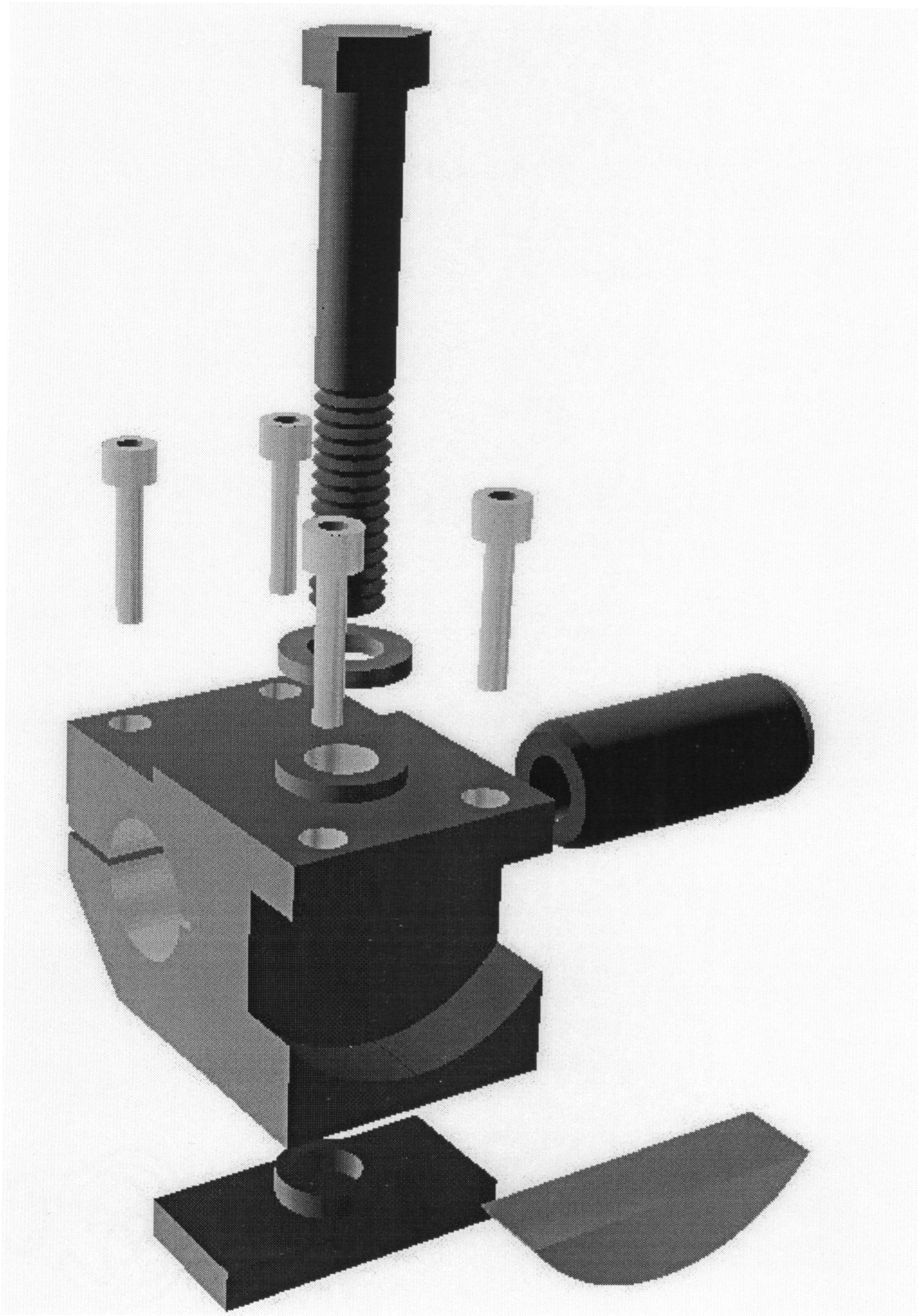

Figure 1: A 3-D Solid Model Created Using Microstation

design from any angle, test physical properties, and check tolerances.

The development of computer aided drafting (CAD) software has revolutionized the engineering graphics world, thus changing the drafting profession. Duelm (1986) considered CAD to be an integral part of the backbone of American industry. The United States Bureau of Labor Statistics (1994) estimated that by 2005, all drafters will use CAD regularly. CAD makes engineers and drafters more productive by eliminating time consuming, repetitive hand work (Goetsch, 1986). Consequently, drafters are able to devote more time to design related issues rather than traditional drafting tasks such as hand lettering, sharpening pencils, and the like.

According to Burns (1986), changes in the nature of the drafting profession may necessitate a higher level of education and experience than previously required. The emergence of this change can be seen in the United States Bureau of Labor Statistics (1994) report which states that employers prefer applicants for drafting positions who have training beyond the high school level. Further, Irwin

(1992) reported that fifty-two percent of all locally employed CAD operators had graduated from a junior or community college. Irwin (1992) also found that while thirty-three percent of local CAD operators acquired CAD skills at a junior or community college, only seven percent did so in a high school setting. Imel (1990) summarized the educational implications of the changing labor market:

> Despite the general rising trend in educational requirements associated with employment, there will still be many good jobs available in 2000 for individuals without a bachelor's degree. Some of these jobs will require only a high school education, but most will require some postsecondary education and training (p. 1).

The United States Bureau of Labor Statistics (1994) provides a description of the contemporary drafting profession:

> Drafters prepare technical drawings used by production and construction workers to build spacecraft, automobiles, industrial machinery, and other manufactured products, as well as structures such as

office buildings, houses, bridges, and oil and gas pipelines. Their drawings show the technical details of the products and structures from all sides, with exact dimensions, the specific materials used, procedures to be followed, and other information needed to carry out the job. Drafters prepare and fill in technical details, using drawings, rough sketches, specifications, and calculations made by engineers, surveyors, architects, and scientists.

There are two methods by which drawings are prepared. In the traditional method, drafters sit at drawing boards and use compasses, dividers, protractors, triangles, and other drafting devices to prepare the drawing manually. Drafters also use computer aided drafting (CAD) systems. They use computer work stations to create the drawing on a video screen. They may print the drawing on paper but also may store it electronically so that revisions and/or duplications can be made more easily. These systems also permit drafters to easily prepare many variations of the design (Occupational Outlook Handbook, p. 226).

Clearly, CAD has become an integral part of the drafting profession. Without CAD skills, drafters are hardly employable. According to Hu (1988), "CAD training for prospective draftsmen, engineers, and other technical designers is no longer merely a luxury. Computer aided design is a survival skill for tomorrow's technical artists" (p. 16). As more and more drafting tables are replaced by computer workstations, this will continue to be the case. Consequently, CAD technology must be integrated into the educational programs charged with preparing those who will enter the drafting profession.

Use of CAD in Education

While many community college drafting programs offer CAD training, much confusion surrounds the issue of CAD integration. Several attempts have been made to determine the content and strategies for teaching CAD. Much of the literature of the 1980's called for drafting teachers to resist the temptation to replace traditional drafting equipment with CAD stations (Addison, 1988; Burns, 1986; Goetsch, 1986; Isbell & Lovedahl, 1988). Many were afraid that CAD use would grow slowly or that it would turn out to be a passing fad. Yuen (1990), in contrast, conceded that the amount of manual drafting will decrease as industry continues to expand its use of CAD equipment. We may well be ahead of the Bureau of Labor Statistics projection that by 2005, all drafters will use CAD regularly. Research conducted by Irwin (1992) confirms this notion. Irwin found that 76 to 100 percent of drafting work in the Saginaw area of Michigan was conducted using CAD rather than manual drafting procedures.

Despite the prevalence of CAD and all of the attention being given to CAD training in the literature, the best way to integrate CAD into the drafting curriculum is still unknown (Flechsig and Seamans, 1987). According to Becker (1991) the literature is filled with suggestions based on personal opinion rather than research. In an attempt to solve this problem Becker, using the Delphi research technique, reached a consensus among a panel of experts on only 32 (38 %) of 86 statements regarding how drafting tasks should be taught, by using traditional methods or CAD. Further, Becker was unable to reach a consensus on actual strategies for teaching drafting. Becker concluded that CAD programs have little in common either in curriculum content or equipment. To further describe the problematic situation that exists in many CAD programs, Yuen (1990) stated:

> It is the opinion of most teachers that CAD must be integrated into the drafting curriculum. However, the problems are that few of these teachers have been exposed to CAD systems; they have limited budget to obtain and install the CAD systems needed for CAD training; and they lack the curriculum materials needed to meet the program needs (p. 30).

There are other factors which may influence the effectiveness of CAD in the classroom. Kinzie and Delcourt (1991) maintained that prior training strongly influences a teacher's attitude toward computer technology. Yuen (1985) also conducted research on the attitudes of trade and industrial teachers toward the use of computers. Yuen found that trade and industrial teachers who have experience working with computers or who have training in computer use are more in favor of using them in their classes. Further, Yuen's research suggests that teachers who have computers available for their use (either at home or school) show more support for the use of computers in their programs.

Important CAD Skills

Modern CAD offers a variety of productivity tools to designers and drafters from a wide range of disciplines (Wissa, 1988). Using these tools, drafters and designers can produce more drawings in less time than with traditional drafting methods. Yuen (1990) stated that CAD can increase the productivity of the traditional draftsman by as much as 20:1. Burns (1986) identified four basic CAD functions that increase productivity. These are, replication, rotation, scaling, and translation.

Replication refers to the ability to replicate parts of a design or image, thus eliminating the need to redraw the part each time. Dupont Corporation, for example, uses complex schematic diagrams in some machine designs. Rather than draw a schematic each time it is needed, the designer simply retrieves the drawing from the database and inserts it into the new drawing. Raker and Rice (1991) stated, "Most CAD drawings are repetitive. There are many kinds of repetition, ranging from using the same symbols and parts over and over to create drawings with countless variations on a basic design. CAD thrives on repetition" (p. 827).

Rotation refers to the ability to rotate part or all of a design. While rotation is not a complex process, traditional drafting methods precluded rotation after objects were drawn, without erasure. CAD allows any object(s) to be drawn, then rotated to a precise angle whenever necessary. Besides rotating objects, modern CAD systems allow the user to rotate the drawing's viewpoint. It is possible to view a drawing from any angle in three dimensional space. While two dimensional applications of this capability are limited, such viewing tools are extremely important when drawing in three dimensions.

Scaling, another basic function of CAD that increases productivity, refers to the CAD systems ability to scale any object. Indeed, an entire drawing can be drawn, then plotted at the desired scale (i.e., 1/4″=1′, 3/16″=1″). It is also possible to include multiple drawings of differing scales on the same sheet of paper and include both English and Metric dimensions. Further, a drawing's scale(s) may be changed whenever necessary.

Finally, translation refers to the CAD systems ability to move objects from one location to another. In addition, objects can be moved within the same drawing or into a different drawing. Although Burns' list of CAD functions is accurate, it is incomplete. Modern CAD software contains another tool that can bolster the productivity and effectiveness of drafters: customization.

CAD system customization enhances the systems user interface and further increases productivity. Most modern CAD systems have this capability. According to Raker and Rice (1991), customization involves:

- Capturing complex sequences and turning them into simple macros on a menu.
- Grouping pages of macros to fit the flow of your work.
- Creating screen and tablet menu macros that ask for information and then execute commands based on input.
- Understanding how screen, tablet, pull down and button menus work, and tailoring them to your liking.
- Setting the system variables that work behind the scenes in the [CAD] program (p. 828).

They continue, ". . . if you just run [CAD] by typing and picking from the standard [CAD] menu, you're not making the most of the program's abilities" (p.827). Further, Lamit (1994) believed that drafters should develop skills in programming with the CAD system's custom programming language.

Industry is increasingly turning to the use of computer aided drafting equipment to increase productivity. Burns (1986) noted: "Computer aided design (CAD) may represent the greatest increase in productivity since electricity" (p. 10). Demands for higher productivity coupled with increased demands for improved quality and cost efficient designs require that drafters and designers be proficient with the use of every tool modern CAD systems have to offer. Further, to meet the high productivity needs of industry, drafters must understand the system customization process and be able to employ these techniques on the job.

The effect that CAD has had on drafting productivity is clear. By using CAD, drafters are more efficient and their drawings are more accurate than ever before. Goetsch (1986) argued that CAD decreases the amount of time associated with a drafting project by eliminating time-consuming, repetitive hand work. According to Wissa (1988), CAD elevates the work of a drafter to that of a designer, and of designers to that of engineers. This author stated, "Those who can, will be able to assume more and more of the work traditionally done by designers. Designers, in turn, will be able to assume more and more of the work traditionally done by engineers" (p. 20).

Winchip (1990) believes that designers should continue to use CAD as a design tool rather than just a sophisticated drafting machine. The author states,

> Computer utilization enhances and supports the way in which designers work, but it has not changed the design process itself. The increasing application and use of electronic technology in the design process has the potential to enhance the creative, as well as the technical attributes of design (p. 3).

Thus, CAD use has elevated the drafting profession to include design—related functions. To function in this role, drafting students must learn to use the tools of modern CAD systems that enhance and support the design process.

Inasmuch as community colleges are a major source of CAD training, instructors must be proficient with those CAD functions which aid the design process.

Needless to say, the design process is often labor intensive. Many hours can be spent trying to conceptualize the problem, gathering design information, making a model, and preparing reports. According to Winchip (1990), a CAD system can automate many of the design functions. Winchip goes on to state, "A CAD system can produce higher quality results at a lower cost and higher speed. It is not feasible to automate all design functions, but there is an extensive range of cost-effective graphic and non-graphic applications" (p. 7).

Modern CAD systems include a variety of tools which enhance and support the design process. As Winchip (1990) and Lamit (1994) suggested, the application of CAD to design work can be divided into two categories: graphic and non-graphic. Graphic applications of CAD to design work include two and three dimensional drawing, solids modeling, and view shading and rendering. Non-graphic design applications include access to database information and bill of materials generation. Lamit (1994) summarized the implications of CAD use for product design and development:

> CAD systems provide a means to explore any number of design ideas for new products. Since exploring design alternatives with CAD systems is much faster than manual methods, more exploration is possible in the same amount of time. These designs are eventually refined into one finished model.
>
> Most CAD systems significantly aid the design engineer in design detailing and in the verification of the functionality and mechanical resistance of complex parts by employing finite element analysis (FEA) methods interfaced to the 3D model of the structure. FEA methods may be set up to calculate thermal stresses in addition to loads or to model the behavior of the construction material (usually steel) in its elastic or elastoplastic domain (p. 74).

Lamit (1994) and Tatum (1996) also believed that CAD's three dimensional capabilities can help designers to develop creative instincts as well as skills in visualization and graphic communications. CAD modeling is an integral part of today's design work. Lamit (1994) stated,

> Modeling with a 3D CAD system allows the designer to create multiple options for a design. A CAD model can be altered much easier than a layout on paper or a physical model. The CAD model can be used in every phase of the design decision process (p. 652).

Needs Assessment

The successful integration of technology into educational programs requires a great deal of planning. However, before planning decisions can be made, it is important to assess current programs (Finch and Crunkilton, 1993).

Needs assessment has been widely accepted as one of the first steps in educational planning. Benjamin (1989) stated:

> The main benefits which accrue as a result of performing needs assessments/analyses can be found in the planning and problem-solving which this activity generates. Frequently, real problems can be uncovered

and appropriate solutions crafted to fit the requirements of the situation. (p. 12)

Over the past two decades, many authors have attempted to define needs assessment and to provide an appropriate context for the process. Benjamin (1989), for example, provided a commonly accepted definition for needs assessment as, ". . . the formal systematic attempt to determine gaps between current outputs or outcomes and required or desired outputs or outcomes; to place these gaps in priority order; and to select the most important for resolution (p. 13). Other authors have offered similar definitions for needs assessment. Burton and Merrill (1979) defined needs assessment as a, "...process for determining goals, identifying discrepancies between goals and the status quo, and establishing priorities for action" (p. 22).

According to Rossett (1987) needs assessments have at least five purposes. These are:

1. To define optimal performance, or what should be happening,
2. To determine actual performance, or what is happening,

3. To describe the feelings of key stakeholders,

4. To identify the probable causes of the problems,

5. To select and prioritize effective solutions.

In a summary of the literature relating to needs assessment, Benjamin (1989) found several studies supporting the notion that most needs assessment models consist of the following four components:

1. Consideration of goals (desired or required),

2. Procedures for determining current status of goals,

3. Method for identifying, describing, and analyzing discrepancies,

4. Method for prioritizing discrepancies.

In its most recognized form, then, needs assessment involves the identification and prioritization of needs. According to Dick and Carey (1990), a need is a gap between what is and what should be. Supporting this definition, Hirumi (1994) wrote: "Needs assessment is a systematic procedure for identifying problems, setting priorities, and making informed decisions about how to reduce and/or eliminate performance discrepancies" (p. 23).

Further, Hirumi (1994) wrote, "Used primarily as a tool for planning, needs assessment also provides a systematic method for assessing needs in order to make meaningful decisions about material development, program initiation, policy formation, and resource allocation (p.23).

It is clear that needs assessment has evolved into a systematic methodology and is an important part of educational planning. Indeed, federal funding is increasingly being tied to needs assessment, and is mandated in many cases (Hirumi, 1994; Benjamin, 1989). Inasmuch as this is true, one may expect to see an increase in the number of needs assessment activities occurring within schools.

Over the past two decades, a considerable amount of literature has been generated that describes the needs assessment process. Most instructional design textbooks describe the process in some detail. Smith and Ragan (1992) provided a step-by-step approach which echoes contemporary thinking on the subject. The authors list the following steps to be followed in a needs assessment project:

1. List the goals of the instructional system (determine what ought to be).
2. Determine how well the identified goals are already being achieved (determine what is).
3. Determine the gaps between "what is" and "what should be" (these are often stated in percentages).
4. Prioritize gaps (according to size, importance, cost, etc.).
5. Determine which gaps are instructional needs and which are not (pp. 28-30).

Further, according to Smith and Ragan (1992), step one, determination of what ought to be, may involve employees (teachers) describing the skills and knowledge they feel is necessary for them to adequately perform their job. In cases where radical changes are taking place, as is the case with CAD integration, it may be useful to consult resources other than the teachers (i.e., literature) to identify what skills are necessary. With regard to step two, determination of what is, it is appropriate to administer self assessments (i.e., ask teachers to indicate which skills they are currently able to perform). Step three, determining gaps, involves simple percentage calculations. Step four (the prioritization of gaps) can be accomplished in a number of ways. According to Rossett (1982) respondents may be asked to rate or rank their opinions about needs. The author cites research that suggests significant positive correlations between rankings and ratings, thereby concluding that *either* ranking or rating can be used to determine priorities. Finally, step five, determining which gaps are instructional needs and which are not, is equally important to consider. Simply stated, training is not to be considered a solution to every identified need.

There are a myriad of techniques that facilitate the needs assessment process. Nickens, Purga, and Noriega (1980) described the key informant approach, the community forum approach, the rates under treatment approach, the social indicator approach, and the survey approach. While there are many methods available, the survey method is often preferred. The authors state, "When done correctly, with carefully developed and tested methods and materials, it (the survey) is the most scientifically valid for assessing needs and evaluating programs" (1980, p. 5).

Regardless of the technique used when conducting needs assessments, an instrument must be developed to collect the data. The developer must decide what questions to ask. Rossett (1982) provided a summary of the task at hand:

> . . . but what questions does the developer ask? Which behaviors are observed? Which feelings are sought? The challenge is at the item level, as the developer creates the small building blocks of assessment instruments which will serve to structure the inquiry.
>
> The purpose of front end analysis is to better understand the performance problem. What does "better understanding" mean? What is the information the developer needs from all sources, and in this case, the learners themselves? The answer to these questions provides the basis for systematic construction of needs assessment instruments (p. 30).

Rossett continued by describing a typology that can be used when constructing needs assessment instruments. The author identified five possible purposes of needs assessments along with five corresponding item types.

The first type of item, problem finding, is used to determine what type of problems are being experienced. These questions place few restrictions on the respondents and, consequently, will elicit varied responses.

The second type of item, problem selecting, asks respondents to prioritize and select from among several needs. It is important, according to Rossett, to specify, within the instrument, exactly how the needs are to be rated or ranked. This ensures that respondents rank needs in the same way, according to their own needs, or their perceptions about the needs of their colleagues.

Item type three is termed knowledge or skill providing (Rossett, 1982). These items ask respondents to demonstrate specific skills. Items of this type tell the needs assessor what the subjects know or don't know. The inclusion of this item type is equivalent to administering a pre-test (Dick and Carey, 1990). According to Smith and Ragan (1992), the current level of achievement can be ascertained through the use of pencil and paper tests, observations, self assessments, or product evaluations.

According to Rossett (1982), type four items: finding feelings, are included in a needs assessment instrument to uncover the feelings respondents have about a course or skill. Type four items not only seek feelings about the problem, they also uncover attitudes toward being trained in the subject matter.

Finally, type five items are called “cause finding.” According to Rossett (1982), these items ask for the cause of the problem. The inclusion of these items allow the needs assessor to gain multiple perspectives on the cause(s) of the problem. Indeed, answers to this type of question may indicate solutions that are both instructional and non-instructional in nature.

The construction of needs assessment instruments is a very important aspect of the assessment process and Rossett’s five item types can serve as a useful guide to the construction of a more effective instrument. Rossett conceded, however, that the items used must match the purpose(s) of the needs assessment. The actual item composition further depends on how much is already known about the problem. Therefore, any instrument may include some or all of the item types Rossett described.

Purpose of Descriptive Research

Best (1970) provided a detailed description of the purposes of descriptive research. According to Best:

> Descriptive research describes and interprets what is. It is concerned with conditions or relationships that exist; practices that prevail; beliefs, points of view, or attitudes that are held; processes that are going on; effects that are being felt; or trends that are developing (p. 315).

Indeed, the primary purpose of descriptive research is to tell what is. Hirumi (1994) defined needs assessment as: ". . . a systematic procedure for identifying problems, setting priorities, and making informed decisions about how to reduce and/or eliminate performance discrepancies" (p. 23). Typically, needs assessments involve the collection of information or other data to be used by decision makers for many of the same reasons outlined by Best, above. Thus, needs assessment may be categorized as descriptive research, and should follow procedures for instrument development and data collection that are consistent with accepted descriptive research practices.

Instrument Development

Considerable literature has been written with regard to survey research that provides detailed guidelines for the development of questionnaires. Wiersma (1991) summarized the steps involved in survey research. With regard to questionnaire construction, Wiersma offers the following list of activities that are often involved:

- Development of items or selecting instruments
- Development of anticipated analysis procedures
- Pilot run
- Revision of items (as necessary)

The development of specific items to be included on the instrument is perhaps the most difficult task for the researcher. There is consensus among researchers that shorter questionnaires are more effective (Nickens, 1980). All other factors being equal, respondents are more likely to complete and return a short survey as opposed to a long one. Therefore, the instrument should contain only those items necessary to answer the research question(s) (Wiersma, 1991; Frary, 1991). When deciding which items to include, the researcher should consult colleagues and potential consumers of the research (Frary, 1991). Further, a literature review can provide the researcher with an understanding of the variables included in the study and, therefore, influence the inclusion or exclusion of items (Wiersma, 1991).

With regard to item format, individual items may be categorized as either (1) forced choice or (2) open ended (Wiersma, 1991). Forced choice items produce data that is easily tabulated. These items force respondents to choose from among a few responses that are provided by the researcher. By their nature, therefore, these items limit the responses that can be obtained. Forced choice items should be used, therefore, to the extent that they can yield accurate information (Wiersma, 1991). On the other hand, since open-ended items allow for varied responses they can be more difficult to tabulate. They may be used, however, to uncover important information (Frary, 1991). For example, open ended items allow a respondent to state, in their own words, feelings or perceptions they may have. Another concern is that open-ended items may introduce response bias due to differences in the participant's ability and willingness to respond to items in writing (Frary, 1991). Frary further stated that it is acceptable to include these types of items when (1) respondents are homogeneous with respect to their ability and willingness to respond and (2) there are less than 50 subjects. With regard to needs assessments, Rossett (1982) maintained that needs assessment instruments should contain items that match the purpose of the assessment activity.

Once potential items have been selected and formatted to yield the desired data, it is necessary to "pilot" the questionnaire with a small group of individuals (Wiersma, 1991; Nickens, 1980). The purpose of this pilot is to uncover problems that may exist with individual items such as ambiguity, confusion, or redundancy (Wiersma, 1991; Nickens, 1980). According to Wiersma (1991) it is not necessary to test the instrument with a random sample of the population. Instead, such testing can be conducted with individuals who are familiar with the variables under study.

Further, Frary (1991) states: "this activity may involve no more than informal, open-ended interviews" (p. 2).

Data Collection

The successful collection of accurate data via mailed survey is not a simple task. The primary weakness of survey research is the problem of non-response. Nickens (1980) and Wiersma (1991) stated that a high level of non-response may bias the results of mailed surveys. There are, however, procedures which a researcher can follow to minimize the chances of biased results and lead to a higher rate of return.

Nickens (1980) advocated sending a letter of introduction to each respondent in advance of the survey. According to the author, this alerts the respondents to the coming survey and stresses the importance of their response. Many studies have shown that advance notice of the survey instrument being sent can increase the return rate (Erdos, 1983). Nickens (1980) also cited earlier research evidencing the effectiveness of an advance letter in increasing the rate of return.

Research also suggests that a brief, personally worded and typed cover letter and a stamped return envelope sent along with the instrument can significantly increase the rate of return (Erdos, 1983; Nickens, 1980). According to Erdos (1983) the cover letter must create a feeling of personal communication between the researcher and respondent. In addition, the cover letter should stress the importance of the research project, the importance of getting a response from each individual, provide a deadline, include a statement of confidentiality, and express appreciation for a timely response (Erdos, 1983).

Incentives may also be used to increase return rates for mailed surveys (Erdos, 1983; Nickens, 1980; Wiersma, 1991). According to Erdos (1983), monetary incentives are especially effective due to their ability to get immediate attention.

Finally, to further reduce the number of non-respondents, it is necessary to conduct follow-up mailings. The follow-up procedure provided by Erdos (1983) is quite comprehensive, and is described below. According to Erdos (1983) the first step in follow-up procedures involves a routine reminder, sent out to the entire group three to five days after the initial mailing. The second step, according to Erdos, is to send another instrument and reply envelope that is identical to the initial mailing. This should be done three to four weeks after the initial mailing. To avoid duplication, Erdos (1983) recommended that follow-up mailings be made only to those who have not responded. If possible, the cover letter should be a shortened version of the original. In addition, this letter must express appreciation for those who have already responded, and must be tactful when reminding those who have not. The third step in follow-up procedures involves another mailing, similar to the second, to each subject who has not responded. This should take place six to seven weeks after the initial mailing (Ary, Jacobs & Razavieh, 1985). According, to Erdos (1983) and Ary, Jacobs & Razavieh (1985), further follow-up efforts may only slightly increase the response rate. These efforts may be conducted via mail, or telephone, but will not usually lead to a significant increase in responses. Therefore, it is acceptable to end data collection with three follow-ups; eight or nine weeks after the initial mailing was made.

Summary

In this chapter, it is shown that the use of Computer Aided Drafting equipment offers many advantages over traditional drafting methods. It is clear that drafters using CAD are more productive than those without CAD technology. Many corporations have now incorporated CAD into their engineering departments. The productivity gains created by the use of CAD technology have changed the drafting profession. Drafters are increasingly being asked to perform design-related functions. Consequently, entry into the drafting profession requires a higher level of education and experience than previously required. Employers often seek drafters with technical training beyond high school. It is important that community colleges meet the challenge of providing students with the skills to enter the increasingly design-oriented drafting profession. Therefore, it is important to integrate CAD technology into these programs.

Preparing community college CAD instructors to use and integrate CAD technology into the drafting curriculum may require staff development. If so, a staff development plan should be developed through a process which allows for teacher input. Content for staff development activities should be based on how teachers use computers in the classroom and their perceived competence with the technology. As previous research indicates, it is likely that problems exist in certain areas and, therefore, it is important to consider the teacher's perceptions about resource needs, need for training, current CAD use, current skill levels, past experience, past training, and computer availability.

As a form of descriptive research, needs assessment is an effective way to gauge the teacher's perceptions. Further, when proper procedures for instrument development and data collection are followed, the survey research technique is a scientifically valid method for gathering data. The survey instrument may contain several types of items; depending upon the purpose(s) of the assessment. Regardless of the type of instrument used, accepted methods of data collection must be followed. These procedures aim to increase the number of returned surveys.

CHAPTER III: PROCEDURES

Introduction

This chapter includes a description of the procedures used in this research study: a description of the population, development of the instrument, collection of the data, and analysis of the data.

For clarity, this chapter is organized into the following six sections:

1. Introduction
2. Description of the population
3. Development of the instrument
4. Collection of the data
5. Analysis of the data
6. Research Questions and Items on the Instrument
   a. Instructor Characteristics
   b. items for research question one
   c. items for research question two
   d. items for research question three
   e. items for research question four
   f. items for research question five
   g. items for research question six

Description of the Population

The population used in this study included all full time community college faculty within drafting, design, or engineering programs, who taught computer aided drafting at the 23 publicly funded community colleges in Virginia during the 1994—1995 school year. Upon request, the Virginia Community College System (VCCS) provided a list of the telephone numbers of all community colleges in the Commonwealth. The researcher telephoned each college and obtained the names of all members of the population. The total number of full-time community college faculty who were identified as having taught computer aided drafting within drafting, design, or engineering programs during the spring 1995 semester was 42. One instructor was retiring at the end of the spring 1995 semester and was not, therefore, solicited to participate in the study. An additional five faculty were identified as part-time CAD instructors, and were disqualified. Hence the total number of instructors targeted to participate in the study was 36.

Many community colleges in Virginia hire part-time faculty to teach technical subjects. Their real world work experience and technical skills make them a valuable asset to any occupational training program. Also, these instructors have little experience in the classroom. Consequently, while they may have a high level of technical skills, they are often less prepared pedagogically than full-time community college faculty. Due to the characteristics of part-time faculty, they were considered systematically different from the population of full time faculty under consideration in this study. This notion was confirmed by discussions with community college faculty and administrators alike. Therefore, part-time faculty were not targeted as participants in this study.

Development of the Instrument

In line with contemporary survey research methodology, a survey questionnaire was developed to determine the computer aided drafting related needs (instructional and non-instructional) of community college CAD instructors in Virginia. The questionnaire was developed through the following procedure:

1. A group of possible questions was identified from (a) a review of related literature, (b) informal

consultations with individuals knowledgeable of computer aided drafting technology and community college level instructional programs, and (c) the personal knowledge and experiences of the researcher. It was concluded that the instrument should focus on gathering data related to (1) CAD related training needs, (2) CAD integration needs, and (3) resource needs.

2. Individual items were written that would yield the data necessary to answer the research questions.

3. A first draft of the questionnaire was reviewed by the researcher's doctoral committee. Some of the selected questions were rewritten, being critical of item clarity, completeness, and possible offensiveness.

4. As recommended by Frary (1991) and Wiersma (1991), a second draft of the questionnaire was submitted to a group of experts to test the instrument. The group was composed of three secondary drafting instructors. Each member was chosen based on his or her knowledge of CAD technology and CAD training. The purpose of this activity was to examine each item for clarity and to further ensure the appropriateness of the items for the study.

5. Individual items were revised, where necessary, based on the comments made by the group of experts and the final instrument was prepared.

Collection of the Data

An advance letter was sent to each respondent prior to the actual mailing of the survey instrument. The letter described the study and asked the respondents to provide a summer address. A summer address was necessary due to the fact that some faculty were on nine-month contracts, and could not be reached at their school address during summer months. Along with the advance letter, each individual was given $1.00. This gift served as an incentive and a token of appreciation for participation in the study. Then, the questionnaire, along with a cover letter from the researcher describing the study and a self-addressed, stamped envelope for convenience in returning the completed instrument was sent to each respondent (as recommended by Erdos, 1983; and Nickens, 1980). Coding was utilized to maintain confidentiality and assist in non-respondent follow-up procedures.

As recommended by Erdos (1983), Wiersma (1991) and Nickens (1980), one week after the initial mailing, a reminder was mailed to the entire population. This consisted of a short letter to remind participants of the need to respond and served to express gratitude to those who had already replied.

A second follow-up questionnaire was mailed to all who had not responded twenty-one days (3 weeks) after the original mailing. This mailing was similar to the original, but contained a different cover letter.

Finally, as recommended by Erdos (1983), a third follow-up mailing was made to non-respondents. This mailing was made six weeks after the original mailing. The contents of this mailing were identical to the second mailing.

Additional follow-up procedures included telephone contact and additional mailings where appropriate (see chapter IV for actual numbers of responses gained through each follow-up activity). Finally, data collection was halted, eight weeks after the initial mailing. Figure 2 provides a graphic depiction of the data collection process.

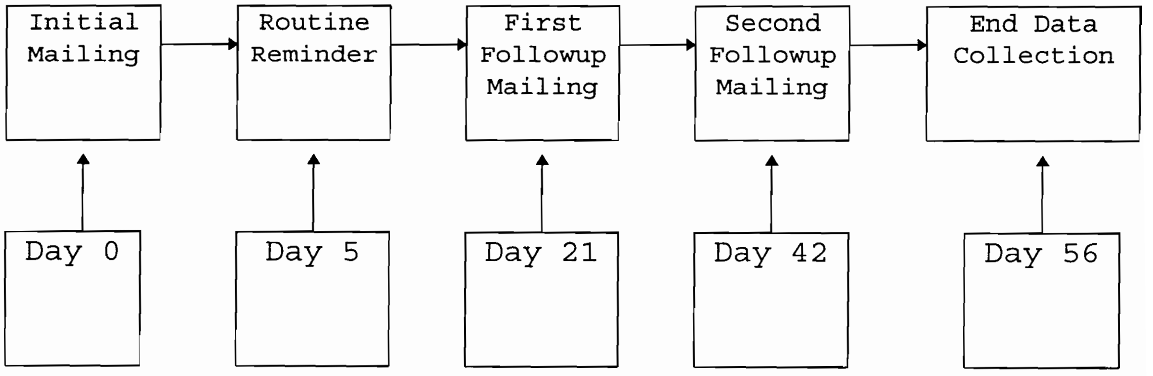

Figure 2: Data Collection Process and Timeline

Analysis of the data

The analysis of the data was accomplished through the use of the Statistical Package for the Social Sciences (SPSS—PC version). The program is available commercially and a licensed copy of the program is owned by the researcher.

Since the study included the entire population, no sampling technique was carried out. Further, inferential statistical procedures were not used. Rather, descriptive parameters were used to answer the research questions. Specific descriptive procedures were chosen based on the appropriateness of the procedure for the type of data that were collected by each item on the instrument. Norusis (1993) stated, "If measurements are obtained from an entire population, the population can be characterized by the various measures of central tendency, dispersion, and shape..." (p. 250). The median is insensitive to extreme values and, therefore, is a more resistant measure than the mean (Norusis, 1993). Further, the median is the best indicator of "typical performance" on a scale (Ary, Jacobs & Razavieh, 1985). Consequently, medians and modes are reported as measures of central tendency. Frequency distributions were reported to further describe the distribution of responses and to answer the research questions.

Research Questions and Items on the Instrument

Note: Research questions 1-5 refer to 14 CAD categories, shown below:

1. Basic drawing and editing commands (i.e., line, arc, circle, trim, extend, move, erase, etc.)
2. Scaling commands (i.e., plotting a drawing to scale)
3. Rotation commands(i.e., rotating to 45 degrees)
4. Replication commands (i.e., copy, array, mirror)
5. Dimensioning commands
6. Creating CAD menus (creating menu macros)
7. Writing custom CAD programs (i.e., AutoLISP, MDL, etc.)
8. Creating re-usable symbols (i.e., blocks, cells, etc)
9. Three-dimensional drawing commands (not solids modeling)
10. Three-dimensional viewing commands (viewing in 3D)
11. Solids modeling commands
12. View shading and view rendering commands

13. Non-graphical database functions (i.e. Customized Bill of Materials generation)

14. Finite Element Analysis (FEA)

Instructor Characteristics

In addition to the items designed to specifically answer the questions stated for this research, the instrument also included items that were designed to gather information related to the instructor's demographic characteristics identified through the literature as important. These are (1) prior CAD training, (2) prior CAD experience, and (3) exposure to CAD technology. To gather data related to these characteristics, respondents were asked to answer each of the following questions:

1. Do you have a computer with CAD software at home?

YES

NO

2. How did you primarily learn to use CAD software?

(1) Self taught

(2) Tutored by another teacher

(3) Attended a formal class

(4) Other (specify)

3. Is your community college an authorized training center (ATC) for any specific software company?

YES

NO

4. Do you have any special CAD certifications?

YES

NO

5. During the past year have you attended any of the following?

(1) CAD training at a university or other college?

(2) CAD users group meeting?

(3) CAD training held by a private training firm?

(4) Other CAD training (Specify)

6. Have you used CAD as part of a job in an industry setting?

YES

NO

<u>Item(s) for Research Question 1</u>

What is the perceived level of skill with regard to selected CAD functions of community college drafting instructors in Virginia?

To answer this research question, respondents were asked to indicate their current skill level for each of the 14 CAD categories outlined at the beginning of this section.

Item(s) for Research Question 2

What is the perceived level of need for technical training with regard to selected CAD functions of community college drafting instructors in Virginia?

To answer this research question, respondents were asked to indicate their current level of need for technical training for each of the 14 CAD categories outlined at the beginning of this section.

Item(s) for Research Question 3

What is the perceived level of skill of community college drafting instructors in Virginia in integrating selected CAD functions into their drafting curriculum?

To answer this research question, respondents were asked to indicate their current level of skill in integrating each of the 14 CAD categories outlined at the beginning of this section.

Item(s) for Research Question 4

To what extent do community college drafting instructors in Virginia perceive that selected CAD functions have been integrated into their drafting curriculum?

To answer this research question, respondents were asked to indicate the extent to which each of the 14 CAD categories outlined at the beginning of this section has been integrated into their drafting curriculum.

Item(s) for Research Question 5

What is the community college drafting instructors' perceived level of need for training in integrating selected CAD functions into their drafting curriculum?

To answer this research question, respondents were asked to indicate their current level of need for training in integrating each of the 14 CAD categories outlined at the beginning of this section.

Item(s) for Research Question 6

What resources do community college drafting instructors believe are needed to further integrate CAD into their curriculum?

To answer this research question, respondents were asked to rank a list of individual and program needs as shown in the lists below. Also, respondents were asked to indicate any additional needs they may have (No. 8, 9, and 11, below).

Program Needs

1. Increased Budget
2. New Curriculum Materials
3. Better Curriculum Materials
4. Experience using CAD on the job (i.e., summer internship)
5. New or updated hardware
6. New or updated software
7. Technical CAD training

---Other (specify below):

8. ______________________________

9. ______________________________

Individual (personal) Needs

1. Increased budget
2. New resources for learning CAD
3. Better resources for learning CAD
4. New hardware
5. New software
6. CAD work experience
7. Integration training
8. Technical training

9. Pedagogical assistance

10. Technical assistance

11. Other

CHAPTER IV: ANALYSIS OF THE DATA

Introduction

In the previous chapter, the procedures utilized to collect and analyze the data for this study are discussed. This chapter presents the results of the data analysis and provides an interpretation of the findings for each of the research questions.

To facilitate the presentation of the findings of this study, chapter IV is divided into four sections. The first section provides demographic data which describe the respondents. Included in this section are the frequency distributions of (1) the number of community college drafting instructors responding to the survey at each stage of data collection, (2) school category, (3) CAD teaching experience, (4) highest degree, and (5) degree type of respondents.

The second section presents data for the items that were designed to gather information related to the instructor's characteristics which were identified through the literature as being important to the stated research questions. These are (1) type of prior CAD training, (2) years of prior CAD experience, and (3) exposure to CAD technology.

The third section includes data that were collected to answer research questions 1 through 5. It presents the instructors' perceptions regarding their level of skill, technical training needs, curriculum integration abilities, extent of integration and curriculum integration training needs for each of the 14 CAD categories.

Section four reports data that were collected to answer research question six. It presents the instructors' perceptions regarding program and personal resource needs.

Section I: Description of the Respondents

The demographic data, reported in tables 1 through 5, describe the respondents. Frequency distributions describe the number of drafting instructors responding to the survey questionnaire (table 1). Instructors are also described by school category (table 2), extent of CAD teaching experience (table 3), education level (table 4), and degree type (table 5).

Drafting Instructors Responding to the Survey Questionnaire

The instrument designed to collect the data was mailed to 36 community college drafting instructors in the 23 community colleges in Virginia. Table 1 contains a frequency distribution of instructors responding to the survey at each stage of data collection.

As table 1 shows, the initial mailing resulted in 25 returned surveys (69 %). A follow-up questionnaire was mailed to all instructors who had not responded within three weeks (21 days) after the initial mailing. This mailing resulted in an additional 5 (14 %) surveys being returned. A second follow-up questionnaire was mailed six weeks (42 days) after the first follow-up. This effort proved unsuccessful, yielding no new returns. As a final follow-up procedure, telephone contact was attempted for each instructor who had not responded by the tenth day after mailing of the second follow-up questionnaire (52 days). Actual contact was made with four of the six remaining instructors. This contact produced three new returns. After an additional four days, data collection ceased at eight

Table 1

Frequency Distribution of Virginia Community college Drafting Instructors Responding to the Survey

	Number of Respondents (%)							
	Initial Mailing		First Follow-up		Second Follow-up		Telephone Follow-up	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
New Returns	25	(69)	5	(14)	0	(0)	3	(8)
Total Returns	25	(69)	30	(83)	30	(83)	33	(92)

weeks (56 days). The total return rate was 33 of 36, which equates to 92 % of the target population.

School Category

Instructors were asked to indicate their school's location as either rural, suburban, or urban. Table 2 displays the response frequency for that question and shows that the respondents were evenly distributed across all school locations. Approximately one-third of the respondents indicated that their school existed in each a rural, suburban, or urban environment.

CAD Teaching Experience

In order to establish teaching experience, the instructors were asked to indicate how long they had taught CAD at the community college level. Table 3 displays the response frequency for that question. Most (51 %) had less than seven years experience teaching CAD. Further, only 24 % had ten or more years experience teaching CAD.

Education Level

Respondents were asked to indicate their highest educational level completed. Table 4 displays the response frequency for that question. As might be expected at the

Table 2

Instructor's Response to School Location

	Urban		Sub-Urban		Rural		No Response	
	No.	(%0)	No.	(%)	No.	(%)	No.	(%)
Number Responding	10	(30)	10	(30)	11	(33)	2	(6)

Note. Due to rounding, percentages may not add up to 100 %.

Table 3

Years of CAD Teaching Experience of Respondents

Years of CAD Teaching Experience	Number of Respondents No.	(%)	Cumulative Total Percent
1	1	(3)	3
2	3	(9)	12
3	6	(18)	30
4	2	(6)	36
5	4	(12)	48
6	1	(3)	51
7	3	(9)	60
8	2	(6)	66
9	3	(9)	75
10	5	(15)	90
11	1	(3)	93
12	1	(3)	96
13	0	(0)	96
14	0	(0)	96
15	1	(3)	99

Note. Due to rounding, percentages may not add up to 100 %.

Table 4

Education Level of Respondents

Highest Degree	Number of Respondents No.	(%)
High School Diploma	0	(0)
Associates Degree	0	(0)
Bachelors Degree	7	(21)
Masters Degree	25	(76)
Doctoral Degree	1	(3)

Note. Due to rounding, percentages may not add up to 100 %.

postsecondary level, three quarters (76 %) of the respondents had Master's degrees. While none of the instructors had less than a Bachelor's degree, only one instructor had received a Doctoral degree.

Degree Type

To further describe the respondents educational background, they were asked to indicate the area of their highest educational degree. As shown in Table 5, most respondents (66 %) highest degree was in education or engineering (21 %).

Section II: Instructor's Characteristics

This section includes the data that were collected on instructor characteristics shown to be important through the literature. These characteristics are (1) prior CAD training, (2) prior CAD experience, (3) exposure to CAD technology.

Prior CAD Training

To collect data related to prior CAD training, the respondents were asked, "How did you learn to use CAD software?", and "What CAD training have you attended in the

Table 5

Degree Type of Respondents

Highest Degree Area	Number of Respondents No.	(%)
Education	22	(66)
Engineering	7	(21)
Counseling	1	(3)
Industrial Technology	1	(3)
Industrial Arts	1	(3)
Architecture	1	(3)

Note. Due to rounding, percentages may not add up to 100 %.

past two years?" Table 6 and 7, respectively, show the responses to those questions.

As Table 6 shows, almost three quarters (73 %) of the respondents indicated that they were self taught. In addition, over half (52 %) indicated that they learned to use CAD software in a formal class. Some respondents indicated multiple methods of learning CAD, therefore the sum of the percentages in Table 6 is greater than 100. Table 7 shows what training the instructors have attended during the past two years. As the table shows, approximately one-third of the respondents indicated that they had attended either CAD training at a university, users group meeting, or training at a private firm. None of these methods, however, was the major source of past training for these instructors.

Prior CAD Experience

To collect data related to prior CAD experience, the instructors were asked, "Have you used CAD as part of a job in an industry setting?", and "Do you have any special CAD certifications?" Tables 8 and 9 are frequency distributions of the instructor's responses to those questions.

Table 6

How did you learn to use CAD software?

How did you learn to use CAD software?	Number of Respondents	
	No.	(%)
Peer Taught	1	(3)
Self Taught	24	(73)
Formal Class	17	(52)
Other	0	(0)

Note. Some instructors indicated multiple learning methods, therefore percentages do not add up to 100 %.

Table 7

CAD Training Attended By Respondents During the Past Two Years

During the past two years have you attended any of the following?	Number of Respondents No.	(%)
CAD Training at a university or other college	11	(33)
CAD Users Group Meeting	12	(36)
CAD Training held by a private firm?	9	(27)
Other	0	(0)
No Response	1	(3)

Note. Due to rounding, percentages may not add up to 100 %.

Table 8

CAD Work Experience of Respondents

Have you used CAD as part of a job in an industry setting?	Number of Respondents No.	(%)
Yes	11	(33)
No	22	(67)

Table 9

CAD Certification of Respondents

Do you have any special CAD certifications?	Number of Respondents No.	(%)
Yes	5	(15)
No	28	(85)

As shown in table 8, only one-third (33 %) of the instructors indicated that they had actually used CAD as part of a job in industry. Further, only 5 instructors (15 %) indicated that they were CAD certified. These results are shown in Table 9.

Exposure to CAD Technology

To gather data related to the instructors' exposure to CAD technology, the instructors were asked, "Is your community college an Authorized Training Center (ATC) for any specific CAD software company?", and "Do you have a computer with CAD software at home?"

As shown in Table 10, a large majority (88 %) of the instructors indicated that their college was not an Authorized Training Center (ATC) for any CAD software company. In addition, as shown in table 11, just under two thirds (64 %) of the respondents indicated that they had a computer with CAD software at home.

Section III: Research Questions 1 through 5

Section II of the questionnaire contained 14 CAD category items related to traditional drafting tasks, CAD system customization, and the use of CAD as a design tool.

Table 10

ATC Status of Respondents

Is your community college an authorized training center for any specific software company?	Number of Respondents	
	No.	(%)
Yes	4	(12)
No	29	(88)

Table 11

Computer With CAD Software At Home

Do you have a computer with CAD software at home?	Number of Respondents	
	No.	(%)
Yes	21	(64)
No	12	(36)

The instructors were asked to indicate their (1) technical skill, (2) need for technical training, (3) level of integration, (4) level of skill in integration, and (5) need for integration training, for each CAD category. A four-point scale was provided, making use of the following key: 1=no skills, no need, no integration, 2=few skills, little need, little integration, 3=some skills, some need, some integration, 4=expert skills, much need, full integration. Tables 12 through 21 present frequency distributions and measures of central tendency for the instructor's perceived technical skill, need for technical training, level of integration, level of skill in integration, and need for integration training, for each CAD category, respectively.

Research Question 1: Instructors' Perceived Level of Technical Skill for the 14 CAD Categories

The integration of microcomputers into educational programs starts with making sure that teachers know how to use the computer themselves. Previous research suggests that the teacher's perceived confidence with computer technology is important to consider. One type of needs assessment item asks respondents to assess their own skill level. To collect data related to the CAD instructors' perceived confidence with CAD, respondents were asked to indicate their technical skill level on the 14 CAD categories. Table 12 is a frequency distribution of the instructor's perceived technical skill level for each of the CAD categories. Table 13 shows the mode and median relative to instructors' perceived level of technical skills for each of the CAD categories.

As shown in Table 12, on CAD categories related to traditional drafting tasks (categories 1-5), a large majority of instructors perceived their skill level to be high. In contrast to this trend, one instructor perceived "no" skills in basic drawing and editing commands. On functions related to customization (categories 6-8) responses were different. Almost one-half of the instructors rated their technical skill level to be "few" or "no" skills in custom menus. Likewise, 69 % of the instructors perceived their technical skill in the area of

Table 12

Instructors' Perceived Technical Skill Level for Selected CAD Functions

CAD Category	Level of Technical Skill							
	1 No Skills		2 Few Skills		3 Some Skills		4 Expert Skills	
	No.	%	No.	%	No.	%	No.	%
1.Basic Drwg/Editing	1	3	0	0	4	12	28	85
2.Scaling	0	0	2	6	12	36	19	58
3.Rotation	0	0	2	6	6	18	25	76
4.Replication	0	0	2	6	4	12	27	82
5.Dimensioning	0	0	1	3	11	33	21	64
6.Custom Menus	5	15	11	33	10	30	7	21
7.Custom Programs	13	39	10	30	9	27	1	3
8.Custom Symbols	0	0	2	6	13	39	18	55
9.3D Drawing	1	3	7	22	13	41	11	34
10.3D Viewing	2	6	4	13	16	50	10	31
11.Solids Modeling	5	16	12	38	8	25	7	22
12.Shading/Rendering	5	16	10	31	11	34	6	19
13.Database	8	25	13	41	8	25	3	9
14.FEA	21	66	7	22	3	9	1	3

Note. due to rounding, percentages may not add up to 100 %.

Table 13

Measures of Central Tendency for Instructor's Perceived Level of Technical Skill

CAD Category	Descriptive Statistics	
	Median	Mode
1.Basic Drawing and Editing	3.91	4
2.Scaling	3.63	4
3.Rotation	3.84	4
4.Replication	3.89	4
5.Dimensioning	3.71	4
6.Custom Menus	2.55	2
7.Custom Programs	1.85	1
8.Custom Symbols	3.58	4
9.3D Drawing	3.15	3
10.3D Viewing	3.16	3
11.Solids Modeling	2.46	2
12.Shading & Rendering	2.64	3
13.Database	2.15	2
14.FEA	1.29	1

custom programs to be low. An exception to this pattern, however, was in the custom symbols category. Here, a majority of instructors perceived their technical skills to be high.

With the exception of two categories, instructors perceived lower technical skills on the advanced CAD categories related to design (categories 9-14). On three dimensional drawing and viewing functions instructors generally perceived a slightly higher technical skill level, however. At least three-quarters of the instructors rated their technical skills as "some" or "expert" in these two categories.

Research Question 2: Instructors' Perceived Levels of Needs for Technical Training for the 14 CAD Categories

Literature suggests that when planning for the integration of CAD technology into the classroom, it is important to base staff education on teacher input. When conducting a needs assessment, it is important to uncover the participant's attitudes about being trained in the subject matter. In this study, respondents were asked to indicate their need for technical training on the 14 CAD categories. Table 14 is a frequency distribution of the instructors' perceived need for technical training. Table 15 shows the mode and median relative to the instructors' perceived need for technical training for each of the CAD categories.

On the CAD categories related to traditional drafting tasks (categories 1-5), a majority of the instructors perceived "little" or "no" need for technical training. On the other hand many of the instructors indicated "some" or "much" need for technical training on CAD categories related to customization and design (categories 6-14).

With regard to instructors' perceived need for technical training, three additional patterns are evident. First, while a large majority of instructors perceived high technical skills on categories 1 through 5 and 8 through 10, a number of instructors (in some cases a majority) perceived a high level of need for technical training in these same categories. Second, while only 12 % of the instructors perceived high technical skills on FEA, only 50 % perceived a high level of need for technical training in FEA. As shown in Table 15, equal numbers of instructors perceived

Table 14

<u>Instructors' Perceived Needs for Technical Training for Selected CAD Functions</u>

CAD Category	Level of Need: 1 No Need		2 Little Need		3 Some Need		4 Much Need	
	No.	%	No.	%	No.	%	No.	%
1.Basic Drwg/Editing	20	61	4	12	7	21	2	6
2.Scaling	11	33	12	36	6	18	4	12
3.Rotation	19	58	6	18	6	18	2	6
4.Replication	20	61	7	21	5	15	1	3
5.Dimensioning	15	45	6	18	11	33	1	3
6.Custom Menus	8	24	9	27	10	30	6	18
7.Custom Programs	4	12	7	21	10	30	12	36
8.Custom Symbols	14	42	7	21	8	24	4	12
9.3D Drawing	8	25	7	22	8	25	9	28
10.3D Viewing	8	26	10	32	9	29	4	13
11.Solids Modeling	9	28	3	9	10	31	10	31
12.Shading/Rendering	6	19	8	25	9	28	9	28
13.Database	6	19	6	19	12	38	8	25
14.FEA	7	22	9	28	5	16	11	34

<u>Note.</u> due to rounding, percentages may not add up to 100 %.

Table 15

Measures of Central Tendency for Instructors' Perceived Levels of Need for Technical Training

CAD Category	Descriptive Statistics	
	Median	Mode
1.Basic Drawing and Editing	1.33	1
2.Scaling	1.96	2
3.Rotation	1.37	1
4.Replication	1.33	1
5.Dimensioning	1.75	1
6.Custom Menus	2.44	3
7.Custom Programs	3.05	4
8.Custom Symbols	1.86	1
9.3D Drawing	2.69	4
10.3D Viewing	2.35	2
11.Solids Modeling	2.95	(4) 3*
12.Shading & Rendering	2.77	(4) 3*
13.Database	2.88	3
14.FEA	2.50	4

* Multi-Modal

"some" and "much" need for technical training in solids modeling and shading and rendering.

Research Question 3: Instructors' Perceived Levels of Integration Skill for the 14 CAD Categories

Literature related to planning for technology in education suggests that in addition to technical skills, teachers must have skills in integrating computer technology into the curriculum. As stated earlier, the curricular integration of CAD may be seen as the overall process of using the technology within the instructional program. In addition to technical skill, it involves specific knowledge of when and how the technology can be used to teach the subject matter. As with technical skill level, respondents were asked to indicate their level of skill in integrating each of the 14 CAD categories into their program. Table 16 is a frequency distribution of the instructors' responses to integration skill level for each of the CAD categories. Table 17 shows the mode and median relative to the instructors' perceived levels of integration skill for each of the CAD categories.

Table 16

Instructors' Perceived Integration Skill Levels for Selected CAD Functions

CAD Category	Level of Integration Skill							
	1 No Skills		2 Few Skills		3 Some Skills		4 Expert Skills	
	No.	%	No.	%	No.	%	No.	%
1.Basic Drwg/Editing	0	0	2	6	10	30	21	64
2.Scaling	0	0	1	3	22	69	9	28
3.Rotation	1	3	2	6	13	39	17	52
4.Replication	0	0	2	6	11	33	20	61
5.Dimensioning	0	0	2	6	16	48	15	45
6.Custom Menus	7	21	12	36	6	18	8	24
7.Custom Programs	18	55	8	24	5	15	2	6
8.Custom Symbols	1	3	8	24	11	33	13	39
9.3D Drawing	3	9	11	34	7	22	11	34
10.3D Viewing	4	13	12	38	6	19	10	31
11.Sol.Modeling	8	25	13	41	5	16	6	19
12.Shading/Rendering	6	19	13	41	8	25	5	16
13.Database	11	34	10	31	7	22	4	13
14.FEA	21	66	7	22	2	6	2	6

Note. due to rounding, percentages may not add up to 100 %.

Table 17

Measures of Central Tendency for Instructors' Perceived Level of Integration Skill

CAD Category	Descriptive Statistics	
	Median	Mode
1.Basic Drawing and Editing	3.71	4
2.Scaling	3.20	3
3.Rotation	3.53	4
4.Replication	3.68	4
5.Dimensioning	3.41	3
6.Custom Menus	2.29	2
7.Custom Programs	1.42	1
8.Custom Symbols	3.18	4
9.3D Drawing	2.86	2 (4)*
10.3D Viewing	2.50	2
11.Solids Modeling	2.15	2
12.Shading & Rendering	2.31	2
13.Database	2.05	1
14.FEA	1.29	1

* Multi-Modal

A large majority of instructors indicated "some" or "expert" integration skills on CAD categories related to traditional drafting tasks (categories 1-5). For advanced functions related to customization and design (categories 6-14), however, instructors perceived their integration skills to be somewhat lower. The majority of the instructors indicated either "few" or "no" integration skills for each of these categories. Also, a majority of the instructors indicated "no" integration skills on custom programs (55 %) and FEA (66 %). Finally, as shown in Table 17, an equal number of instructors perceived "few" and "expert" skills in integrating 3-D drawing functions into the drafting curriculum.

Research Question 4: Instructors' Perceived Levels of Integration for the 14 CAD Categories

As stated earlier, a primary purpose of descriptive research is to describe a situation as it exists. In order to determine which CAD functions are being taught in community college drafting courses in Virginia, respondents were asked to indicate the level of integration for each CAD category. Table 18 is a frequency distribution of the instructors' perceived levels of integration for each of the CAD categories. Table 19 shows the mode and median relative to the instructor's perceived level of integration for each of the CAD categories.

With regard to the instructors' perceived level of CAD integration, a pattern of responses similar to that discovered for the instructors' perceived technical skill existed. On CAD categories related to traditional drafting tasks (categories 1-5), a high percentage of the respondents indicated "some" or "full" integration. On categories related to customization (categories 6-8) a majority of instructors perceive low integration. However, one exception to this pattern is in the custom symbols category, where 84 % of the instructors perceive high (some or full) integration. A considerable number of faculty indicated "little" or "no" integration on the CAD categories related to design (categories 9-14). Further, it is interesting to note that a number of the instructors indicated "no" integration of FEA functions (75 %), database (47 %), and custom programs (48 %). On the other hand, a majority

Table 18

Instructors' Perceived Levels of Integration for Selected CAD Functions

CAD Category	Level of Integration 1 No Integra No.	 %	 2 Little Integra No.	 %	 3 Some Integra No.	 %	 4 Full Integra No.	 %
1.Basic Drwg/Editing	0	0	0	0	10	30	23	70
2.Scaling	0	0	3	9	18	55	12	36
3.Rotation	2	6	2	6	11	33	18	55
4.Replication	0	0	2	6	8	24	23	70
5.Dimensioning	0	0	5	15	10	30	18	55
6.Custom Menus	9	27	11	33	8	24	5	15
7.Custom Programs	16	48	9	27	6	18	2	6
8.Custom Symbols	3	9	2	6	15	45	13	39
9.3D Drawing	3	9	11	34	8	25	10	31
10.3D Viewing	4	13	8	25	9	28	11	34
11.Sol.Modeling	11	34	8	25	6	19	7	22
12.Shading/Rendering	10	31	9	28	8	25	5	16
13.Database	15	47	8	25	7	22	2	6
14.FEA	24	75	6	19	1	3	1	3

Note. due to rounding, percentages may not add up to 100 %.

Table 19

Measures of Central Tendency for Instructors' Perceived Levels of CAD Integration

CAD Category	Descriptive Statistics	
	Median	Mode
1.Basic Drawing and Editing	3.78	4
2.Scaling	3.25	3
3.Rotation	3.58	4
4.Replication	3.78	4
5.Dimensioning	3.58	4
6.Custom Menus	2.18	2
7.Custom Programs	1.56	1
8.Custom Symbols	3.27	3
9.3D Drawing	2.81	2
10.3D Viewing	3.00	4
11.Solids Modeling	2.19	1
12.Shading & Rendering	2.22	1
13.Database	1.69	1
14.FEA	1.19	1

of instructors indicated a high level of integration on the 3D drawing (56 %) and 3D viewing (62 %) categories.

Research Question 5: Instructors' Perceived Levels of Need for Integration Training for the 14 CAD Categories

As with the instructors' perceptions about the need for technical training, respondents were asked to indicate their need for training on how to integrate each CAD category. Again, these items attempt to uncover the instructors' attitudes about being trained in the subject matter. Table 20 is a frequency distribution of the instructors' perceived need for integration training. Table 21 shows the mode and median relative to the instructors' perceived level of need for integration training for each of the CAD categories.

On CAD categories related to traditional drafting tasks (categories 1-5), a majority of the respondents perceived "little" or "no" need for integration training. Still, approximately one-third of the instructors perceived at least "some" need for integration training on categories 1-5. A majority of the instructors perceived "some" or "much" need for integration training on CAD categories related to customization and design (categories 6-14). Two exceptions

Table 20

Instructors' Perceived Need for Integration Training for Selected CAD Functions

CAD Category	Level of Need: 1 No Need No.	%	2 Little Need No.	%	3 Some Need No.	%	4 Much Need No.	%
1.Basic Drwg/Editing	13	39	7	21	12	36	1	3
2.Scaling	11	33	11	33	10	30	1	3
3.Rotation	18	55	5	15	9	27	1	3
4.Replication	19	58	4	12	9	27	1	3
5.Dimensioning	16	48	5	15	12	36	0	0
6.Custom Menus	9	27	4	12	15	45	5	15
7.Custom Programs	8	24	5	15	14	42	6	18
8.Custom Symbols	12	36	5	15	14	42	2	6
9.3D Drawing	9	27	6	18	12	36	6	18
10.3D Viewing	9	27	7	21	12	36	5	15
11.Solids Modeling	8	24	4	12	10	30	11	33
12.Shading/Rendering	6	18	6	18	13	39	8	24
13.Database	7	21	5	15	13	39	8	24
14.FEA	8	24	10	30	4	12	11	33

Note. due to rounding, percentages may not add up to 100 %.

Table 21

Measures of Central Tendency for Instructors' Perceived Levels of Needs for Integration Training

CAD Category	Descriptive Statistics Median	Mode
1.Basic Drawing and Editing	2.00	1
2.Scaling	2.00	1
3.Rotation	1.42	1
4.Replication	1.37	1
5.Dimensioning	1.60	1
6.Custom Menus	2.73	3
7.Custom Programs	2.75	3
8.Custom Symbols	2.40	3
9.3D Drawing	2.63	3
10.3D Viewing	2.54	3
11.Solids Modeling	2.95	4
12.Shading & Rendering	2.85	3
13.Database	2.85	3
14.FEA	2.35	4

to this trend occur in the custom symbols and FEA categories. Here, a majority of instructors perceived a low level of need for integration training. This result is inconsistent with most of the instructors' previous indication of low technical and integration skills on the FEA category.

Section IV: Research Question 6

Research question six asked, "What resources do community college drafting instructors believe are needed to further integrate CAD into their curriculum? Section III of the survey instrument asked the instructors to rate their current level of individual and program need for each of several items such as curriculum materials, budget, hardware, software, technical assistance, etc. A description of the instructors' responses to those questions is contained in the following paragraphs.

Perceived Program Needs

Respondents were asked to rank their program's level of need for better curriculum materials, new curriculum materials, increased budget, new hardware, and new software. A four-point scale was used for the ranking which provided the following key: 1-no need, 2-little need, 3-some need, 4-much need. Table 28 is a frequency distribution of the instructors' perceived program needs.

As shown in Table 28, the need for increased budget, new hardware and new software was rated high. Ninety percent of the instructors perceived either some or much need for increased budget, while 81 % indicated some or much need for new hardware and new software. In addition, slightly more than half of the instructors (54 %) indicated either "some" or "much" need for new and better curriculum materials.

Perceived Individual Needs

Respondents were asked to rank their individual level of need for better curriculum resources, new curriculum resources, increased budget, new hardware, new software, CAD work experience, integration training, technical training, pedagogical assistance, and technical assistance. These needs are considered individual in that they are for the instructors' personal use in developing CAD skills and integrating CAD into the curriculum. A four-point scale was used for the ranking which provided the following key: 1-no need, 2-little need, 3-some need, 4-much need. Table 29 is a frequency distribution of the instructor's perceived individual (personal) needs.

As shown in Table 29, a majority of respondents indicated some or much need for each category except integration training. Further, technical assistance, pedagogical assistance, and integration training were evenly split; with nearly one-half of the instructors indicating a low level of need and one-half indicating a high level of need. Table 29 shows the specific response pattern for each item.

Table 28

Instructors' Perceived Program Needs

CAD Category	1 No Need No.	1 No Need %	2 Little Need No.	2 Little Need %	3 Some Need No.	3 Some Need %	4 Much Need No.	4 Much Need %
Better Curriculum Materials	4	12	11	33	14	42	4	12
New Curriculum Materials	2	6	13	39	13	39	5	15
Increased Budget	1	3	2	6	14	42	16	48
New Hardware	1	3	5	15	12	36	15	45
New Software	0	0	6	18	13	39	14	42

Level of Need

Note. due to rounding, percentages may not add up to 100 %.

Table 29

Instructors' Perceived Individual Needs

CAD Category	1 No Need No.	%	2 Little Need No.	%	3 Some Need No.	%	4 Much Need No.	%
Better Resources for learning CAD skills	1	3	11	33	13	39	8	24
New Resources for learning CAD skills	1	3	9	27	15	45	8	24
Increased Budget for personal use	0	0	5	15	14	42	14	42
New Hardware for instructor's use	3	9	5	15	17	51	8	24

Note. due to rounding, percentages may not add up to 100 %.

Table 29, continued

Instructor's Perceived Individual Needs, continued

CAD Category	Level of Need							
	1 No Need		2 Little Need		3 Some Need		4 Much Need	
	No.	%	No.	%	No.	%	No.	%
CAD Work Experience	4	12	6	18	14	42	9	27
Integration Training	9	27	9	27	12	36	3	9
Technical Training	3	9	4	12	16	48	10	30
Pedagogical Assistance	5	15	10	30	11	33	7	21
Technical Assistance	3	9	13	39	6	18	11	33
New Software	2	6	4	12	14	42	13	39

Note. due to rounding, percentages may not add up to 100.

CHAPTER V: SUMMARY, DISCUSSION, AND IMPLICATIONS

Summary

The purpose of this study was to identify the CAD related needs of community college drafting instructors in Virginia. Although this study was designed specifically to gather information to assist those involved in planning for the integration of CAD into drafting programs in Virginia, it provides a model for planning the integration of related technology into educational programs. In addition, this information can be used by CAD vendors and manufacturers in their efforts to provide resource materials for community college drafting instructors.

To more clearly define its purpose, the following research questions were identified for this study:

1. What is the perceived level of skill with regard to selected CAD functions of community college drafting instructors in Virginia?

2. What is the perceived level of need for technical training with regard to selected CAD functions of community college drafting instructors in Virginia?

3. What is the perceived level of skill of community college drafting instructors in Virginia in integrating selected CAD functions into their curriculum?

4. To what extent do community college drafting instructors in Virginia perceive that selected CAD functions have been integrated into their drafting curriculum?

5. What is the community college drafting instructors' perceived level of need for training in integrating selected CAD functions into their drafting curriculum?

6. What resources do community college drafting instructors believe are needed to further integrate CAD into their curriculum?

To collect the data required to answer the research questions, a survey instrument was developed and mailed to 36 full-time drafting instructors at 23 community colleges in Virginia. Prior to mailing the instrument, a pilot test was conducted, to uncover items that were problematic in any way. Once tested, the instrument was submitted to the researcher's doctoral committee for approval.

An advance letter was sent to each of the 36 community college drafting instructors prior to the actual mailing.

The letter described the study and asked the respondents to provide a summer address. Each individual was given $1.00 as an incentive to participate in the research study.

The instrument, along with a cover letter and return envelope was sent to each drafting instructor. The instruments were coded to maintain confidentiality and assist in follow-up procedures. One week after the initial mailing, a reminder was mailed to the entire population. A follow-up mailing of the questionnaire was made three weeks after the original mailing. Further, a second follow-up mailing was made to all of the instructors who had not responded, six weeks after the initial mailing. Telephone contact was then attempted with each remaining instructor. Data collection was halted eight weeks after the initial mailing. The total response rate was 92 percent.

The "PC" version of the Statistical Package for the Social Sciences (SPSS) was used to analyze the data obtained through the survey technique. Descriptive statistics were used to answer the research questions that were identified for the study. Specifically, descriptive statistics included the calculation of measures of central tendency for each of the CAD category items and items related to perceived needs. Frequency distributions were reported to describe response patterns where appropriate.

Based on the analysis of the data obtained, the major findings are as follows:

1. The CAD teaching experience of community college CAD instructors in Virginia ranged from 1 to 15 years of experience. Most of the instructors have less than 7 years of experience teaching CAD.

2. A majority (79 %) of instructors had a Master's degree or higher. Further, a majority (66 %) indicated that their highest degree is in education.

3. The primary methods for acquiring CAD skills among community college instructors were self instruction and attending a formal class. Many instructors indicated that they used a combination of both methods to acquire CAD skills.

4. Only one-third of the instructors had attended CAD training held at a university or other college during the past two years. Further, only 36 % had attended a users

group meeting during that time. Fewer than one-third (27 %) had attended CAD training held by a private firm.

5. Most (67 %) of the community college CAD instructors in Virginia had not used CAD as part of a job other than teaching.

6. A large majority (85 %) of community college CAD instructors in Virginia were not certified in CAD use. Further, most (88 %) of the community colleges in Virginia were not Authorized Training Centers for any CAD software company.

7. Most (64 %) CAD instructors had access to a computer with CAD software at home. Still, over one-third did not.

8. Generally, the highest level of technical skill and integration skill was perceived on CAD categories related to basic drafting tasks. The lowest technical and integration skills were perceived to be in the advanced CAD categories related to design and customization.

9. Generally, the highest perceived need for technical and integration training was in the advanced CAD categories related to design and customization. The least perceived

need was in the CAD categories related to basic drafting tasks.

10. The CAD categories with the highest level of integration were those related to basic drafting tasks. The least integration occurred within those categories related to design tasks and customization.

11. A majority of community college CAD instructors perceived a high level of need for increased budget, new hardware and new software for use in their programs. A majority of community college instructors perceived a high level of personal need for CAD resources, increased budget, new hardware and software, CAD work experience, and technical training. Instructors responses were more evenly split between high and low level of need on perceptions about need for pedagogical assistance and technical assistance.

Discussion

Data were collected specifically to answer the research questions identified in the study. This section presents a discussion of the findings that resulted from the collected data.

Previous research suggests that if instructors feel competent with computer technology, they are more likely to use the technology and to incorporate it into their drafting program. The high level of skill that was indicated on CAD categories related to basic drafting tasks suggests that community college drafting instructors in Virginia feel comfortable with using CAD in a traditional drafting environment. Indeed, faced with basic drafting tasks such as drawing and editing, these instructors appear to feel highly competent. It is clear, however, that the drafting profession increasingly involves design-related tasks. The instructors' perceptions of relatively low technical skills in the CAD categories related to design (i.e. FEA, solids modeling, shading and rendering, etc.) suggest that these instructors feel unable to use those CAD functions.

The respondents' perceptions about skills and needs were most widely distributed on the items relating to design and customization (with the exception of custom symbols). This may indicate vast differences in curriculum content from school to school.

A high level of need for technical training was perceived among community college drafting instructors in Virginia for technical training in the CAD categories related to design and customization. These are also the categories where technical skills were perceived to be the lowest. Similarly, the lowest need for technical training was felt for the categories where the instructors perceived their technical skills to be highest. The highest perceived need for technical training was in FEA, database, shading and rendering, solids modeling, and custom programs. The instructors perceived much less of a need for technical training in the categories related to basic drafting tasks. The lowest need for technical training existed in the basic drawing and editing, rotation, replication, and custom symbols categories.

One might expect that on CAD categories where technical skills are high, perceived need for technical training will be low. This was the case on most of the CAD categories presented. As stated earlier, a high percentage of instructors perceived their technical skills to be high on CAD categories related to basic drafting tasks. Still, a number of instructors indicated "some" or "much" need for technical training on these categories. A possible explanation is that, while instructors felt competent with many of the CAD functions presented in this study, they felt that formal training was needed to verify and strengthen their existing skills.

One additional inconsistency in the response pattern is worthy of discussion. On the FEA category, only 12 percent of the instructors perceived their technical skills to be high. Still, only 50 percent of the instructors indicated either "some" or "much" need for technical training. One explanation for this is that some instructors perceived FEA to be beyond the scope and capability of their drafting program, making technical training unnecessary.

The thirty-three community college drafting instructors perceived their skill in integrating CAD into the drafting curriculum as high for those CAD categories related to basic drafting tasks. Instructors felt most comfortable with their skill in integrating basic drawing and editing, scaling, rotation, replication, and dimensioning functions into their program. On the other hand, these drafting instructors perceived the least skills in integrating CAD for the custom programs, solids modeling, shading and rendering, database, and FEA categories. These results suggest that the instructors do not feel prepared to integrate design-related CAD skills into the drafting curriculum. Indeed, many instructors may question their ability to do so. Even on design-related functions where a majority of instructors perceived high technical skills, such as 3D drawing and viewing, perceptions about integration skills were lower. This result lends credence to the idea that skills in CAD use do not necessarily equate to skills in CAD integration.

The extremely high level of integration of the basic drawing and editing, scaling, rotation, replication, dimensioning, and custom symbols CAD categories suggests that community college CAD instruction in Virginia centers around the use of CAD as a drafting tool, rather than a design tool. It is important to note that some instructors were attempting to integrate the design related functions into their drafting programs. A number of the instructors perceived a relatively high level of integration for CAD categories related to design. As stated earlier, however, a large percentage of instructors also perceived a high level of need for technical training in CAD categories related to design, suggesting that some instructors with low levels of skill may be attempting to teach these CAD functions.

As with instructors' perceptions about the need for technical training, perceived need for training on how to integrate CAD was generally highest for those CAD categories where the technical skill and integration was perceived to be least. Similarly, the perceived need for integration training was least for those CAD categories where the technical skill and integration was perceived highest. Specifically, the instructors perceived the need for integration training to be highest on the FEA, database, shading and rendering, solids modeling, and custom programs categories. Of the categories presented, the lowest need for integration training was felt on the basic drawing and editing, scaling, rotation, replication, and dimensioning categories.

These results indicate that, while instructors may have perceived themselves to be competent technically, a high percentage of them felt that they needed help learning to integrate CAD into their programs. This is especially true for the advanced CAD categories related to design, where relatively low levels of technical skills and skills in integrating CAD into the curriculum were perceived.

Based on the instructors' perception of program needs, there would appear to be a high level of need for increased budget, new software, new hardware, and new or better curriculum materials. With regard to individual needs, a high level of need was perceived by the instructors for all categories presented, except integration training. Specifically, a need exists for new and better resources for learning CAD skills, increased budget for individual use, new hardware and software for personal use, CAD work experience, technical training, pedagogical assistance, and technical assistance with CAD related problems.

The need for increased budget, new hardware and new software was rated high among instructors. It is also important to note that while almost half of the instructors perceived "much" need for increased budget, new software and new hardware, only a small percentage ranked the need for curriculum materials as high. Based on these results, one may conclude that if additional funds were made available, the majority of instructors would use them to purchase new hardware and/or software for use within their program, rather than curriculum materials. Further, the instructors indicated high levels of need on items related to money (budget, software, hardware) and lower levels of need for items such as technical assistance and pedagogical assistance. This may indicate a tendency to solve instructional problems with money, before first considering other solutions.

In summary, the overall pattern of responses to the items on the survey questionnaire may paralell some of the strengths and weaknesses of community college drafting programs in Virginia. From the instructors' perceptions of skill and need, it seems that a high level of instruction existed in the CAD categories related to traditional drafting tasks. However, it seems that fewer instructors had ventured into instruction in the CAD categories related to design and customization. Many of the instructors who had attempted to teach the design and customization-related

CAD categories felt uncertain about their technical skills and skills in integrating CAD functions into their program. Further, the fact that responses were often split between high and low needs or skills suggests that some level of uncertainty exists about the categories of CAD skills related to design and customization.

Recommendations For Practice

Based on the findings of this study, the following recommendations for professional practice are presented:

1. Over two-thirds of the instructors responding to the survey instrument indicated not having experience using CAD in a job other than teaching. Therefore, each community college should assess drafting instructors' level of experience and develop creative opportunities for full time community college drafting instructors to obtain industry-based CAD work experience.

2. The instructors perceived a high level of technical skill on CAD categories 1-5. Still, a number of these instructors indicated some or much need for technical training on these same categories. Therefore, it is recommended that resources be provided to help community

college drafting instructors validate and improve existing skills in CAD categories related to traditional drafting tasks (categories 1-5).

4. The instructors' perceptions of low technical skills in CAD categories related to design suggest that they feel unable to use those functions. Further, the instructors perceived a high level of need for technical training in those categories. Therefore, it is recommended that each community college assess the technical skill level of drafting instructors and provide resources to help these instructors develop skills in the use of CAD categories related to design and customization (categories 6-14).

5. Many instructors perceived low skills in integrating design related CAD categories into their curriculum. Therefore, it is recommended that each community college assess the instructors' current level of skill in integrating these CAD functions and provide resources to help these instructors develop skills in integrating CAD categories related to design and customization (categories 6-14) into the drafting curriculum.

Recommendations for Future Research

Based on the findings of this study, the following recommendations for future research are made:

1. A research study should be conducted to compare community college drafting instructors perceptions about the importance of CAD categories related to customization and design to those of practicing drafters.

2. A research study should be conducted to determine the feasibility of teaching CAD functions related to design and customization within drafting programs.

3. It is unclear what variables affect the instructors' perceptions of skill and need. To account for the considerable variation in response patterns, future research should compare the instructor's responses to CAD category items related to design and customization (categories 6-14) by years of experience, CAD exposure, prior CAD training, educational background, and certification status.

4. A qualitative research study should be conducted to determine each individual instructor's actual technical skills and skills in CAD integration for the CAD categories presented in this study.

5. Instructors perceived a high level of need for items related to money (increased budget, new hardware and software), but perceived lower levels of need for items related to technical support, technical assistance, work experience, and pedagogical assistance. Therefore, a study should be conducted to compare community college drafting programs by amount of funding to determine the effect of funding on the level of CAD integration.

REFERENCES

Addison, D. B. (1988). The changing technical drafting curriculum: CAD alters the content and the process of instruction. _Industrial Education, 77_(6), 18-20.

Ary, D., Jacobs, L. C., & Razavieh, A. (1985). _Introduction to research in education._ Fort Worth, TX: Holt, Rinehart and Winston.

Becker, K. (1991). Content and strategies for teaching computer aided drafting. _Journal of Industrial Teacher Education, 28_(2), 38-46.

Benjamin, S. (1989). A closer look at needs analysis and needs assessment: What ever happened to the systems approach? _Performance & Instruction, 28_(9), 12-16.

Best, J. W. (1970). Research in education. Englewood Cliffs, N.J.:Prentice-Hall.

Burns, W. E. (1986). Computer Aided Design (CAD). _Industrial Education, 75_(6), 10-11.

Burton, J. K., & Merrill, P. F. (1977). Needs assessment: Goals, needs, and priorities. In L. J. Briggs (Ed), Instructional design: Principles and application (pp.21-45). Englewood Cliffs, N.J.:Educational Technology Publications.

Dick, W., & Carey, L. (1990). The systematic design of instruction. New York: Harper Collins.

Duelm, B. L. (1986, December). Computer Aided Design in the classroom. Paper presented at the annual convention of the American Vocational Association, Dallas, Texas. (ERIC Document Reproduction Service No. ED 276 885)

Erdos, P. L. (1983). Professional mail surveys. Malabar, FL: Robert E. Kreiger Publishing Company.

Finch, C. R., & Crunkilton, J. R. (1993). Curriculum development in vocational and technical education. Needham Heights, MA: Allyn & Bacon.

Flechsig, A. J., & Seamans, D. A. (1987). Determining the value of PLATO computer based education for a freshman engineering course. Engineering Education, 77(4), 240-242.

Frary, R. B. (1991). A brief guide to questionnaire development. Unpublished manuscript, Virginia Polytechnic Institute and State University, Blacksburg.

Goetsch, D. L. (1986). The changing drafting curriculum. Design Graphics World, 10(9), 32,35.

Gordon, H. R. D. (1993). Analysis of the computer anxiety levels of secondary technical education teachers in West Virginia (Clearinghouse Report No. CE 063 619). Charleston, WV: Department of Vocational Education. (ERIC Document Reproduction Service No. ED 357 218)

Hirumi, A. (1994). Assessing the needs of public education: A tale of two models. Performance & Instruction, 33(5), 23-30.

Holloway, H. D. (1987). Developing high technology curriculums. Industrial Education, 76(5), 12-13.

Hu, Cheng-Hwa (1988). Computer aided drafting applications in drafting programs in Colorado. Unpublished doctoral dissertation, Colorado State University, Fort Collins.

Imel, S. (1990). Jobs in the future. (Report No. EDO-CE-90-95). Washington, D. C.:ERIC Clearinghouse on Adult, Career, and Vocational Education. (ERIC Document Reproduction Service No. ED 318 913)

Irwin, J. L. (1992). An investigation into computer aided drafting and design (CADD) in the Saginaw area from the viewpoint of mechanical drafting and design employers. Unpublished Master's Thesis, Ferris State University.

Isbell, C. H., & Lovedahl, G. G. (1988). Introducing CAD into the traditional drafting program. Industrial Education, 77(8), 13-14.

Kinzie, M. B., & Delcourt, M. A. B. (1991, April). Computer technologies in teacher education: The measurement of attitudes and self efficacy. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL. (ERIC Document Reproduction Service No. ED 331 891)

Lamit, L. G. (1994). Technical drawing and design. St. Paul, MN:West Publishing.

Langhorne, M. J. (1989). Teaching with computers: A new menu for the 90's. Phoenix, AZ: Oryx Press.

Molla, S. T. (1987). A comparison of college students' attitudes toward computers. Unpublished doctoral dissertation, The University of Tennessee, Knoxville.

Nelson, O. (1985). IA educators at all levels must teach computer skills. School Shop, 44(9), 22-23.

Nickens, J. M., Purga, A. J., & Noriega, P. P. (1980). Research methods for needs assessment. Washington, D. C.: University Press of America.

Norusis, M. J. (1993). SPSS for Windows base system users guide, release 6.0. Chicago, IL:SPSS.

Picciano, A. G. (1994). Computers in the schools: A guide to planning and administration. New York: Merrill.

Pickard, N. J. (1983). Attitudes of South Dakota home economics teachers toward the use of microcomputers. Unpublished Master's thesis, South Dakota State University.

Raker, D., & Rice, H. (1991). Inside Autocad. Gresham,OR:New Riders Publishing.

Rossett, A. (1982). A typology for generating needs assessments. Journal of Instructional Development, 6(1), 28-33.

Rossett, A. (1987). Training needs assessment. Englewood Cliffs, N.J.:Educational Technology Press.

Smith, P. L., & Ragan, T. J. (1992). Instructional Design. New York: Merrill.

Sormunen, C. & Chalupa, M. (1994). Perceived preservice and inservice technology training needs of Indiana business teachers. The Delta Pi Epsilon Journal, 36(1), 14-23.

Tatum, S. (1996). An exercise in 3-D visualization. Tech Directions, 55(6), 14-15.

Tu, R. J. (1991). An analysis of perceived literacies and attitudes concerning microcomputer usage by technical education instructors at two year colleges and technical institutes in Tennessee. Unpublished doctoral dissertation, The University of Tennessee, Knoxville.

United States Bureau of Labor Statistics (1994). Occupational Outlook Handbook. Washington, D.C.: Author.

Wiersma, W. (1991). Research methods in education. Needham Heights, MA: Allyn & Bacon.

Winchip, S. (1990, November) Computer applications in the design process. Paper presented at the international conference of the Association for the Development of Computer-based Instructional Systems, San Diego, CA. (ERIC Document Reproduction Service No. ED 332 674)

Wissa, F. F. (1988). The evolution of computer aided drafting, design, and manufacturing (CAD/CAM) in engineering, construction, and manufacturing industries (1952-1987). Unpublished Master's Thesis, California State University, Long Beach.

Yuen, S. C. (1990). Incorporating CAD instruction into the drafting curriculum. The Technology Teacher, 50(3), 30-32.

Yuen, S. C. (1985). Attitudes of trade and industrial teachers toward the use of microcomputers. Journal of Vocational Education Research, 10(2), 51-64.

APPENDICES

Appendix A

Survey Instrument

SURVEY OF COMMUNITY COLLEGE CAD PROGRAMS IN VIRGINIA

Division of Vocational and Technical Education
Virginia Polytechnic Institute and State University

Section I: General Information

Directions: Please respond to each question below as accurately as possible by circling the number of your response or providing the necessary information.

1. Would you categorize your school as:
   (1) Urban
   (2) Suburban
   (3) Rural

2. How long have you taught CAD at the community college level (to the nearest year)?

   __________ yrs

3. Describe the type of computer hardware you **PRIMARILY** use to teach CAD?

Compatibility (PC-386, 486, Apple, Macintosh, etc.): ________________________________

RAM (Megabytes): ________________________________

4. Which software do **YOU** use to teach CAD? (circle all that apply and indicate version used)

   (1) AutoCAD (DOS) ver__________
   (2) AutoCAD (WIN) ver__________
   (3) Microstation ver__________
   (4) CADKEY ver__________
   (5) VersaCAD ver__________
   (6) Other (specify) ver__________

   ____

5. Do you have a computer with CAD software at home?

   (1) No (2) Yes

6. Indicate your Highest Educational Level:
   (1) High School
   (2) Associates
   (3) Bachelors
   (4) Masters
   (5) Doctorate

7. In what area is your highest degree? (i.e., education, engineering, etc.)

   ____

8. How did you **primarily** learn to use CAD software?

   (1) Self taught
   (2) Peer taught (i.e., another teacher, etc.)
   (3) Attended a formal class
   (4) Other (specify)____________________

9. Is your community college an authorized training center (ATC) for any specific software company (i.e., Autodesk or Intergraph)?

   (1) No (2) Yes

10. Do YOU have any special CAD certifications (i.e., passed the Autocad certification exam)?

   (1) No (2) Yes

11. During the past two years have you attended any of the following?

   a. CAD training at a university/other college
      (1) No (2) Yes
   b. CAD users group meeting
      (1) No (2) Yes
   c. CAD training held by a private training firm
      (1) No (2) Yes
   d. Other CAD training (specify) __________

   ____

12. Have you used CAD as part of a job in an industry setting (i.e., worked as a CAD operator)?

   (1) No (2) Yes

Section II: CAD Use and Integration

SCALES FOR SECTION II

	①	②	③	④
A.	① No Skills	② Few Skills	③ Some Skills	④ Expert Skill Level
B.	① No Need	② Little Need	③ Some Need	④ Much Need
C.	① No Integration	② Little Integration	③ Some Integration	④ Full Integration
D.	① No Skills	② Few Skills	③ Some Skills	④ Expert Skill Level
E.	① No Need	② Little Need	③ Some Need	④ Much Need

Directions: Please use the scales shown above to rate items A through E for each of the following 14 categories.of CAD functions shown below. For example, for item "1A" below, use scale "A" shown above. Circle the number of your response for each item below.

☞ **NOTE: "Integration" is defined as the extent to which drafting content is taught using CAD.**

1. Basic Drawing and Editing Commands (i.e., lines, arcs, circles, trimming, extending, etc.)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions.. 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

2. Scaling Commands (i.e., plotting a drawing to a specific scale)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions.. 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

3. Rotation Commands (i.e., rotating all or part of a drawing to a specific angle)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions.. 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

4. Replication Commands (i.e., copy, mirror, array, etc.)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions.. 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

5. Dimensioning Commands (i.e., setting up and using dimensioning commands)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions.. 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

6. Creating CAD menus (i.e., writing menu macros)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions.. 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

7. Writing Custom CAD programs (i.e. AutoLISP, MDL, ADS, etc.)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

8. Creating Re-usable Symbols (i.e., Blocks, Cells, Figures, etc).

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

9. 3-Dimensional Drawing Commands (not solids modeling)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

10. 3-Dimensional Viewing Commands (not shading or rendering)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

11. Solids Modeling Commands (i.e., Boolean Operations, etc.)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

12. View Shading and Rendering Commands

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

13. Non-graphical Database Functions (i.e., automatic bill of materials generation)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

14. Finite Element Analysis (FEA)

A. Your technical skill level with these CAD functions.. 1 2 3 4
B. Your need for technical training on these CAD functions... 1 2 3 4
C. The level of integration of these CAD functions into your drafting curriculum................ 1 2 3 4
D. Your level of skill in integrating these CAD functions into your drafting curriculum...... 1 2 3 4
E. Your need for training on how to integrate these CAD functions into your drafting curriculum ... 1 2 3 4

Section III: Program Resource Needs

Directions: Please use the scale shown below to rate the current level of need for each of the following resources in your drafting program. Circle the number of your response for each item.

① No Need ② Little Need ③ Significant Need ④ Extreme Need

1. Increased budget (for overall drafting program)	1	2	3	4
2. New curriculum materials (texts, competency lists, etc.)	1	2	3	4
3. Better curriculum materials (texts, competency lists, etc.)	1	2	3	4
4. New or updated hardware (for student use)	1	2	3	4
5. New or updated software (for student use)	1	2	3	4
——Other CAD related needs within your drafting program (specify below)				
6. ________________________________	1	2	3	4
7. ________________________________	1	2	3	4

Section IV: Personal Resource Needs

Directions: Please use the scale shown below to rate YOUR current level of need for each of the following resources (i.e., to help you personally develop CAD related skills). Circle the number of your response for each item.

① No Need ② Little Need ③ Significant Need ④ Extreme Need

1. Increased budget (for going to CAD seminars, etc)	1	2	3	4
2. New learning resources (i.e., materials to help you develop CAD skills)	1	2	3	4
3. Better learning resources (i.e., materials to help you develop CAD skills)	1	2	3	4
4. New or updated hardware (for your personal use)	1	2	3	4
5. New or updated software (for your personal use)	1	2	3	4
6. On the job experience using CAD (i.e., summer work in industry for you)	1	2	3	4
7. Technical assistance (i.e. telephone support for CAD software and hardware problems)	1	2	3	4
8. Pedagogical assistance (i.e., help with the identification of strategies for teaching CAD)	1	2	3	4
9. Technical CAD training	1	2	3	4
10. Training on how to integrate CAD into your drafting program	1	2	3	4
——Other CAD related personal needs (specify below)				
11. ________________________________	1	2	3	4
12. ________________________________	1	2	3	4

Please use the space below to indicate any additional CAD related needs you may have or to provide any other information that would be helpful to the VCCS in supporting your drafting program.

Appendix B

Advance Letter of Introduction

«Title» «FirstName» «LastName» April 18, 1995
«JobTitle»
«Company»
«Address1»
«Address2»
«City» «State» «PostalCode»

Dear «Title» «LastName»:

We are writing to you because your help is urgently needed in conducting a needs assessment of community college drafting programs in Virginia. You were selected from a list of drafting faculty in the state and we sincerely hope that you are able to help.

The purpose of this assessment is to identify the needs of drafting instructors in Virginia. By doing this, we will be able to plan for in-service and related activities and make resource allocations that will better enable you to meet your student's needs.

The end of Spring semester can be a very busy time. Therefore, we have decided to conduct the needs assessment during the summer months. A brief questionnaire will be mailed to you during the month of June. This should take no more than fifteen minutes to complete. We assure you that any individual information gathered through this study will remain confidential.

Since the questionnaires will be mailed in June we ask that you provide a valid summer address. Please fill out the form below and return it in the enclosed envelope by May 1, 1995.

Your participation is extremely important. Your time is valued, so we have enclosed $1.00 as a modest token of our appreciation. We look forward to your prompt reply and thank you for your assistance.

Sincerely,

Arnold K. Murdock
Division of Vocational and Technical Education
Virginia Tech

✂--✂

Return By May 1, 1995 To: **Arnold K. Murdock**
Lynchburg, VA 24502

Name: ______________________________
Summer Address: ______________________________
____
____
Summer Telephone: ______________________________

Appendix C

Cover Letter

<Date>

Mr. <CAD Instructor's Name>
<Street Address>
<City, State Zip code>

Dear Mr. <Last Name>:

Last May, I contacted you regarding a needs assessment of the community college drafting programs in Virginia. You were identified as a key instructor within these programs in the state. Consequently, your input is vital to the success of this effort.

As you may recall, I promised to forward a short survey to you during the summer months. I have included that survey with this letter, along with a stamped envelope for you to use when returning it to me. Please note that the deadline for response is July 28, 1995.

As you fill out the survey, please remember that all responses will be treated with strict confidentiality. Your responses will be combined with others from across the state in summary fashion to identify response patterns and trends that are developing.

If you should have questions or need assistance, please do not hesitate to contact me at my home in Lynchburg. My telephone number is (xxx) xxx-xxxx.

Again, your input is extremely important to the success of this effort. Please accept my sincere appreciation for your participation.

Sincerely,

Arnold K. Murdock
Doctoral Candidate
Virginia Tech
Blacksburg, VA 24061

Appendix D

First Reminder Letter

<Date>

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«City», «State» «PostalCode»

Dear Mr. «LastName»:

Last week, I mailed to you a survey of community college drafting programs in Virginia. Some of the instruments have already been returned and we are preparing to analyze the responses.

To those of you who have already returned the instrument, many thanks!

If you have not already done so, please take a few minutes to fill out the questionnaire and return it in the envelope provided.

Again, let me stress the importance of your reply. The small number of participants in this study (36) means that every non-respondent represents a significant gap in the data that is collected.

Thank you so much for your participation.

Sincerely,

Arnold K. Murdock
Doctoral Candidate
Virginia Tech

Appendix E

Followup Letter

<Date>

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«City», «State» «PostalCode»

Dear Mr. «LastName»:

In July, I mailed to you a survey of community college drafting programs in Virginia. To date, I have not received your completed instrument. Therefore, I have included another copy of the instrument and a self addressed, stamped envelope for your convenience.

Again, let me stress the importance of your reply. The small number of participants in this study (36) means that every non-respondent represents a significant gap in the data that is collected.

Please take a few minutes to fill out and return the enclosed instrument as soon as possible so that we may begin to process the data. Note that the return address (formerly Lynchburg, VA) has now been changed as follows:

Arnold Murdock
<Street Address>
<City, State Zipcode>
<Telephone>

If you need additional information or have comments or questions regarding this study, please do not hesitate to contact me at this address. I do appreciate your help. Please return your instrument today.

Sincerely,

Arnold K. Murdock
Doctoral Candidate
Virginia Tech