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PERCEIVED IMPORTANCE OF NATIONAL OCCUPATIONAL CADD SKILL

STANDARDS

AMONG FACULTY OF NAIT ACCREDITED INSTITUTIONS
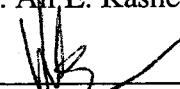
A Dissertation

Submitted

In Partial Fulfillment

of the requirements for the Degree

Doctor of Industrial Technology

Approved:

_____
Dr. Ali E. Kashef, Committee Chair

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Dr. Nilmani Pramanik, Committee Co-Chair

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Dr. Lesta A. Burgess, Committee Member

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Dr. Douglas Mupasiri, Committee Member

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Dr. Andrew Gilpin, Committee Member

Ronald Shava
University of Northern Iowa
July 2005

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PERCEIVED IMPORTANCE OF NATIONAL OCCUPATIONAL CADD SKILL

STANDARDS

AMONG FACULTY OF NAIT ACCREDITED INSTITUTIONS

An Abstract of a Dissertation

Submitted

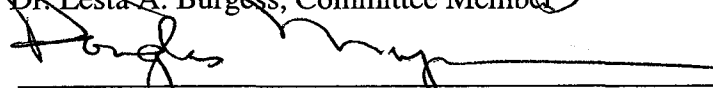In Partial Fulfillment

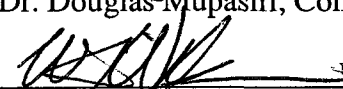of the requirements for the Degree
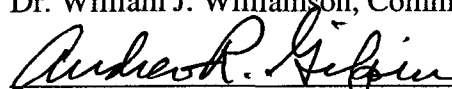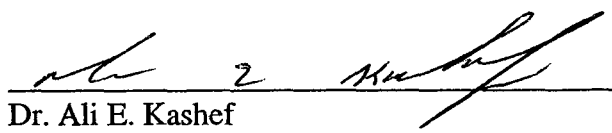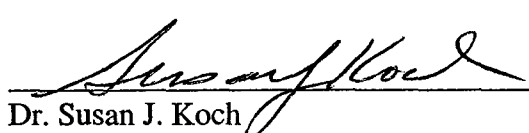
Doctor of Industrial Technology

Approved:

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Dr. Ali E. Kashef
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July 2005

ABSTRACT

This study presents a descriptive survey that examined the importance and relevance of National Occupational CADD Skills based on the perceptions of faculty teaching at National Association of Industrial Technology (NAIT) accredited institutions. The major goal of the study was to determine what National Occupational CADD Skill Standards are relevant and important to faculty teaching CADD courses. The study was also designed to determine ratings of the perceived importance and relevance of National Occupational CADD Skill Standards by faculty teaching CADD courses at NAIT accredited institutions based on their area of specialization, professional ranking, and teaching experience. This study provided NAIT accredited programs, professionals, and affiliated organizations a reflection of CADD standards developed, adopted, and practiced by faculty teaching CADD courses at NAIT accredited institutions in relation to National Occupational CADD Skill Standards. The population used for this study includes faculty teaching CADD courses in various Industrial Technology programs. For testing hypothesis I, a single sample was used for survey responses. Independent samples were used for survey responses in hypotheses II, III, and V.

A single survey instrument was developed for this study. The survey instrument has five sections representing: demographics, fundamental drafting skills, fundamental computer skills, basic CADD skills, and advanced CADD skills

A research hypothesis (H_1: $\mu \neq 3$) was established for hypothesis I for each item. Research hypotheses (H_1 At least one pair of the category means would be different) were established for hypotheses II, II, and IV. Hypothesis I was tested using a single sample t-test

at the .05 level of significance for each of the CADD skill standard item. The ANOVA was used to test hypotheses II, III, and IV.

The results of the statistical analyses were used to arrive at inferences on the importance and relevance of National Occupational CADD Skill Standards developed by National Coalition for Advanced Manufacturing (NACFAM) by faculty teaching at NAIT accredited institutions. Statistical analyses also checked on the balance of opinions on importance and relevance of National Occupational CADD Skill Standards between industry and educators. Statistical analyses failed to establish significant mean differences on how faculty teaching CADD at NAIT accredited institutions perceive the importance and relevance of National Occupational CADD Skill Standards in the four hypotheses tested. The four hypotheses are stated in Chapter 1 of the study. Recommendations for further studies are provided in Chapter 5.

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DEDICATED TO

MY FAMILY

ACKNOWLEDGEMENTS

I would like to thank those whose support was essential for me to complete this research study and make it something I am proud of. With that thought in mind, I would like to express my heartfelt appreciation to the following people.

First and foremost to my wife Christine who has sacrificed part of her life with continued and unwavering support that has seen me complete this research even though we have been miles away for such a long time. I also want to extend appreciation to her for taking care of our boys, Munyaradzi and Munashe while I was away from home pursuing my academic career. To my boys, thank you very much for your patience. Thank you mom and dad for your love, for without you this was not going to be possible. I love you all.

Special thanks go to my advisory committee members, Dr Ali. E. Kashef, Dr. Nilmani Pramanik, Dr. Lesta A. Burgess, Dr. Douglas Mupasiri, Dr. Andrew Gilpin, and Dr. William J. Williamson for their professional advice and guidance which remained steadfast throughout the research study. My deepest appreciation is extended to the advisory committee for their unflagging attention to detail and willingness to provide assistance regardless of many other pressing responsibilities. A special thank you goes to Dr. John E. Williams who assisted me greatly in creating the web based survey instrument and the data collecting web page used in this study even though he was not a member of my advisory committee.

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encouragement. Finally thank you Dr. Ronald Bro and Mrs. Mary Bro, you made all this possible. You have been my family and it will remain that way. I truly appreciate the love, the moral support, and financial support you willingly invested towards my academic career. I will always cherish your free love.

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CHAPTER 1

INTRODUCTION

Computer Aided Design and Drafting (CADD) technology has evolved to become

one of the most important utilities in the manufacturing and construction industry.

Tremendous developments and innovations in CADD technology have kept the industrial

world stimulated and ever changing for the past thirty years. CADD technology has

grown from being merely a drafting tool meant to replace traditional manual drafting to a

completely complex integrated drafting and design tool. In the manufacturing industry,

new powerful low-end and high-end parametric solid modeling CADD software packages

can now be integrated with other manufacturing technologies such as Computer Aided

Manufacture (CAM), Computer Numerical Control systems (CNC), Rapid Prototyping,

and Finite Element Analysis (FEA). The latest trends in CADD technology show a

growing interest in Application Service Providers (ASPs) technology. ASP services

include on-line rentals of CADD software, file conversion, analysis and simulation

services, Mechanical CADD (MCADD) design software, expert knowledge, design

collaboration, supply chain collaboration, interoperability, project and resource

management, intellectual property management programs on an as-needed basis (Greco,

2001a, 2001b).

With these recent developments and improvements, the CADD community in the

United States of America was challenged to come up with CADD skills that are basic and

core to all CADD users (Foundation for Industrial Modernization [FIM], 1994). One

important concern that complicated this task was the diversity of CADD users' areas of

expertise and the numerous types of CADD software available on the market. Confronted with these daunting challenges, the FIM Executive Committee and a cross-section of a Technical Committee made up of experts representing the entire CADD community embarked on a project aimed at standardizing basic and core CADD skills (FIM, 1994). FIM is a non-profit partisan 501(C) (3) organization which serves as the research and educational arm of the National Coalition for Advanced Manufacturing (NACFAM). FIM's mandate is to sustain and revitalize America's infrastructure with the aim of improving global economic competitiveness, developing a highly skilled workforce, promoting improved standards for all citizens, and creating a cleaner environment (National Coalition for Advanced Manufacturing [NACFAM], 1994). FIM published the first CADD standards document in April 1994. This document has since been revised, with the latest version published in January 1999. The document provides a list of skills that are core to all CADD disciplines and generic to all software as well as entry level competence requirements by industry. The proposed National Occupational CADD Skill Standards were placed into the following broad categories: (1) fundamental drafting skills; (2) fundamental computer skills; (3) basic CADD skills; and (4) advanced CADD skills. In addition, the document provided information stipulating required and related academic skills in communication, math, and science; employability skills; tools and equipment for CADD training; recommended hours of instruction; and instructor qualifications (NACFAM, 1996).

On the other hand, professional societies and academic institutions are important sources for guiding, directing, and influencing community colleges, universities and

industry in the development of specific curricula to meet societal needs. Accreditation organizations representing different engineering fields and disciplines in industry publish standards and requirements that determine whether academic programs offered at various institutions can be accredited to them or not. Accreditation standards vary considerably among professional accreditation organizations and/or within one accreditation organization and this relates to areas of specialization.

One of the most important professional organizations that accredits Industrial Technology programs is the National Association of Industrial Technology (NAIT). The NAIT organization has accredited Industrial Technology programs at over 125 universities and community colleges in the United States of America (National Association of Industrial Technology [NAIT], 2002a). The NAIT organization defines Industrial Technology as a field of study intended to prepare technical and/or management oriented professionals for employment in business, industry, education, and government. Graduates from Industrial Technology programs are primarily involved in management, operations, and maintenance of complex technological systems while graduates from Engineering and Engineering Technology are primarily involved with design and installation of systems (NAIT, 2000).

The inspiration to conduct this study was a result of the researcher's keen interest in CADD technology as well as developments in CADD standards, especially those pertaining to Industrial Technology programs. The researcher has worked as a CADD/Drafting instructor for at least four years at a NAIT accredited institution. The researcher has also participated and contributed both professionally and academically at

CADD workshops/conferences across the country. A review of CADD standards

developed and adopted at NAIT accredited institutions in relation to National

Occupational Skills CADD Standards was worth exploring in order to determine whether

Industrial Technology CADD courses are in conformity with NACFAM expectations.

Statement of the Problem

This descriptive study was designed to establish perceived similarities and

differences on CADD standards developed and adopted by faculty teaching at NAIT

accredited programs in relation to National Occupational CADD Skill Standards

developed by NACFAM. The study was also used to determine significant differences

and similarities of CADD standards adopted by four popular Industrial Technology

programs offered at NAIT accredited institutions. The four most popular Industrial

Technology programs are: (1) Manufacturing, (2) Industrial Technology, (3)

Construction, and (4) Design/Graphics (NAIT, 2002b). More specifically, this study

addressed the following four problems.

1. On the average, do faculty teaching CADD skills at NAIT accredited

institutions view CADD skill standards prescribed by NACFAM relevant and important?

2. Are there any perceived differences on NACFAM CADD skills standards by

faculty teaching CADD in different Industrial Technology programs at NAIT accredited

institutions?

3. Does CADD teaching experience at NAIT accredited institutions influence the

faculty's perceptions on the importance of CADD skills standards prescribed by

NACFAM?

4. Are there any perceived differences on the importance of CADD skills standards prescribed by NACFAM by faculty at NAIT accredited institutions based on professional ranking (instructor/assistant professor/associate professor/professor)?

<u>Statement of Purpose</u>

The purpose of this study was to provide NAIT accredited institutions, professionals, and affiliated organizations a reflection of CADD standards developed, adopted, and practiced by NAIT accredited institutions in relation to National Occupational CADD Skill Standards. Knowledge gained from this study could be used as a means of influencing and standardizing CADD courses at NAIT accredited institutions. Results from this study could also provide useful information in identifying variations in CADD skill standards adopted by different Industrial Technology programs among NAIT accredited institutions. NAIT accredited institutions might use findings from this study to review, improve, and update current CADD curricula in the different Industrial Technology programs.

As is the case with most professional organizations, NAIT strives to meet specific educational needs of various businesses and industries throughout the country. Industrial Technology programs offered at NAIT accredited institutions are designed to provide individuals with knowledge, skills, and competencies that are so much in need in this high-performance world of work. The NAIT organization may use this study to evaluate its CADD standards against those of other accreditation societies/organizations. Industrial Technology graduates from NAIT accredited institutions are able to determine CADD

competencies that are expected of them from the different programs and their employment opportunities upon graduating by going through the findings of this study.

Findings from this study may provide useful information to prospective employers so as to ascertain basic and fundamental CADD skills and credentials of graduates from NAIT accredited institutions in different Industrial Technology programs. Employers can also use this study to compare CADD standards developed and adopted by other professional accreditation societies/organizations with NAIT so they can make rational decisions when hiring CADD personnel. Finally, employers may use findings from this study in developing in-house CADD training courses since they are able to determine CADD competencies/skills that are lacking or that are strong in potential employees graduating from NAIT accredited institutions/programs.

<div align="center">Statement of Need</div>

Skill standards in any profession are aimed at helping the industry and all other forms of occupation to improve the skills of the workforce. Skill standards assist educators and trainers in the development and innovations of teaching curriculum. Skill standards also ensure that students and workers develop necessary and relevant skills for employment in industry. In 1994, President Clinton called for the development of tough world-class academic and occupational standards for all American students and workers. In his State of the Union Address, President Clinton also stressed the importance of providing students and teachers/instructors the necessary tools to meet the tough world-class academic and occupational standards (FIM, 1994). This call prompted FIM to embark on a project whose main goal was to produce a document that represented skills

that are core to all CADD disciplines and generic to all software and occupational entry levels (NACFAM, 1996).

NACFAM published the first draft of the National Occupational CADD Skill Standards in 1994 (NACFAM, 1996). A total of 90 CADD skill standards were established. The proposed National Occupational CADD Skill Standards were placed into four broad categories; (1) Fundamental Drafting Skills, (2) Fundamental Computer Skills, (3) Basic CADD Skills, and (4) Advanced CADD Skills. The broad skills categories mentioned above have well defined lists of CADD skills standards accompanied by a concise description for each standard. A complete copy of the document on National Occupational CADD Skill Standards is provided in Appendix A.

Due to the comprehensiveness of National CADD Occupational Skill Standards developed and published by NACFAM it is impossible for CADD users employed in different engineering disciplines to adopt all of them. CADD users will certainly appreciate those CADD Skill standards that pertain to their industry or area of specialization (NACFAM, 1996). Literature review shows that CADD users tend to select and work with particular skills standards that are in line with their professions or fields. The same can be said of academic and training institutions. An appraisal of CADD courses offered by universities across the United States of America confirms this assertion. Professional societies/organizations such as NAIT play a significant role in influencing and advising academic/training institutions on CADD skills standards in order to satisfy industrial and business needs. Reviews of CADD courses within institutions accredited to particular professional societies/organizations such as NAIT

may also show preferential differences to CADD skill standards from those developed by NACFAM. Within this broad context this study satisfied the following specific needs.

1. The need for the NAIT organization to review and evaluate CADD skill standards adopted and practiced by its accredited institutions relative to National Occupational CADD Skill Standards developed and published by NACFAM.

2. The need to establish perceived differences on the importance of National Occupational CADD Skill Standards developed by NACFAM by faculty teaching at NAIT accredited institutions.

3. The need to establish perceived differences on the importance of occupational CADD Skill Standards developed by NACFAM among faculty teaching in different Industrial Technology programs at NAIT accredited institutions.

4. The need to determine the perceived differences on the importance of National Occupational CADD Skill Standards developed by NACFAM by faculty at NAIT accredited institutions in regards to faculty professional rankings and teaching experience (level of expertise).

5. The need to provide employers a measurement of CADD skill standards and competencies of Industrial Technology graduates from NAIT accredited institutions in regard to National Occupational CADD Skill Standards.

<u>Research Questions</u>

This study presents a survey of CADD instructors/professors teaching at NAIT accredited institutions. The major goal of this study was to establish perceived views on National Occupational CADD Skill Standards developed through NACFAM by faculty

teaching CADD skills at NAIT accredited institutions. This study was also aimed at establishing perceived differences on occupational CADD skill standards practiced by faculty teaching in different Industrial Technology programs at NAIT accredited institutions. Further, the study examined CADD skill standards differences and similarities among the various Industrial Technology programs accredited to the NAIT organization in regard to National Occupational CADD Skill Standards. Five research questions are associated with this study.

1. Are there any perceived differences on importance of National Occupational CADD Skill Standards developed by NACFAM with regard to faculty teaching at NAIT accredited institutions?

2. Are there any differences perceived by faculty on the importance of National Occupational CADD Skill Standards developed by NACFAM among faculty teaching different Industrial Technology programs offered at NAIT accredited institutions?

3. Do faculty teaching at NAIT accredited institutions perceive National Occupational CADD Skill Standards important and relevant according to professional ranking?

4. Do the faculty teaching at NAIT accredited institutions perceive National Occupational CADD Skill Standards important and relevant according to professional experience?

5. If there are any perceived differences on National Occupational CADD Skill Standards developed by NACFAM, what are the implications for: (1) NAIT CADD programs, (2) CADD skill competences of candidates graduating from NAIT accredited

institutions, and (3) employment opportunities for graduates from NAIT accredited institutions?

Research Hypotheses

The research hypotheses for this study were derived from supporting evidence elicited from an extensive review of the literature. The research questions derived from the review of literature were formulated into four hypotheses.

1. On the average, faculty teaching CADD skills at NAIT accredited institutions will view National Occupational CADD Skill Standards approved by NACFAM as relevant and important.

2. Respondents from different Industrial Technology programs teaching CADD at NAIT accredited institutions will show significant mean preferences on National Occupational CADD Skill Standards developed and approved by NACFAM.

3. Faculty teaching CADD at NAIT accredited institutions will rate National Occupational CADD Skill Standards as significantly different according to their own professional rank.

4. Faculty teaching different CADD courses at NAIT accredited institutions will rate National Occupational CADD Skill Standards as significantly different according to their own experience.

Assumptions

This research study is based on the following six assumptions.

1. It was assumed that faculty teaching CADD courses at NAIT accredited institutions are familiar with National Occupational CADD Skill Standards developed and approved by NACFAM.

2. It was assumed that the National Occupational CADD Skill Standards developed by NACFAM were published after extensive consultations with CADD experts from academic institutions, professional organizations, employers, CADD users, software/hardware developers, industry, and the government.

3. It was assumed that all NAIT accredited institutions operated within the same stipulated association guidelines and regulations when developing curricula for CADD courses in the various Industrial Technology programs.

4. It was assumed that there was uniformity in the adoption and practices of CADD skill standards among the different Industrial Technology programs offered by NAIT accredited institutions.

5. It was assumed that all instructors/professors surveyed were familiar with the NAIT requirements on CADD skill standards as well as the organization's goals to the industry.

6. It was assumed that all instructors/professors who participated in the survey were all CADD experts.

Delimitations

Three factors delimited this study.

1. This research was delimited to CADD skill standards adopted and practiced by NAIT accredited institutions in relation to National Occupational CADD Skill Standards.

2. This research was delimited to CADD instructors/professors teaching at NAIT accredited institutions listed in the 2002 NAIT Baccalaureate directory.

3. For the second null hypothesis, the research was delimited to the following popular four Industrial Technology programs offered at NAIT accredited institutions, and these are: Manufacturing, Industrial Technology, Construction, and Design/Graphics (NAIT, 2002b).

<div align="center">Definition of Terms</div>

The following terms are defined to clarify their specific use in the context of this research, and in the conduct of this study.

Accrediting bodies of professional societies--publish standards and requirements that academic and training institutions must meet in order for member institutions to be recognized as accredited.

Advanced manufacturing technology--manufacturing, production, or fabrication technologies characterized by extensive application of computer integration and automation of production processes (Goetsch, 1990).

ANOVA -- acronym for the analysis of variances.

ASPs'--acronym for application service providers; ASPs are applications that reside on the server of a software hosting company. Users rent the software either by running the design tools on a as-needed basis over the Internet or they can upload their files to an ASP server where translations and analysis are performed. ASPs services include CADD software rentals, file conversion, analysis and simulation services, Mechanical CADD (MCADD) design software, expert knowledge, design collaboration,

supply chain collaboration, interoperability, project and resource management and/or intellectual property management (Greco, 2001a, 2001b).

CADD --acronym for computer aided drafting and design; an automated method for producing engineering drawings; a representation of an object or system as an electronic system (Freedman, 1991); the end result of the CADD process is a depiction of an object as a digital image stored on magnetic or optical media and can be exported or imported to different manufacturing software packages.

CADD/CAM--acronym for computer aided design and computer aided manufacturing; use of computers for geometrical designs and numerical control (NC) program generation.

CADD skill standards--they are job related and industry specific; they identify the knowledge, skill and level of ability needed to perform a given job; standards can be tailored to any industry to reflect particular needs and economic requirements, and environments (FIM, 1994).

CNC--acronym for computer numerical control; usually used with reference to machine tools; a form of tooling using a computer package/software to control the motion and actions of a machine through the use of numerical values stored on medium such as computer disks, magnetic tape, or punched paper tape.

Competency--a learned performance which can be measured to specific determined standards, and is used as an instructional objective in the education and training process.

FEA--acronym for finite element analysis; a powerful analytical tool for solving engineering problems such as deformation and stress of solids, the transfer of heat, and the flow of fluids; engineers/designers use virtual models to evaluate system failures, operation conditions, and responses to loading, cracking, and buckling (Zhang, 1999).

FIM--acronym for Foundation for Industrial Modernization; an education, research, and service provider arm to NACFAM.

Integration--the linking of all parts of the manufacturing operations using CADD, CNC, CAM, computer communication and networking, and the sharing of other data-bases and documents that are electronically generated and maintained.

Industrial Technology--a field of study intended to prepare technical and/or management oriented professionals for employment in business, industry, education, and government; graduates from Industrial Technology programs are primarily involved in management, operations, and maintenance of complex technological systems while Engineering and Engineering Technology are primarily involved with design and installation of systems (NAIT, 2000).

Manual drafting--representation of design objects on paper, plastic film, or other media using traditional pencil-and-paper techniques; the final result of the manual drafting process is the depiction of the object on a physical medium such as paper, mylar film, or other non-electronic media.

NACFAM--acronym for National Coalition for Advanced Manufacturing; a 501(c)(3) non-partisan umbrella organization that seeks to revitalize America's industrial infrastructure in the interest of the nation's global economic competition; the production

of highly skilled workforce to meet these challenges, and the improvement of standards

of living and a cleaner living environment (NACFAM, 1994).

NAIT--an acronym for the National Association of Industrial Technology; a

professional organization that fosters the improvement of curricula of Industrial

Technology programs within institutions of higher education in the United States of

America (NAIT, 2001).

Product-design-cycle--the complete sequence of operations and activities

involved in the production of products from design inception to delivery of the finished

products to customers.

CHAPTER 2

REVIEW OF LITERATURE

The design environment continues to pose fascinating challenges to engineers,

technologist, designers and all involved in design processes. One of the many challenges

facing product design, processing, and manufacturing professionals occur when product

designs and/or process designs, and projects are moved from one Electronic Design

Automation (EDA) product/platform to another. This usually results in the loss of critical

data mainly due to differences in software formats, characteristics, and most importantly,

the discrepancies in software design developmental standards (Londonderry, 2001).

CADD technology has had a fair share of this problem. Another challenge is

brought about by unprecedented developments in CADD software and hardware products

and systems. This challenge creates problems in standardizing CADD design tools, and

also makes it difficult to determine basic user skills pre-requisites. Globalization has also

had a significant impact on CADD/CAM technology because of differences on

occupational skill standards practiced by different countries. It has become a big

challenge to standardize occupational CADD skill standards. Product designs and

manufacturing processes are now occurring across the globe on a 24-hour basis, 7 days a

week.

Manufacturing companies and corporations across the world are now able to

exchange design data on real time. One obvious advantage of this development is that

product development time cycles are cut significantly and ultimately reduce production

costs. This trend calls for standardized design and manufacturing techniques in,

particular the manufacturing construction industry. Developments in Computer

Integrated Manufacturing (CIM) technology continue to place enormous pressure on

academic professionals, institutions, designers and manufacturers to continuously renew,

review and update CADD standards.

The manufacturing and construction industry in the United States of America in

collaboration with educational institutions has since been working on a number of

projects aimed at addressing and developing basic but comprehensive CADD standards.

President Clinton's call for the development of tough world class academic and

occupational standards for all American children, students, academic institutions, and

industry led to an accelerated development of National Occupational Skill Standards in

many disciplines, including CADD (FIM, 1994).

Reacting to the call by President Clinton in 1994, the Foundation for Industrial

Modernization in the United States of America took over 36 months to develop National

Occupational Skill Standards for Computer Aided Drafting and Design. These standards

continue to be a base for developing specific CADD standards for particular engineering

fields and CADD programs at learning institutions.

<u>Computer Aided Drafting and Design Technology</u>

CADD packages are now extensively used in almost all engineering fields

(Bedworth, Henderson & Wolfe, 1991). Developments in computer technology,

especially, the ability of the computer to manipulate large amounts of information

involved in design processes have completely changed the art of drafting and design, with

the most outstanding benefit being improvements in productivity (Duelem, 1986).

CADD files or CADD databases can now be used as production tools to develop computer numerical control (CNC) machine codes, which are ultimately used to produce parts (Stewardson & Mann, 1994).

Pollard (1987) cited the following reasons for switching to CADD: speed, ease of editing, use of stored symbols, accuracy, less tediousness, and less manual skill requirements. Rodenstein (1985) complemented Pollard's list by adding the following benefits: easy modifications of designs, provision of more time to experiment with designs, CADD with 3-D enhancement cuts costs and time in model building, and the flexibility of CADD to create and combine drawing views on different layers. Rodenstein also suggested that a person using a CADD system is four to eight times faster and more efficient than a person using a traditional drafting machine. However, to achieve this level of efficiency there is a need to establish skills standards from which one can work from.

CADD technology can be split into two broad categories, 2D CADD and 3D CADD. The latter form of CADD is becoming popular with most manufacturing and construction industries. A survey conducted by Dataquest in 1996 revealed that 66% of CADD users in Europe were using 3D CADD as their main design method. The French were the biggest users of 3D CADD with 82%. The Germans ranked last with 47% in the use of 3D CADD, but were in the forefront in the use of 2D CADD (Hars, 1996).

Findings from the Dataquest study also showed that the economic stature and type of industry influence the use of 2D or 3D CADD technology in any country. For instance, most CADD users in German tend to use 2D software over 3D because of the

huge machinery-building industry (Hars, 1996). Designers find it easier to work with 2D CADD due to the complex design projects that are common in the Germany industry. In North America CADD investments are usually made on a project basis such as building a new plane or automobile and hence, the use of 3D CADD technology over 2D CADD (Hars, 1996).

Studies conducted in the United States of America show that design firms are increasingly turning to CADD. In a study conducted in 1991 in the USA by Computer Graphics World involving 150 architectural, engineering and construction firms showed that 93% of the respondents used some form of CADD on design work. The study by Computer Graphics World also revealed that 61% of the respondents accomplished 75 to 100% of their 2D drafting with a CADD system (Teichoilz, 1991). Twenty three percent of the survey respondents were already using 3D CADD for all of their design work. Most firms were seriously considering installing 3D CADD systems. This shift is attributed to the advanced impact on design and presentation activities available in 3D CADD technology (Teichoilz, 1991). They include 3D modeling and numerous rendering techniques.

The use of 2D or 3D CADD technology in any industry is dependent on many factors. Hars (1996) stated that, "The main difference in users worldwide is not so much relative to geography as it is to the type of product they're creating and the type of industry they're in" (p. 21).

Historical Developments in CADD Technology

In order to appreciate why we need CADD skill standards, how they are developed, and why there is need to constantly review the skills standards; a comprehensive understanding of the history of CADD technology is important. Developments in CADD software, internet technology, and computer hardware have a direct link to the CADD skill standards that are in use at any given time. The history of CADD technology is discussed in detail below.

Design and drafting technology go back as early as the medieval period. The coming of the Industrial Era resulted in the increase in use of a variety of drawing techniques relating to industrial development. Drafting and design history shows that, as early as the 1770s people like James Watt were already using sophisticated scale drawings as evidenced by the drawings of his famous revolutionary steam engines (Brown, 2000). Available notes and work of Leonardo da Vinci also show clear evidence of how old the drafting and design field is. Orthographic projection designed for representing a three-dimensional object by using two-dimensional graphical illustrations was invented by a French mathematician Gaspard Monge between 1746 and 1818 (Zeid, 1991). Formalization of working drawings allowed designers to communicate their thinking to the makers more effectively and efficiently.

Up to and until the mid 50s, drafting and design techniques were solely paper based and became commonly known as drafting. Drafting required the use of several specialized tools and media. They included paper, vellum, polyester film, pen, lead pencils, triangles, measuring scales, T-squares, templates, irregular curves, drafting

machines, erasers, parallel bars, compasses, and dividers (Boyer, Meyers, Croft, Miller, & Demel, 1991). Research has also shown that freehand sketching was and is still one of the most frequently used graphics skills even with the advent of computer graphics (Raudebaugh, 1996).

In manual drafting, the use of high quality instruments is always recommended in order to save time and to produce accurate drawings. The technique of using each tool must be thoroughly mastered to produce acceptable drawings (Spence, 1988). Manual drafting practices are still popular with small firms and educational institutions particularly in most developing countries. Most large firms and educational institutions in the developed world such as the United States of America, Japan and Europe are now totally computerized, from early design up to the final realization of projects (Kliment, 1990).

The roots of today's computer graphics technology go back to the mid-1950s when the United States of America Air Force's semi-automatic ground environment project (code-named SAGE) was launched. Increasing security concerns over the Soviet Union after the Korean War compelled the United States of America Air Force to launch this project. The SAGE project resulted in the development of important computer technologies, which included the invention of high-performance computers, large magnetic core memories and computer graphics (Weisberg, 2000). The Massachusetts Institute of Technology's (MIT) Lincoln laboratories were instrumental for most of these discoveries. The Lincoln Lab developed one of the most powerful computers in the world at that time, the TX-2. Ivan Sutherland, a MIT Ph.D. student in 1960 decided to do

his thesis on the application of computer graphics to engineering. His project called "The Sketchpad" published in 1962 is credited by many historians and experts in technology and design as the beginning of CADD technology (Weisberg, 2000).

The Sketchpad Project demonstrated that it was possible to create drawings and make alterations of objects interactively on a cathode ray tube (CRT). During the same period, ITEK Corporation and another joint venture between General Motors (GM) and IBM were involved in the development of two other computer graphics projects. In 1964 GM announced their DAC-1 (design augmented by computers) system. Out of this project came many advances in computer timesharing technology, which is the use of a single processor by two or more terminals. In 1965 Lockheed Aircraft and Bell Telephone Laboratories introduced CADDAM and GRAPHIC 1 systems respectively (Weisberg, 2000; Zeid, 1991).

In the late 1960s several computer graphics developers, which included Calma, Applicon, and Computervision, began selling "turnkey" computer drafting systems. These graphic systems were complete computer packages where the hardware and the software were specifically designed to work together. Nonetheless one could not run another vendor's CADD system on the same computer system (Duelem, 1989). A few of these computer systems were capable of advanced work such as solid modeling but most were designed to carry out simple two-dimensional drafting tasks similar to manual drafting.

The typical system consisted of a 16-bit minicomputer with 8 kilobytes to 16kB of main memory and a disk system capable of holding 2.5 megabytes to 10MB of data.

The interface was a custom designed 11-inch storage tube display. However, by the end of the 70s the main memory size had increased to 128kB-512kB even though the turnkey systems remained 16-bit microcomputers. Most systems had one to four user stations and sold for $100,000 to $600,000 (Weisberg, 2000).

The research efforts in computer graphics of the 1960s began to yield important and significant results in the 70s. Interactive computer graphics improved productivity in industry, the government, and educational and training institutions (Zeid, 1991). There was tremendous development in hardware technology, which included the design of miniature circuits, less expensive and clearer displays, and networking. The use of miniature circuits considerably lessened the size and significantly reduced the cost of the computer. Miniature circuits also increased the speed and power of computers and this gave way to smaller minicomputers for running CADD systems. Software developers also designed various innovations and ingenious programs (Duelem, 1986). The software developers specialized in CADD programs only, leaving the computer companies to produce computer hardware. These software developers wrote programs, which could be run on different computers. This allowed any company, which had any computer system to add CADD workstations.

Another important development in the late 70s was the initiation of the IGES standard (Initial Graphics Exchange Specification) by the National Bureau of Standards in 1979. The purpose of the IGES standards was to specify a common way through which computers interpret and present graphical images. This made it possible for different CADD programs to exchange drawing data (Duelem, 1989; Zeid, 1991). The

IGES did a good job in transmitting two-dimensional drawings (Baumgartner, 1998). Networking also became popular in the 70s and this enabled several designers to use the same computer and software at the same time. For the first time, different departments within a manufacturing company could access and share design data from the same computer database resulting in efficiency, speed, quality work and rapid modifications of design projects.

Most advances in CADD technology occurred in the 1980s. Smaller computers came into being, better displays were developed, and a wide range of input devices came into existence. The most important achievement was the development of the microcomputer commonly known as the personal computer (PC; Duelem, 1989). IBM introduced its first PC in 1981. The introduction of this PC created a tidal wave of change, which ultimately changed the entire CADD industry. Although this Intel microprocessor based PC had limited memory, it could run CADD programs. The PC sold for $6,000 (Weisberg, 2000). The PC CADD bridged the gap between industry and education as a result of the significantly reduced costs for the PCs. The new low cost PC CADD systems could perform like the larger and more expensive systems (Duelem, 1989). Software developers also began writing programs which ran on low cost PCs.

One of the most significant software developments during the late 1980s was the ability to integrate solid modeling into the design software. Most high-end systems developed in the early 80s had fairly comprehensive 3-D wire-frame capabilities and reasonable surface geometry. Further developments in the late 80s led to the introduction of parametrically driven solid models. Parametric Technology Corporation introduced

one of the earliest parametric software, Pro/Engineer, in 1988 (Weisberg, 2000).

Parametric programs resulted in drawings becoming by-products of the entire design

process. During the same period there were remarkable developments in Finite Element

Analysis (FEA) software packages to work alongside with parametric modeling

packages. The 1980s also experienced an extensive development in the use of on screen-

menus and numerical control programs (Weisberg, 2000).

By the mid 80s an advanced software translator for different CADD and

computer-aided manufacturing (CAM) programs, The Standard for the Exchange of

Product Data (STEP) was developed by STEP Tools in Troy, New York. STEP enabled

complete product data to be transmitted digitally and made information available on

many different platforms throughout the entire engineering process, from design to

manufacturing. STEP simplified the integration of diverse engineering systems. This

technology made it easier for engineers and designers to assemble large and complex

product models using component models created in different CADD programs

(Baumgartner, 1998).

One major development in the 90s was the demise of the turnkey system vendor

and the emergence of the "task-specific" or "point solution" software and hardware

vendors (Weisberg, 2000). There was also an escalation in the development of key

software products which ran on most of the available workstations as well as PCs.

Several software companies began offering to large CADD companies, such as

AutoDesk, everything from simple symbol libraries to complex and sophisticated

mechanical and electronic analysis programs. The advent of the Internet added a

different dimension to CADD technology, which apparently is still expanding and developing. In the late 1990s, SOLIDWORKS introduced a new type of compressed electronic drawing file, "e-Drawing". This electronic file allowed users to create, view, send and receive mechanical design drawings via the e-mail (Tyrka, 2000). The 21st century is likely to see an escalation of CADD technology over the Internet. Next solid modeling packages may run primarily on a Web based server (Grayson, 2000).

There is need to review and relate the implications of these developments to drafting and design education constantly. An important concern with most educational and training institutions has been the costs involved in acquiring resources and adapting to this rapidly changing technology. An encouraging development related to this issue has been the significant decrease in prices for computer hardware and software (Babcock, 1998). Educational institutions could now integrate CADD technology into the learning system. This development has managed to drastically narrow the gap in technology between industry and educational institutions. Colleges and universities were now able to offer a larger variety of technical and engineering courses/occupational skills that were more relevant to the industry.

Educators and trainers need to recognize that there are numerous CADD software packages used in industry hence there is a need to expose students to several software packages available on the market. Each new CADD software package comes with new design features. This fact makes it necessary to continuously review and update CADD skill standards among other changes to CADD curricula in colleges. Teaching of CADD skills is aimed at acquainting students with effective utilization of computers so as to

enhance the quality and efficiency of the problem-solving process, not to prepare mere CADD workstation operators (Raudebaugh, 1996). With this in mind, educators/trainers have to continuously keep trek with changes in design technology and manufacturing processes alongside new CADD technologies available at any given time. This obviously means occupational CADD skill standards need to be reviewed constantly so that CADD users are able to adjust to meet these new demands. Industrial Technology Education should be able to prepare the students for the future rather than being retrogressive. It is imperative to note that the information and resources necessary to obtain the essential and contemporary graphic skills associated with design are available on a variety of media (Raudebaugh, 1996). The challenge for educators/trainers is to be able to research, identify tools, and come-up with present-day methodologies necessary to improve occupational CADD skills as they prepare students for employment.

The education system must acquaint students with 3-D solid modeling technology as this has become the practice with most design fields (Raudebaugh, 1996). Students should leave class with a complete and comprehensive understanding of the solid geometry theory and application if they are to function meaningfully and effectively in the 21st century (Rannels, 1998).

Educational institutions should be able to take advantage of the developments in CADD technology over the Internet. Such developments should bring about substantial gains to schools, colleges and universities. Apart from reducing costs, educational institutions are able to share and exchange files over the Internet (Grayson, 2000). Entire automobiles, airplanes and jet engines are now being built on an integrated manner

through the use of sophisticated web-based communication methods. Industry is now using the Internet to exchange and share data among engineering design teams located in different parts of the world using complicated up/down-loading platforms. Complete design components and systems models can be moved from one location to the next through these new innovations. Consequently, CADD instructors are challenged to impart these new forms of technology into their programs so that students graduating from the school system are equipped with enough skills to function effectively in this web-based economy (Weisberg, 2000).

The big challenge is how to keep educators and trainers abreast with the rapidly changing technology if meaningful learning is to take place. CADD technology programs in the education system must constantly be mindful of the changes occurring in this highly competitive manufacturing world at all times. Any technological changes have direct impact on occupational skill standards in all fields among other things.

Developments in Application Service Provider Technology in CADD/CAM

As the design environment continues to change, engineers, designers and other CADD/CAM users are constantly confronted with new technologies at an unprecedented rate. One such area that is growing fast is the concept of application service provider technology (ASP). As designers and engineers exchange design data on a 24-hour basis across the globe they risk loosing some design data as they move from one electronic design automation (EDA) product/platform to another. This is due to differences in software formats, characteristics, and most importantly, the discrepancies in software design developmental standards (Londonderry, 2001). One way around this problem has

been for companies to purchase most of the integration tools from the same vendor in an attempt to preserve a uniform design environment. While this approach attempts to solve design integration problems, it tends to restrict users from using the best tools for each design stage on a product, and cost bargaining for the best EDA. The second approach has been the development of internal, custom-made interfaces based on some loosely defined standards, which include intermediate file formats, electronic data interface and many others (Londonderry, 2001). This has led to the development of translators. The automotive industry alone spends over $1 billion in data translation tools and services alone annually (Day, 2001). However, the drawback with this approach is the ability to switch back and forth between different software packages in product design. If not handled properly, the translation process creates "dump solids", which in most cases does not allow modifications of original features once the translation process has occurred (Silbert, 2002). Translators usually provide unidirectional movement of data and do not provide a path to the original tool (Londonderry, 2001). This is certainly a problem for engineers and designers particularly when working on design modifications.

The advent of the Internet has spawned many new innovative cutting-edge ways of data distribution and exchange. As a result, the CADD/CAM industry and education sectors among others are experiencing a robust technological development phase in CADD-related products and services. The pressure is on users to keep abreast with this development. There were over 10,000 CADD-related web sites by 2001 (Duggal, 2000). The figure given above on the number of CADD-related web sites available to CADD users posses challenges in regard to keeping track of reputable ASP providers to invest

in. The objective of using ASP technology is efficiency, cutting costs, and to reduce the

product development cycle. Issues of confidentiality, property privacy, and security of

design data have to be considered seriously when selecting ASPs. The results of a survey

conducted by Design News (2001), whose respondents were engineers and designers in

the United States working for large manufacturing and construction firms, showed that

82% were using the Internet for research work. A significant finding of the Design News

study is that 74% of the respondents agreed Internet facilities and services shortened

design life cycles (Porter, 2001).

Developments in CADD/CAM Application Service Providers (ASPs) technology

have been viewed by many as a long-term economic solution to cutting time in product-

development-cycle, particularly to design integration processes. The product

development lead-time has been cut tremendously in most large manufacturing and

construction enterprises as a result of ASP technology. The growth of this technology

can also be determined in terms of investment and a scrutiny of who is making the

investment. Results from the Design News survey also showed that 17% of design

engineers in the USA were involved in some form of on-line collaboration with CADD

software suppliers. This clearly demonstrates the emergence and growth of ASP

technology.

Between 1998 and 2000, over US$450 million was invested in construction-

related dot-coms alone (Dalton, 2000; CADD Systems, 2000). The 2001 Design News

survey revealed that there was a remarkable percentage increase in downloading of

CADD files from suppliers' sites via the Internet between 2000 and 2001. The survey

results indicated that in 2000, 25% of engineers surveyed were downloading CADD files

from various supplier sites compared to 38% in 2001 (Porter, 2001).

Application Service Providers Technology Tools

It is easier to describe the concept of ASP by reviewing and discussing some of

the major applications. ASPs are applications that reside on the server of a software

hosting company. Users rent the software either by running the design tools on as-

needed basis over the Internet or they can upload their files to the ASP server where

translations and analysis are performed. ASP's services include CADD software rentals,

file conversion, analysis and simulation services, mechanical CADD (MCADD) design

software, expert knowledge, design collaboration, supply chain collaboration,

interoperability, project and resource management, and intellectual property management

(Greco, 2001a, 2001b).

Although the price of CADD software has declined reasonably over the years,

upgrading and license renewals continue to be costly for most investors. Prices for the

traditional boxed CADD software can cost as much as $10,000 per license seat for

commercial users (Digitizing, 2005). ASPs enable users to rent CADD software for as

little as $7.95 a day, $100-$300 a month or special rental arrangements can be made

between the ASP suppliers (Greco, 2001b). Educational institutions are able to rent

software on a semester basis thereby cutting cost considerably. In situations where the

need for CADD software is limited, it is logical to rent. Rentals also provide the user with

flexibility to choose the best software for the design needs at much lower costs.

A big challenge to ASP technology is the inherent differences in CADD "native" and "neutral" file formats and this tends to create problems whenever design data is moved from one platform to another as is the case with most design integration steps and processes (Day, 2001). The non-exhaustive list of CADD file formats include some of the following: IGES, STEP, PRT, CATIA, STL, DXF/DWG, VRML, VDA-FS HPHL, PRT, CGM, SAT, ACIS, CADDS, ECADD, INT, NEUTRAL, PARASOLID, VRML, I-DEA, Unigraphics, and ZGL among others (Greco, 2001b). Typically, the targeted tool recognizes only 60 to 70 percent of data whenever CADD design data is exchanged. The rest of the CADD data is lost. The target tool selects data that are familiar to its environment (Londonderry, 2001). Manual repairs may be necessary to restore the design to its prior state. A number of ASPs dot-coms also offer services that help repair or "heal" design files whenever a file conversion occurs in instances were data is lost.

Closely related to concept of file formats is CADD software interoperability technology. This technology enables the automatic transfer of a model's design features, history, and geometry from one CADD application to another (Tyrka, 2002). Glover (1998) described interoperability as the ability to mix CADD design tools from different vendors within a single design. Interoperability is dependent on CADD systems using the same kernel. It is easy to achieve some level of interoperability between CADD systems, which have the same kernel such as Parasolid, ACIS, or Granite. Interoperability is almost impossible with CADD systems that are widely different, such as CATIA and Unigraphics. To achieve interoperability between systems with different modeling kernels translation will have to take place (Wedrychowsky, 2001).

Collaboration technology is based on concurrent engineering practices where different product design and developmental activities towards a common goal are accomplished by diverse groups of people without geographical or organizational boundaries using web-based technologies (Rowe, 2000). Collaboration involves working together to create a shared understanding of an intellectual endeavor through consensus. Information is exchanged between different parties in real time. The Web provides an excellent medium for collaboration. ASP collaboration enables for instance, a team of engineers in different locations to fully communicate, edit, and modify a design on-line in a real-time environment (Rowe, 2000). Several ASPs offer collaboration service to as many as 200 native and neutral CADD/CAM file formats (Greco, 2001c). It is common for a concept developed in the US to be designed in Asia, prototyped in Eastern Europe and manufactured in Western Europe or South America, all within a 24-hour development collaboration process.

ASPs provide tools for engineering analysis and simulation. These tools allow users to perform finite element analysis (FEA), thermal analysis, computational fluid dynamics, and run motion simulations based on real-world physical problems involving force, mass, gravity, and acceleration among others (Greco, 2001a, 2001b).

Project and resource ASP tools provide online project and document-management applications. Included in this package are programs for task scheduling, complete with Gantt charts, team calendars, and timesheets. Intellectual management tools enable the management and movement of documents in a secure and speedy manner beyond the firewalls of corporations (Greco, 2001b). The technology is based on compression and

encryption of client files. Files are transferred or delivered to various parties involved in the design and manufacturing process at the request of the client.

<div align="center">National CADD Skill Standards</div>

The National Coalition for Advanced Manufacturing (NACFAM) through FIM together with help from over 50 industrial, business, labor, education organizations, and hundreds of CADD users developed the CADD Skills Standards (NACFAM, 1996; FIM, 1994). The purpose of this project was to produce a skill standard document that represents skills that are core to all CADD disciplines and generic to all software and occupational CADD skills entry levels (NACFAM, 1996). Standardization of CADD skills allows users to access, interpret, and disseminate information rapidly in a uniform and universal manner (Harry, 2001).

The $2.5 million National Occupational Skill Standards project for CADD (funded by a federal grant from the Department of Education and with capital injection from the industrial sector) was launched in 1992 (NACFAM, 1996). An extensive conclusive report on the project was published in 1996 with the first draft of the National Occupational CADD Skill Standards published in 1994. The principal functions of FIM are to foster revitalization of America's industrial structure to fight off challenges from the ever-increasing global economic competition, produce highly skilled workers, improve the standard of living for all Americans, and create a cleaner living environment for all (NACFAM, 1994). Major challenges that faced the FIM participants on the National Occupational CADD Skill Standards project included the rapid changes and developments in CADD technologies, existence of many different software/hardware,

and working with a diversified team of CADD users coming from varying industrial/manufacturing and educational disciplines.

The Foundation for Industrial Modernization Executive Committee in collaboration with a Technical Committee selected from CADD experts from industry and educational organizations were responsible for bringing together the CADD community to a consensus on CADD skills that are basic and core to all CADD users. For the first time senior executives from major software developers deliberated and agreed on the project policy issues (FIM, 1994). At the end, a comprehensive generic list of core CADD skills was produced by industry experts and verified by the CADD community.

Finally, the CADD Skills identification project report covered a variety of issues that included a definition of a CADD Skills Set, identification of fundamental drafting and computer skills, pre-requisite related academic skills, and acknowledgements of all participants. The National Occupational CADD Skill Standards document also stipulated pre-requisite related academic skills which are pertinent to each skills standard item. The pre-requisite academic skills that are pertinent to the National Occupational CADD Skill Standards are: 1. Communication Skills (C); 2. Math Skills (M); and 3. Science Skills (S). Another interesting aspect which the project team undertook was creating supplementary listings of recommendations on required employability skills, fundamental tools and equipment for CADD training, proposals on minimum training hours, qualifications for CADD instruction, and expected measurable skills (FIM, 1994). After going through a thorough and exhaustive verification process by a large and diversified

group from the CADD users, the National Occupational Skill Standards for Computer Aided Drafting and Design document was published in April, 1994 (NACFAM, 1996).

The National Occupational CADD Skill Standards document covers four major categories: (a) Fundamental Drafting Skills, (b) Fundamental Computer Skills, (c) Basic CADD Skills, and (d) Advanced CADD Skills. The Fundamental Drafting Skills Standards area covers four topics: Drafting Skills, Orthographic Projections, Pictorial Drawings, and Dimensioning. Fundamental Computer Skills Standards are meant to check on basic computer hardware and operating systems knowledge and necessary competencies. National Occupational CADD Skill Standards in this category also cover physical and safety needs for CADD users with regards to computer usage. The Basic CADD Skills Standards category is made up of the following standards: 1. Create, 2. Edit, 3. Manipulate, 4. Analyze, and 5. Dimensioning, as basic and necessary competencies to be developed by any would-be CADD user. The last group of standards, Advanced CADD Skills, is an extension of the Basic CADD Skills Standards group with productivity and work habits standards added (NACFAM, 1994).

In the CADD Skills Standards document, each standard is given a number, the identification of the skill necessary to develop the standard, the objective for learning that standard, an evaluation criterion, and finally a very concise description of that particular standard (NACFAM, 1999). The latest revised version of the CADD Skills Standards was published in 1999. A complete report copy of the National Occupational Skill Standards for Computer Aided Drafting and Design Project can be found in Appendix A.

<u>National Association of Industrial Technology</u>

As discussed before, the National Association of Industrial Technology (NAIT) is

a professional organization established and incorporated under the laws of the State of

Ohio pursuant to the Articles of Incorporation filed on March 17, 1977 (NAIT, 2001).

The relevance of this discussion is to put into perspective the function of NAIT. NAIT is

recognized as a professional body that seeks to:

- Promote Industrial Technology in business, industry, education, and government;

- Accredit Industrial Technology programs in colleges, universities, and technical

  institutes; and

- Certify Industrial Technologists and recognize continued professional

  development (NAIT, 2000).

NAIT defines Industrial Technology as a field designed to prepare technical

and/or management oriented professionals who are employable in business, industry,

education and government. NAIT further on classifies Industrial Technology as a

profession that is primarily involved with the management, operation, and maintenance

of complex technological systems/designs while Engineering and Engineering

Technology exclusively deal with design and installation of systems/designs (NAIT,

2000).

As of 2002, the organization had a membership of over sixty-six NAIT accredited

institutions offering Associate/Baccalaureate degree programs (NAIT, 2002a).

There are numerous Industrial Technology programs offered at NAIT accredited institutions. A demographic survey conducted by NAIT in 2002 established the following list of Industrial Technology programs offered at NAIT accredited institutions:

- Manufacturing;

- Electronics;

- Construction;

- Design/Graphics;

- Computer Integrated Manufacturing;

- Computer Technology;

- Industrial Technology;

- Aerospace;

- Industrial Management;

- Occupational Safety;

- Production Planning/Control;

- Packaging-Automotive;

- Digital Communication;

- Printing Management;

- Quality Control-Plastics;

- Instrumentation;

- Bio-Medical;

- Fashion and Graphics Arts;

- Telecommunication;

- Technology Management;

- Facilities Management; and

- Aviation Management (NAIT, 2002a).

Interestingly, an informal scrutiny of IT programs offered at NAIT accredited institutions shows that CADD courses are in most cases prerequisites to overall curriculum requirements. On-line search reviews of different syllabi on CADD courses offered at various NAIT accredited institutions show that CADD hardware/software packages options vary from program to program as well as among institutions. This fact is likely to pose challenges on standardizing occupational CADD skills.

CHAPTER 3

METHODOLODY

This research was a descriptive study whose aim was to establish perceived differences on the importance of National Occupational CADD Skill Standards developed by NACFAM among faculty at NAIT accredited institutions. The necessary opinion data regarding perceived positions held by respondents on National Occupational CADD Skill Standards drafted by NACFAM were obtained through the use of a web-based survey instrument developed by the researcher. These data were subjected to appropriate statistical analyses. Survey research allows collection of data in order to determine specific characteristics of a group (Fraenkel & Wallen, 2000).

The Population and the Sample of the Study

The target population consisted of experienced CADD professors/instructors from NAIT accredited institutions listed in the NAIT Baccalaureate Program Directory, 2002. These professors/instructors (units of analysis) teach various CADD courses in over 25 Industrial Technology programs offered at NAIT accredited institutions. A total sample of 172 CADD professors/instructors was selected from the list provided by the NAIT Baccalaureate Program Directory (NAIT, 2002a). The units of analysis are all CADD experts as evidenced by information provided in the NAIT Baccalaureate Program Directory, 2002. The review of literature provides concise details of Industrial Technology programs offered by NAIT accredited institutions. A complete and comprehensive list of NAIT accredited programs is available on the NAIT website (www.nait.org). Results from this study may not reflect the opinions of respondents who

were not selected to be part of this survey. However, the outcome of this study will help

to describe CADD skill standards expected from graduates from NAIT accredited

institutions.

<div align="center">Development of the Research Instrument</div>

The primary source of the research instrument was developed from the National

Occupational CADD Skill Standards document published in 1999. The instrument

consisted of five parts. Part I sought to evaluate the demographic data of the units of

analysis. Part II was meant to measure the relevance of Fundamental Drafting skills in

NAIT accredited institutions. Part III of the instrument was supposed to evaluate

Fundamental Computer skills. Basic CADD skills were to be evaluated in the Part IV of

the instrument. Finally, Part V of the instrument sought to evaluate Advanced CADD

skills. The respondents were expected to voluntarily take perceived positions on the

importance of National Occupational CADD Skill Standards drafted by NACFAM (see

Appendix C). A Likert-type scale instrument with five alternative choices was used in

parts II, III, IV and V of the research instrument. The scale used was: 1 (strongly

disagree); 2 (disagree); 3 (neither disagree nor agree); 4 (agree); and 5 (strongly agree).

The big advantage of using a survey research instrument is its ability to provide the

researcher with a lot of information on a large sample of individuals (Stephen & William,

1972; Fraenkel & Wallen, 2000). The survey instrument used in this study was designed

as web pages and posted on a web site provided by the University of Northern Iowa

(http://www.psych.uni.edu/research/CADD/). The NAIT Baccalaureate Program

Directory, 2002 did not provide physical addresses or phone numbers of NAIT

instructors at the time of this study. The only contact information on respondents provided by the 2000 NAIT directory was individuals' email addresses, thus it was logical to email the survey instrument to selected respondents.

Participants were required to click on coded radio buttons or check boxes provided next to the survey items when making choices on survey items. At the end of each part, respondents were required to click on a coded submit button for them to proceed to subsequent parts. This was done so as to maximize data capture in the event some respondents decide to discontinue completing the survey or due to unexpected computer glitches during the completion of the survey instrument. Completion of the survey instrument was expected to take 10-15 minutes.

Instrument Validation and Pilot Testing

The quality of instruments used in any research study is extremely important since conclusions and recommendations are drawn from the various sets of data derived from the research instruments. Validity and reliability are key factors that determine the quality of a good research instrument. Validity is concerned with drawing correct conclusions based on the data obtained from research assessments (Fraenkel & Wallen, 2000). An instrument is deemed valid when it measures what it is meant to measure and is specific to the particular purpose for which the instrument is used (Ary, Jacobs & Razavieh, 2000). Reliability is about consistency of scores obtained from individual scores of sample subjects from one administration of the instrument to another. Good reliability in an instrument can be likened to a darts player whose aim on the bulls-eye on the dart board is always on target. A reliable instrument is supposed to yield the same

results (or at least close results) regardless of different administration environments. On one hand, an unreliable research instrument can be compared to a darts-player whose attempts on the bulls-eye are found all over the dart board, missing the bulls-eye most of the time (Fraenkel & Wallen, 2000).

The validity and reliability of the research instrument for this study was verified by CADD experts and classroom practitioners at the University of Northern Iowa. The research instrument was sent to Drs'. Giesse, Kashef, O'Meara, Salim, and Pramanik. These five CADD experts teach various Industrial Technology courses at the University of Northern Iowa (UNI) and they have vast industrial experience in manufacturing and construction. The University of Northern Iowa is a NAIT accredited institution. Drs'. Giesse, Kashef, O'Meara, Salim, and Pramanik were tasked to evaluate the content of the questionnaire, conciseness, comment on clearness and appropriateness of instrument items. The same group of CADD experts was used for a pilot test. The major purpose of the pilot test was to determine the average time it would take to complete the questionnaire. Results and recommendations from the pilot test were used to adjust and make necessary corrections to the questionnaire before it was sent to respondents.

Data Collection and Statistical Analyses Methodology

A single web-based survey instrument developed by the researcher with assistance from webpage design experts was used to collect all research data. A cover letter requesting respondents to participate in the survey with the webpage link for the survey instrument (http://www.psych.uni.edu/research/CADD/) was emailed to faculty at NAIT accredited institutions. The cover letter explained the purpose of the study and also provided information on how to complete the survey instrument (each web page forwarded the results back to the sender). Contact information as well as faculty's area of specialization for each respondent was obtained from the NAIT Baccalaureate Program Directory, 2002. A total of 172 faculty members teaching various CADD courses in different Industrial Technology programs at NAIT accredited institutions were each emailed the cover letter containing the survey instrument link page. The survey instrument included the Human Participants Review Informed Consent form at the top of the web page (see Appendix B).

The data-collection method adopted in this study was intended to encourage a high response rate and also to significantly reduce logistical costs. Mailing the survey instrument would have proved too costly considering the number of participants involved as well as follow-ups. A follow-up email was sent to participants requesting they respond to the earlier mail containing the survey instrument. The follow-up email also contained the survey instrument link page.

Survey data was instantly sent back to the researcher's web linked data base upon the completion of each section of the survey instrument. To ensure that respondents

remained anonymous, random identification numbers were assigned to each individual

the moment they accessed the survey link page and had agreed to participate. Internet

Service Provider (ISP) numbers and time recordings were used to verify that each

respondent participated only once. A program to parse the web-based survey results was

created to write as a table delimited file capable of opening in the SPSS software

package. This made handling of survey results much easier. A total of 61 respondents

participated in this study and all responses were used in analyzing the data for the study.

CHAPTER 4

ANALYSIS OF DATA

Results of statistical analyses of data collected from a sample of 61 CADD

instructors teaching at NAIT accredited institutions are presented in this chapter.

Analyses of data relevant to hypotheses derived from the research questions are presented

in table form together with descriptions as well as discussions where possible. Four

hypotheses were analyzed and a summary of the implications of the results for CADD

skills standards is provided. All data analyses were computed using the SPSS software

package. Simultaneous statistical tests as well as different variable combinations from

one source of data were easily computed and analyzed using the software.

For hypothesis I, single-sample t-tests were conducted on each of the 94 items

representing the CADD skill standards developed by NACFAM. The means for each

item from the 61 respondents were computed independently using a test value, $\mu=3$ in

order to retain or reject H_0, with alpha set at .05. The t statistic is used for hypothesis

testing when the population standard deviation is unknown. In this study the population

standard deviation was unknown; hence the sample standard deviation was used to test

H_0 (Gravetter & Wallnau, 2002).

For hypothesis II, Analysis of Variance was used to analyze the perceptions of

the four Industrial Technology programs by faculty from NAIT accredited institutions on

NACFAM CADD skill standards. The Industrial Technology programs analyzed were:

Manufacturing, Design Graphics, Construction, and Industrial Technology. Analysis of

variance is a statistical procedure that is used to evaluate mean differences between two

or more treatments or populations. With the ANOVA we are able to establish whether there were real differences between the populations or treatment. Nonsignificant results indicate any observed differences between groups are simply due to chance. Alternatively, the ANOVA should establish that the populations being evaluated really do appear to have different means (Gravetter & Wallnau, 2002).

As for hypothesis III, the ANOVA was used to analyze the faculty perceptions on NACFAM CADD skill standards according to professional rank. Five professional ranking groups were evaluated. The five professional ranks used were: 1. Lecturer; 2. Instructor; 3. Assistant Professor; 4. Associate Professor; and 5. Professor. Again, this statistical test evaluated the mean differences between the five professional groups at NAIT accredited institutions.

The last hypothesis was also tested using the ANOVA. The ANOVA was used to analyze the faculty perceptions on National Occupational CADD Skill Standards according to CADD teaching experience. Faculty teaching CADD at NAIT accredited institutions were placed into five groups, each representing CADD teaching experience. The five groups were: (1) 0-1 years, (2) 2-3 years, (3) 4-5 years, (4) 6-7 years, and (5) 8+ years. The researcher's intention was to establish perceived mean differences between these experience groups.

Results for Hypothesis I: On the Average, Faculty Teaching CADD Skills at NAIT Accredited Institutions will View National Occupational CADD Skill Standards Approved by NACFAM as Relevant and Important.

This portion of the research study represents statistical analysis of hypothesis 1: On the average, faculty teaching CADD skills at NAIT accredited institutions will view

National Occupational CADD Skill Standards approved by NACFAM as relevant and important. This was tested by computing the mean score on each item and then carrying out a single-sample t-test; (for test value $\mu=3$). Individual items were coded (e.g. SEC2A7). The code for this item, SEC2 represented the second category of CADD skill standards prescribed by NAIT (Fundamental Computer Skills). The letter A represented the sub-section within category 2, and the number 7 represented the actual item. CADD skill standards prescribed by NACFAM are split into four categories; Fundamental Drafting skills (SEC1), Fundamental Computer Skills (SEC2), (Basic CADD Skills (SEC3), and Advanced CADD Skills (SEC4).

The mean of all respondents was compared to the National Occupational CADD Skill Standards mean ($\mu=3$) for each CADD skill standard item using a two-tailed t-test at the .05 level of significance. If the results of the t-tests failed to establish a statistically significant difference between National Occupational CADD Skill Standards mean ($\mu=3$) and the mean from faculty teaching at NAIT accredited institutions for each item at the .05 level of significance, then the null hypothesis was retained.

Retention of the null hypothesis was taken as indicating that there was no agreement on average by faculty teaching CADD skills at NAIT accredited institutions on the importance and relevance of National Occupational CADD Skills standards prescribed by NACFAM. In these cases, there may be no need to review or change CADD skill standards taught at NAIT accredited institutions since they may be similar to National Occupational CADD Skill Standards prescribed by NACFAM.

On the other hand, rejection of the null hypothesis at the .05 level of significance was interpreted as indicating that the alternative hypothesis ought to be accepted. This result was taken to mean that there was a statistically significant difference between CADD skill standards prescribed by NACFAM and those taught at NAIT accredited institutions. Therefore, there was a need to review and include or not to include the individual National Occupational CADD Skill Standards tested to CADD courses taught at NAIT accredited institutions so as to meet the industry's requirements on occupational CADD skills.

Single sample t-tests were conducted on each of the 94 items representing the CADD skill standards prescribed by NACFAM. The means for each item from a sample of 61 respondents were computed independently using a test value, $\mu=3$, in order to retain or reject the null hypothesis. For convenience and coherence, the results of the t-tests are presented in tabular format. Results of the sample statistics and the t-test for each item are reported in Table 1. The means for each item ranged from moderate agreement to agree as shown in Table 1. The statistical t-test results presented in Table 1 indicate that none of the 94 items representing National Occupational CADD Skill Standards reported significant differences with those practiced by faculty teaching at NAIT accredited institutions hence, the null hypothesis (H_o) was retained in all cases. The results can be interpreted as meaning that faculty teaching CADD skill standards at NAIT accredited institutions conform to National Occupational CADD Skill Standards stipulations. As discussed further in Chapter 5, failure to reject the null hypothesis did not necessarily mean that there were no perceived differences on National Occupational CADD Skill

Standards by faculty teaching at NAIT accredited institution. The low response rate in this study may have contributed to the outcome of these results.

Table 1

NACFAM CADD Skill Standards—NAIT Faculty Perception: One-sample t-Test

Survey Item	μ_{NACFAM}	$\mu_{faculty}$	SD	t	p	H$_o$
SEC1A1	3.0000	3.8361	3.4889	1.872	.066	Ret
SEC1A2	3.0000	3.7377	3.4443	1.673	.100	Ret
SEC1A3	3.0000	3.8525	3.4585	1.925	.059	Ret
SEC1A4	3.0000	3.3115	3.3889	.718	.476	Ret
SEC1A5	3.0000	3.6393	3.4401	1.452	.152	Ret
SEC1A6	3.0000	2.9672	3.3861	-.076	.940	Ret
SEC1A7	3.0000	3.4426	3.4473	1.003	.320	Ret
SEC1A8	3.0000	3.7541	3.4528	1.706	.093	Ret
SEC1B1	3.0000	3.3934	3.4989	.878	.383	Ret
SEC1B2	3.0000	3.3443	3.4004	.791	.432	Ret
SEC1B3	3.0000	3.1803	3.4035	.414	.680	Ret
SEC1C1	3.0000	3.1803	3.4230	.411	.682	Ret
SEC1C2	3.0000	3.1148	3.4598	.259	.796	Ret
SEC1C3	3.0000	3.7869	3.4598	1.776	.081	Ret
SEC1D1	3.0000	3.6721	3.4472	1.510	.136	Ret

table continues

Survey Item	μNACFAM	μfaculty	SD	t	p	Ho
SEC1D2	3.0000	3.6885	3.4474	1.560	.124	Ret
SEC1D3	3.0000	3.6721	3.4386	1.527	.132	Ret
SEC1D4	3.0000	3.2295	3.4804	.515	.608	Ret
SEC1D5	3.0000	3.2623	3.4443	.595	.554	Ret
SEC1D6	3.0000	3.2131	3.3819	.492	.624	Ret
SEC1D7	3.0000	3.3934	3.4023	.903	.370	Ret
SEC1D8	3.0000	3.1803	3.3641	.419	.677	Ret
SEC1D9	3.0000	3.4262	3.4470	.966	.338	Ret
SEC1D10	3.0000	3.1475	3.3953	.339	.735	Ret
SEC2A1	3.0000	3.3279	3.3898	.755	.453	Ret
SEC2A2	3.0000	3.3934	3.3728	.911	.366	Ret
SEC2A3	3.0000	3.4754	3.3991	1.092	.279	Ret
SEC2A4	3.0000	3.5246	3.4670	1.182	.242	Ret
SEC2A5	3.0000	3.1639	3.3970	.377	.708	Ret
SEC2A6	3.0000	3.1475	3.3805	.341	.734	Ret
SEC2A7	3.0000	3.1311	3.3589	.305	.761	Ret
SEC2B1	3.0000	3.0492	3.3288	.115	.909	Ret
SEC2B2	3.0000	3.0328	3.3564	.076	.939	Ret
SEC2C1	3.0000	3.5082	3.3942	1.169	.247	Ret

(table continues)

Survey Item	μNACFAM	μfaculty	SD	t	p	Ho
SEC2C2	3.0000	3.6557	3.4732	1.475	.146	Ret
SEC2C3	3.0000	2.9508	3.4080	-.113	.911	Ret
SEC2C4	3.0000	3.5902	3.4175	1.349	.182	Ret
SEC2C5	3.0000	4.0984	4.7634	1.801	.077	Ret
SEC2C6	3.0000	3.4098	3.3782	.948	.347	Ret
SEC2C7	3.0000	3.4590	3.4184	1.049	.299	Ret
SEC2C8	3.0000	3.6230	3.4456	1.412	.163	Ret
SEC3A1	3.0000	3.5902	3.4611	1.322	.188	Ret
SEC3A2	3.0000	3.6721	3.4435	1.524	.133	Ret
SEC3A3	3.0000	3.6885	3.4329	1.566	.122	Ret
SEC3A4	3.0000	3.7213	3.4454	1.635	.107	Ret
SEC3A5	3.0000	3.6066	3.4268	1.382	.172	Ret
SEC3A6	3.0000	3.5902	3.4126	1.351	.182	Ret
SEC3A7	3.0000	3.4426	3.4425	1.004	.319	Ret
SEC3A8	3.0000	3.3115	3.4183	.712	.479	Ret
SEC3A9	3.0000	3.0328	3.3959	.075	.940	Ret
SEC3A10	3.0000	3.4426	3.4377	1.006	.319	Ret
SEC3A11	3.0000	3.4754	3.4574	1.074	.287	Ret
SEC3B1	3.0000	3.7377	3.4443	1.673	.100	Ret

(table continues)

Survey Item	μ_{NACFAM}	$\mu_{faculty}$	SD	t	p	H_o
SEC3B2	3.0000	3.7213	3.4503	1.633	.108	Ret
SEC3C1	3.0000	3.4426	3.4377	1.006	.319	Ret
SEC3C2	3.0000	3.7377	3.4346	1.678	.099	Ret
SEC3C3	3.0000	3.6230	3.4213	1.422	.160	Ret
SEC3C4	3.0000	3.5738	3.4325	1.306	.186	Ret
SEC3C5	3.0000	3.5902	3.4466	1.337	.186	Ret
SEC3C6	3.0000	3.6885	3.4239	1.566	.122	Ret
SEC3C7	3.0000	3.2459	3.5055	.548	.586	Ret
SEC3C8	3.0000	3.3279	3.4240	.748	.457	Ret
SEC3C9	3.0000	3.3770	3.3920	.868	.389	Ret
SEC3D1	3.0000	3.2459	3.3846	.567	.573	Ret
SEC3E1	3.0000	3.6721	3.4386	1.527	.132	Ret
SEC4A1	3.0000	3.0656	3.4490	.148	.882	Ret
SEC4A2	3.0000	3.2787	3.4743	.626	.533	Ret
SEC4A3	3.0000	3.3770	3.4408	.856	.395	Ret
SEC4A4	3.0000	3.4098	3.4126	.938	.352	Ret
SEC4A5	3.0000	3.4098	3.4028	.941	.351	Ret
SEC4A6	3.0000	3.2295	3.4176	.525	.602	Ret
SEC4A7	3.0000	3.1475	3.4633	.333	.741	Ret

(table continues)

Survey Item	μNACFAM	μfaculty	SD	t	p	Ho
SEC4A8	3.0000	3.5082	3.4478	1.151	.254	Ret
SEC4A9	3.0000	3.4262	3.4081	.977	.333	Ret
SEC4A10	3.0000	3.5410	3.4669	1.219	.228	Ret
SEC4A11	3.0000	3.5082	3.4236	1.159	.251	Ret
SEC4B1	3.0000	3.1967	3.3903	.453	.652	Ret
SEC4B2	3.0000	3.2623	3.4200	.599	.551	Ret
SEC4B3	3.0000	3.4098	3.4611	.925	.359	Ret
SEC4B4	3.0000	3.5082	3.4575	1.148	.256	Ret
SEC4B5	3.0000	3.2787	3.4212	.636	.527	Ret
SEC4B6	3.0000	3.3115	3.4183	.712	.479	Ret
SEC4C1	3.0000	3.4098	3.4563	.926	.358	Ret
SEC4C2	3.0000	3.2131	3.4211	.487	.628	Ret
SEC4C3	3.0000	3.1803	3.3838	.416	.679	Ret
SEC4D1	3.0000	3.4262	3.4422	.967	.337	Ret
SEC4D2	3.0000	3.4918	3.4284	1.120	.267	Ret
SEC4D3	3.0000	3.1803	3.3690	.418	.677	Ret
SEC4D4	3.0000	2.6557	3.1827	-.845	.402	Ret
SEC4D5	3.0000	3.1803	3.3641	.419	.677	Ret
SEC4E1	3.0000	2.8361	3.2822	-.390	.698	Ret
SEC4E2	3.0000	2.7541	3.2795	-.586	.560	Ret

(table continues)

Survey Item	μNACFAM	μfaculty	SD	t	p	Ho
SEC4E3	3.0000	3.0328	3.3114	.077	.939	Ret
SEC4E4	3.0000	3.2131	3.4162	.487	.628	Ret

Note. n = 61; df = 60; t_{crit} = ± 2.000

Results for Hypothesis II: Respondents from Different IT Programs within NAIT will show Significant Mean Preferences for National Occupational CADD Skill Standards Prescribed by NACFAM

The second portion of this chapter represents statistical results for hypothesis II: Respondents from different Industrial Technology programs will show significant mean preference ratings for CADD skill standards prescribed by NACFAM. The 61 respondents were assigned to groups representing key Industrial Technology programs and these were: Manufacturing, Design Graphics, Construction, and Industrial Technology.

The ANOVA was used to analyze the perceptions of the four Industrial Technology programs by faculty from NAIT accredited institutions on National Occupational CADD Skill Standards. The means for the CADD courses taught by faculty from the four Industrial Technology programs accredited to NAIT are displayed in Table 2. The result of the ANOVA test is listed in Table 3 shown below.

Table 2

Means for Four IT Programs

IT Program	N	Means	SD	Std. Error
1. Manufacturing	23	4.444	1.055	.220
2. Design Graphics	16	4.491	1.252	.313
3. Construction	7	4.628	1.712	.647
4. Industrial Technology	15	4.628	1.257	.324
Total	61	4.580	1.228	.157

Table 3

ANOVA Results of Faculty from Four IT Programs at NAIT Accredited Institutions

	Sum of Squares	df	Mean Squares	F	Sig.
Between Groups	2.674	3	.891	.579	.631
Within Groups	87.726	57	1.539		
Total	90.400	60			

As seen in Table 3, the statistical analysis failed to establish that faculty teaching different CADD courses at NAIT accredited institutions perceive CADD skill standards prescribed by NACFAM differently. The means were close; however a larger response rate may have provided more conclusive results. The F value obtained, $F = .579$, was not

in the critical region ($p < .05$), therefore we fail to reject H_o. The range of means for the

four groups analyzed was from agreed to strongly agree.

Results for Hypothesis III: Faculty Teaching CADD at NAIT Accredited Institutions Will Rate National Occupational CADD Skill Standards Significantly Different According to Professional Rank

Results for hypothesis III are presented below. Respondents were asked to rank

themselves professionally. Five categories were used to rank CADD faculty from NAIT

accredited institutions. As discussed above, the categories used were: 1. Lecturer; 2.

Instructor; 3. Assistant Professor; 4. Associate Professor; and 5. Professor.

The ANOVA was used to analyze the faculty perceptions on NACFAM CADD

skill standards according to professional rank. Results for the means and statistical test

are presented in Tables 4 & 5 below.

Table 4

Means for Four IT Programs According to Professional Rank

Professional Rank	N	Means	SD	Std. Error
2. Instructor	3	3.964	1.778	1.026
3. Assistant Professor	18	4.23	1.077	.490
4. Associate Professor	10	4.106	.407	.129
5. Professor	30	4.393	.315	5.754
Total	61	4.280	1.228	.157

Table 5

ANOVA Results of Faculty Perceptions from Four IT Programs at NAIT Accredited
Institutions According to Professional Rank

	Sum of Squares	df	Mean Squares	F	Sig.
Between Groups	12.709	3	4.236	2.743	.253
Within Groups	77.691	57	1.363		
Total	90.400	60			

Table 4 shows that the means for the four professional groups ranged from agreed

to strongly agree. As seen in Table 5, the statistical analysis failed to establish that

faculty from different CADD programs at NAIT accredited institutions perceive National

Occupational CADD Skill Standards prescribed by NACFAM differently according to

professional rank. The F value obtained, $F = 2.743$, is not in the critical region ($p < .05$),

therefore we fail to reject H_o.

Results for Hypothesis IV: Faculty Teaching Different CADD Programs at NAIT Accredited Institutions will Rate CADD Skill Standards Significantly Different with Regards to Experience

The final portion of this chapter represents the means and statistical test results for

hypothesis IV. Possible difference in CADD teaching experiences of faculty at NAIT

accredited institutions was used as an independent variable to analyze perceptions on

NACFAM CADD skill standards. Respondents were placed in five groups, each

representing CADD teaching experience. As alluded above the five groups were: (1) 0-1

years; (2) 2-3 years; (3) 4-5 years; (4) 6-7 years; and (5) 8+ years.

ANOVA was used to analyze the faculty perceptions on NACFAM CADD skill standards according to CADD teaching experience. Results for the means and statistical test are presented in Tables 6 & 7 below.

Table 6 shows that the means for the five groups representing faculty teaching different CADD courses at NAIT accredited institutions by experience ranged from agreed to strongly agree. As seen in Table 7, the statistical analysis failed to establish that faculty from different CADD programs at NAIT accredited institutions perceive National Occupational CADD Skill Standards prescribed by NACFAM differently according to CADD teaching experience.

Table 6

Means for Faculty in IT Programs According to CADD Teaching Experience

Experience	N	Means	SD	Std. Error
1. (0-1) year	10	4.562	1.323	.375
2. (2-3) years	5	4.266	.469	.210
3. (4-5) years	13	4.333	.115	.257
4. (6-7) years	30	4.304	.410	.128
5. (8+) years	3	4.359	.000	.000
Total	61	4.384	.235	.187

Table 7

ANOVA Results of Faculty Perceptions Teaching CADD at NAIT Accredited
Institutions According to Experience

	Sum of Squares	df	Mean Squares	F	Sig.
Between Groups	22.565	3	5.641	2.523	.326
Within Groups	67.836	57	1.211		
Total	90.400	60			

The F value obtained, $F = 2.523$, is not in the critical region ($p < .05$), therefore

we fail to reject H_o. Conclusions and recommendations relative to these analyses are

presented in Chapter 5.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The basis for any research is to identify a problem, collect, report and analyze data, make some informed inferences from the findings, then make recommendations based upon those conclusions (Fraenkel & Wallen, 2000). It is also a known fact that no research can be truly conclusive without constant revision and scrutiny. Although this chapter brings closure to this study, the author will continue to conduct research in regard to faculty perceptions on occupational CADD skill standards teaching at NAIT accredited institutions or who work with any other professional organization. Chapter 5 has the following headings: (a) Summary of the Study; (b) Conclusion of the Study; and (c) Recommendations for Further Study.

Summary of the Study

The problem of this descriptive survey research was to establish perceived positions held by faculty at NAIT accredited institutions on National Occupational CADD Skill Standards. Findings of this study will certainly be handy in curriculum development and innovations. Faculty may make informed decisions when developing CADD skill standards that meet the industry needs. Analyses were done using a two-tailed single sample t-test ($\mu=3$) at the .05 level of significance for every item of the survey instrument representing occupational skill standards developed by NACFAM. A further problem of the study was to determine perceived differences on occupational CADD skill standards among faculty teaching at NAIT accredited institutions based on: (1) the Industrial Technology program the faculty teaches in; (2) professional ranking;

and (3) CADD teaching experience. This was done using the ANOVA on each of the

independent variables given above. An hypothesis (H_1: At least one pair of the categories

means would be different) was established for each of the variables mentioned above and

tested using the AVOVA at the .05 level of significance. The ANOVA on Industrial

Technology programs the faculty teach in had 4 groups: (a) Manufacturing; (b) Design

Graphics; (c) Construction; and (d) Industrial Technology. The ANOVA on Professional

Rankings had four groups: (a) Instructor; (b) Assistant Professor; (c) Associate Professor;

and (d) Professor. The ANOVA for CADD teaching experience had five groups: (a) (0-

1) years; (b) (2-3) years; (c) (4-5) years; (d) (6-7) years; and (e) (8+) years. The

calculated values $\underline{F}$ on each independent variable provided a direct measure of how

faculty teaching at NAIT accredited institutions perceived the importance and relevance

of occupational CADD skill standards.

A total of 61 respondents participated in this study. The participants responded to

a web-based survey instrument developed by the researcher with the assistance of web

experts. Data were automatically transmitted back to the researcher upon completion of

each section of the survey instrument. A program was developed for data to be viewed in

the SPSS statistical software package ready for analyses once it was captured. Four

hypotheses were established for this study. The first research hypothesis was: On the

average, faculty teaching CADD skills at NAIT accredited institutions will view National

Occupational CADD Skill Standards approved by NACFAM as relevant and important.

Hypothesis II was: Respondents from different Industrial Technology programs teaching

CADD at NAIT accredited institutions will show significant mean preferences on

National Occupational CADD Skill Standards developed and approved by NACFAM.

Hypothesis III was: Faculty teaching CADD at NAIT accredited institutions will rate

National Occupational CADD Skill Standards as significantly different according to their

own professional rank. Hypothesis IV was: Faculty teaching different CADD courses at

NAIT accredited institutions will rate National Occupational CADD Skill Standards as

significantly different according to their own experience.

As was stated in Chapter 3, the data for hypothesis I (On average, faculty teaching

CADD skills at NAIT accredited institutions view CADD skills approved by NACFAM

relevant and important) were examined at the .05 level of significance for each item. As

seen in Table 1, two-tailed statistical $\underline{t}$-tests results indicate that none of the 94 items

representing NACFAM CADD skill standards reported significant differences with those

practiced by faculty teaching at NAIT accredited institutions; that is we failed to reject

the null hypothesis ($H_{o:}$ μ=3) on any of the items.

The calculated $\underline{F}$ value, $\underline{F}$ = .579 for hypothesis II is not in the critical region

($\underline{p}$<.05). A value exceeding this critical threshold would indicate statistical significant

differences among faculty teaching CADD courses in different Industrial Technology

programs accredited to NAIT on National Occupational CADD Skill Standards. The

calculated $\underline{F}$ value, $\underline{F}$ = 2.743, for hypothesis III is not in the critical region ($\underline{p}$<.05). A

value exceeding this critical threshold would indicate statistical significance, which

would not be due to chance alone. The obtained $\underline{F}$ value, $\underline{F}$=2.523, is not in the critical

region ($\underline{p}$<.05), therefore we failed to reject H_0.

The findings of the study based upon presentation and analyses of data for each hypothesis are provided in Chapter 4. Conclusions and recommendations of the study relative to the findings are presented below.

<div align="center">Conclusions of the Study</div>

Based on the analyses of the data gathered in this study and subject to the stated assumptions and delimitations of this study, it was concluded in regard to research hypothesis I, that none of the two-tailed single sample t-tests of the National Occupational CADD Skill Standards items showed statistical significance. Because the results did not differ significantly from the scale midpoints they could be interpreted to mean that CADD skills taught at NAIT accredited institutions are in conformity with the National Occupational CADD Skill Standards. The implications are that there is no need to review and update CADD courses taught at NAIT accredited institutions so as to meet the needs of industry. However, this assertion cannot be considered conclusive due to lack of statistical power in this research. The response rate was only 35%. A higher response rate is desirable to establish a more conclusive position.

It was concluded that in regard to hypothesis II, that the ANOVA statistical test result, F= .579, on the four Industrial Technology programs was not statistically significant at the .05 level. This result could be interpreted to mean that faculty teaching CADD courses at NAIT accredited institutions view the CADD skills they teach to be in conformity to the National Occupational CADD Skill Standards developed by NACFAM. The implications may mean that, upon graduation, students graduating from NAIT accredited institutions will have similar CADD skill standards regardless of the

Industrial Technology program they go through, and that the CADD skills acquired are in conformity to NACFAM expectations. A larger response rate as well as well large numbers of participants in each group would have established a more powerful statistical significance test from which we could make informed conclusions that could be published as academic findings.

It was concluded in regard to hypothesis III, that the ANOVA statistical test result, $\underline{F}=2.743$, on the four professional rankings, established no statistically significance at the .05 significance level. This result may be interpreted to mean that there are no perceived differences on the importance and relevance of National Occupational CADD Skill Standards by faculty teaching at NAIT accredited institutions according to professional ranking and expertise. Faculty view National Occupational CADD Skill Standards as consistent in importance with the CADD skills they teach at NAIT accredited institutions regardless of level of expertise. In house training on CADD skill standards at NAIT accredited institutions may not be necessary. As with hypothesis II findings, more conclusive inferences could be possible if the response rate were higher. The results for this analysis lacked adequate statistical power.

Finally, it was concluded in regard to hypothesis IV, that the ANOVA statistical result, $F=2.523$, established no statistical differences at the .05 significance level hence we fail to reject H_0. This result may be interpreted to mean that there are no perceived differences on the importance and relevance of National Occupational CADD Skill Standards by faculty teaching at NAIT accredited institutions according to CADD teaching experience. Similar to hypotheses II and III findings, more conclusive inferences

could be possible if the response rate were higher. The findings can be interpreted to mean that CADD teaching experience has no influence on how faculty perceive the importance and relevance of National Occupational CADD Skill Standards. The results for this analysis lacked statistical power due to small numbers of participants in each group; therefore the results were inconclusive.

<div align="center">Recommendations of the Study</div>

Even though we failed to establish significant differences on the four hypotheses tested, this does not conclusively mean that there are not any differences at all. This may be due to type II error. Type II error occurs when the researcher fails to detect significant differences when, in fact, they really exist (Gravetter & Wallnau, 2002). In this study the researcher failed to reject the null hypotheses in each case tested. A low response rate as noted in the introductory part of this chapter may have been a leading contributor to these ambiguous findings. Further replications of this study with some adjustment might produce results that may show significant differences. The η^2 ratio on the Sum of Squares for hypothesis IV ($\eta^2 = .25$) on the ANOVA test indicate a possibility of establishing significant means differences if the response rate was higher (see Table 7).

There might be a need to carry on further studies on this hypothesis. The η^2 ratios for the ANOVA tests on hypotheses II and III are way too low ($\eta^2 = .03$ and $\eta^2 = .104$) to warrant further studies using this statistical test even if the response rate were to increase. The following recommendations are based upon the review of related literature, data analyses, findings, and conclusions established from the study. Given the outcome of this study, recommendations for further study are warranted and may further

help define how faculties teaching at NAIT accredited institutions perceive the importance of National Occupational CADD Skill Standards to CADD courses in the various Industrial Technology programs.

The recommendations for further study, made in regard to this study are:

1. It is recommended that this descriptive study be replicated employing a larger sample while utilizing the same survey instrument used in this study. The law of large numbers stipulates that as the sample size increases, the error between the sample mean and the population mean should decrease (Gravetter & Wallnau, 2002). In this study only 61 participants responded. For a descriptive study, a sample with a minimum number of 100 respondents is recommended in order to make statistically meaningful inferences (Fraenkel & Wallen, 2000). The purpose of a statistical test is to assess differences with enough statistical power that will correctly lead to the conclusion that there is a difference when, in fact, a difference exists. A statement sanctioned by NAIT on the importance of this study may be included in the participants' invitation letter. This might encourage faculty to take part in the survey since this would have the approval of the NAIT organization which accredits the various Industrial Technology programs they teach. Alternatively, a block email with the survey instrument web-link could be sent through the NAIT organization email server requesting faculty teaching in CADD programs to respond. The confidentiality and the security fears and concerns should be alleviated, and bolster participation response rate which is what is required in this study for meaningful research findings. The methodology for collecting survey data would remain the same as used in this

study; (i.e. web-based). Participants would be emailed an invitation letter requesting their participation in the replication of this study. The invitation letter should be as brief as possible, but must highlight the importance and objectives of the study. A web link to the survey instrument should be provided at the end of the invitation letter.

The structure of the survey instrument should be as is. In order to improve the response rate it is suggested that the survey be conducted during the normal academic school year, fall or spring semesters. There are more chances of assessing faculty teaching CADD during this time. One possible reason why the response rate in this study was so low may due to timing. The survey was conducted during the summer break. Chances are that most respondents were away from their work stations possibly vacationing at the time of data collection. This problem and many other summer activities may not have given respondents the opportunity to participate in the survey.

2. It is recommended that this study be replicated by mailing hard copies of the survey instrument to respondents. A follow up survey instrument should be mailed to respondents with a reminder note attached. Timing is very important when sending out survey instruments. The objective is to get respondents to participate in the survey when they are not under pressure from other activities. It is suggested that the survey instruments be mailed to respondents midway into either the fall semester or spring semester when faculty are not under so much pressure from other college activities that are typical at the beginning of the semester or towards the end of the

semester. One distinctive advantage of mail surveys is that it permits the respondents

to take sufficient time to give thoughtful answers to the questions asked (Fraenkel &

Wallen, 2000). The researcher has to be resourceful in finding out the contact

addresses of participants. In this study, the researcher did not have access to the

respondents' physical contact addresses, hence the use of a web-based survey

instrument since the email address are listed in the NAIT Baccalaureate Program

Directory, 2002. A combination of recommendations 1 & 2 could yield interesting

results since this might bolster a higher response rate thereby increasing statistical

power.

     3. It is recommended that findings from a web-based survey instrument be

compared to findings from a paper-based instrument mailed to respondents.

Differences on response rate may help establish different conclusions. Faculty may

not be comfortable with web-based survey instruments. Web-based surveys are a

new phenomenon. There are a number of people who are still not sure how safe a

web-based survey is in regard to spy worms, computer viruses, confidentiality and

privacy. A comparison of the findings from the two methods may help determine a

more efficient method of disseminating the survey instrument and the method of

collecting data. It is important to note that these two methods of administering the

survey instrument are ideal to this study due to the location of participants. The

respondents to this study were spread across the United States. Direct administration,

telephone and interview methods of administering the survey instrument are not

feasible due to costs involved in the collection of data.

4. It is recommended that further studies based on faculty's work stations be conducted. There may be perceived differences on National Occupational CADD Skill Standards from one institution to another. A larger sample size of respondents from individual institutions would allow analysis of faculty's perceived positions on the importance and relevance of National Occupational CADD Skill Standards at the institutional level. Findings may become very relevant when it comes to the accreditation exercise and curriculum reviews. Faculty teaching CADD at NAIT accredited institutions would be able to compare their CADD skills with other institutions. Academic institutions need to frequently review their curricula so it satisfies the demands of the industry. Establishing CADD skill standards that conform to professional organizations such as NACFAM by academic institutions would make graduating candidates more marketable. Employers would be made aware of CADD competencies possessed by potential employees graduating from institutions with known CADD skill standards.

5. It is recommended that this study be used to establish perceived views on the importance of National Occupational Skill Standards by faculty at other institutions not accredited by NAIT. The study could be broadened to include faculty teaching CADD skills in general regardless of professional affiliation or institutional accreditation. This should certainly improve the response rate since the number of potential participants would significantly increase. NAIT accredited institutions would be able to compare themselves on the importance of National Occupational CADD Skill Standards with other institutions accredited to other professional

organization such as the Society for Mechanical Engineers (SME), American Institute of Architecture (AIA), and many others. It would be possible to establish which professional organizations view National Occupational CADD Skill Standards more important and relevant and which ones do not.

6. It is recommended that further review of literature, CADD standards practiced by various professional and industrial organizations, be an on-going process. The survey instrument may be revised to so as to reduce the number of survey items the respondents would have to answer. The survey could be conducted in two parts; the first covering the "Fundamental Drafting Skill" standard and "Fundamental Computer Skills". The second part would include: "Basic CADD Skills" and "Advanced CADD Skills". This would reduce the amount of time the respondent spends on the survey instrument. Some respondents are generally not willing to spend more than ten minutes answering a survey instrument based on the reliability and validity testing conducted on this survey instrument. A reduction on the time spent on completing a survey instrument might encourage more participants. The font size may be increased so to as make reading of the questions much easier.

7. It is recommended that future researchers pursue alternative approaches other than a survey. Alternative methods of collecting data could be through direct administration, telephone, and interviews. The researcher has to take into consideration the following factors: costs involved, facilities needed, training requirements for the questioners, data collection time, response rate, and group administration possibilities. The researcher could also make use of other forms of

research approaches such as true experimental research where one can actually test competencies on National Occupational CADD Skill Standards on students graduating from NAIT accredited programs and then make inferences.

8. As an alternative, setting the null hypothesis I at ($\mu=1$; strongly disagree) might help establish significant mean differences on National Occupational CADD Skill Standards by faculty teaching CADD skills at NAIT accredited institutions. This would give the researcher the opportunity to easily comment on whether faculty strongly disagree or strongly agree on the importance and relevance of National Occupational CADD Skill Standards to NAIT accredited programs and the requirements of the industry.

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APPENDIX A

NATIONAL SKILL STANDARDS FOR COMPUTER AIDED DRAFTING

AND DESIGN (CADD)

National Skill Standards for Computer Aided drafting and Design (CADD)

FUNDAMENTAL DRAFTING SKILLS

Related academic skill(s) required to perform each technical skill listed in our document are contained in braces { } after each item. Skills prefaced by an M are math skills, by a C are communication skills, and by an S are science skills. In some instances, the related academic skill number reference may include all items in its subsection (e.g. {M4} includes M4.1 - M4.4).

1.1. Drafting Skills Related Academic 1.1.1. Use drawing media and related drafting materials (e.g., papers, vellum, mylar; plotter pens, toner cartridges) {C11, C16}

1.1.2. Use basic measurement systems (e.g., fractions, decimals, and metric measurements) {M1, M7.1, M7.4, M13}

1.1.3. Add correct annotation to drawing {C1, C7}

1.1.4. Identify line styles and weights {M8.9}

1.1.5. Prepare title blocks and other drafting formats {C7, M8.9}

1.1.6. Apply metric and/or dual dimensioning drawing standards {S8}

1.1.7. Identify and use appropriate standard symbols {C10, C20, C21}

1.1.8. Reproduction of originals using different methods (e.g., photocopy, plot, blueprint) {M1}

1.1.9. Create freehand technical sketches {M4.2, M6, M8.9}

1.2. ORTHOGRAPHIC PROJECTIONS 1.2.1. Identify, create, and place appropriate orthographic views {M4.4, M8.9}

1.2.2. Identify, create, and place appropriate auxiliary views {M1, M4, M4.4, M6, M8, M8.9}

1.2.3. Identify, create, and place appropriate section views {M6, M8.9}

1.3. PICTORIAL DRAWINGS 1.3.1. Identify and create axonometric drawings (e.g., isometric, dimetric, trimetric) {M1, M6, M8.9}

1.3.2. Identify and create oblique drawings (e.g., cabinet, cavalier) {M1, M6, M8.9}

1.3.3. Identify perspective drawings (e.g., 1-point, 2-point, 3- point) {M8.9}

1.4. DIMENSIONING 1.4.1. Apply dimensioning rules correctly (e.g., avoid redundant dimensioning, avoid dimensioning to hidden lines) {S11}

1.4.2. Use correct dimension line terminators (e.g., arrowheads, ticks, slashes) {S2, S8, S3, S11}

1.4.3. Dimension objects (e.g., lines, arcs, angles, circular) {S2, S3, S8, S11}

1.4.4. Dimension complex shapes (e.g., spheres, cylinders, tapers, pyramids) {S2, S8, S11}

1.4.5. Dimension features from a center line {S2, S3, S8, S11}

1.4.6. Dimension a theoretical point of intersection {S2, S3, S8, S11}

1.4.7. Use appropriate dual dimensioning standards {S2, S8, S11}

1.4.8. Use size and location dimension practices {S3, S8, S11}

1.4.9. Use various dimensioning styles (e.g., Cartesian, polar, ordinate, datum) {S3, S8, S11}

1.4.10. Place tolerance dimensioning and Geometric Dimensioning and Tolerancing (GD&T) on drawings when appropriate {M1, S2, S3, S8}

2. FUNDAMENTAL COMPUTER SKILLS

2.1. HARDWARE 2.1.1. Demonstrate proper care of equipment {C10, C11, C17, S11}

2.1.2. Operate and adjust input devices (e.g., mouse, keyboard, digitizer) {C10, C11, C17, S11}

2.1.3. Operate and adjust output devices (e.g., printers, plotters) {C10, C11, C17, S11}

2.1.4. Correct handling and operation of storage media {C10, C11, C17, S11}

2.1.5. Start and shut down work station {C10, C11, C17, S11}

2.1.6. Adjust monitor controls for maximum comfort and usability {C10, C11, C17, S11}

2.1.7. Recognize availability of information services (e.g., electronic mail, bulletin boards) {C1, C2, C10, C11, S11}

2.2. PHYSICAL AND SAFETY NEEDS 2.2.1. Demonstrate an understanding of ergonomic considerations (e.g., keyboard position, screen position, lighting) {C10, C11, C17, S11}

2.2.2. Demonstrate personal safety (e.g., electrical and mechanical hazards) {C10, C11, C17, S11}

2.3. OPERATING SYSTEMS 2.3.1. Start and exit a software program as required {C10, C11, C17, S11}

2.3.2. Demonstrate proper file management techniques (e.g., copying, deleting) {C10, C11, C17, S11}

2.3.3. Format floppy disk {C10, C11, C17, S11}

2.3.4. Identify, create, and use directory structure and change directory paths {C10, C11, C17, S11}

2.3.5. Demonstrate proper file maintenance and backup procedures {C10, C11, C17, S11}

2.3.6. Translate, import, and export data files between formats (e.g., IGES, DXF) {C10, C11, C17, S11}

2.3.7. Use on-line help {C10, C11, C17, S11}

2.3.8. Save drawings to storage devices {S11}

3. BASIC CADD SKILLS The following skills must be performed in 2D and/or 3D as appropriate.

3.1. CREATE 3.1.1. Create new drawing {M1, M2, M4, M6, M7, M8.9, S11}

3.1.2. Perform drawing set up {C10, C11, C17, M1, M2, M4, M6, M7, M8.9, S3, S8, S11}

3.1.3. Construct geometric figures (e.g., lines, splines, circles, and arcs) {M1, M4, M6, M7, M8.9, S11}

3.1.4. Create text using appropriate style and size to annotate drawings {M1, S8, S11}

3.1.5. Use and control accuracy enhancement tools (e.g., entity positioning methods such as snap and XYZ) {S3, S8, S11}

3.1.6. Identify, create, store, and use appropriate symbols/libraries {C10, C20, C21, M1, M4, M6, M7, M7.1, M8.9, S2, S3, S8, S11}

3.1.7. Create wireframe/solid models {M1, M4, M6, M7.1, M7.4, M8.9, M12, S2, S3, S8, S11}

3.1.8. Create objects using primitives {S2, S3, S8, S11}

3.1.9. Create 2-D geometry from 3-D models {M8}

3.1.10. Revolve a profile to create a 3-D object {M1, M8.9, S3, S8, S11}

3.1.11. Create 3-D wireframe models from 2-D geometry {M8}

3.2. EDIT 3.2.1. Utilize geometry editing commands (e.g., trimming, extending, scaling) {M1, M8.9, S2, S3, S8, S11}

3.2.2. Utilize non-geometric editing commands (e.g., text, drawing format) {M1, M8.9, S2, S8, S11}

3.3. MANIPULATE 3.3.1. Control coordinates and display scale {M8.9, M9, M10, M11, S2, S3, S8, S11}

3.3.2. Control entity properties (e.g., color, line type) {S3, S8, S11}

3.3.3. Use viewing commands (e.g., dynamic rotation, zooming, panning) {M8.9, S11}

3.3.4. Use display commands (e.g., hidden line removal, shading) {M8.9, S11}

3.3.5. Use standard parts and/or symbol libraries {C8, C10, C11, M1, M8.9, S11}

3.3.6. Plot drawings on media using correct layout and scale {M1, M8.9, S2, S3, S8, S11}

3.3.7. Use layering techniques {S11}

3.3.8. Use grouping techniques {S11}

3.3.9. Minimize file size {S11}

3.4. ANALYZE Use query commands to interrogate database (e.g., entity characteristics, distance, area, status) {C11, M5.1, M5.2, M5.3, M5.4, M5.5, M7.1, S8, S11}

3.5. DIMENSIONING Use associative dimensioning correctly {S11}

4. ADVANCED CADD SKILLS

4.1. CREATE 4.1.1. Create wireframe and/or solid models {S2, S3, S8, S11}

4.1.2. Create non-analytic surfaces using appropriate modeling (e.g., non-analytic: NURBS, B-spline, Gordon, Bezier, Coons) {S2, S3, S8, S11}

4.1.3. Create analytic surfaces using appropriate modeling with planes and analytic curves (e.g., conic, cylinder, revolution, ruled) {S2, S3, S8, S11}

4.1.4. Create offset surfaces {S2, S3, S8, S11}

4.1.5. Find intersection of two surfaces {S2, S3, S8, S11}

4.1.6. Create joined surfaces {M8.9, S2, S3, S8,S11}

4.1.7. Create a fillet or blend between two surfaces

4.1.8. Create feature based geometry(e.g., holes, slots, rounds) {M8.9}

4.1.9. Create cut sections {M1, M8.9, S2, S3, S8, S11}

4.1.10. Construct and label exploded assembly drawings {C1, C7, M1, M6, M8.9}

4.1.11. Perform Boolean operations (e.g., union, subtraction, intersection) {S2, S3, S8, S11}

4.2. EDIT 4.2.1. Trim surface {M1, M8.9, S3, S8, S11}

4.2.2. Manipulate surface normals {M1, M8.9, S3, S8, S11}

4.2.3. Extend surface {M1, M8.9, S3, S8, S11}

4.2.4. Edit control points (e.g., surfaces, Bezier) {M1, M8.7, S3, S8, S11}

4.2.5. Modify geometry via Boolean operations {S2, S3, S8, S11}

4.2.6. Edit primitives (e.g., moving, copying, resizing)

4.3. MANIPULATE 4.3.1. Perform axis view clipping {M8.9, S2, S3, S8, S11}

4.3.2. Extract wireframe data from surface/solid geometry {S11}

4.3.3. Shade/render object (e.g., reflectivity, opacity) {M1, M8.9, S2, S3, S5, S6, S7, S8, S11}

4.4. ANALYZE 4.4.1. Extract geometric data {C11, S3, S8, S11}

4.4.2. Extract attribute data {S8, S11}

4.4.3. Identify gASP in non-intersecting surfaces {M4.1, M4.3, M4.4, M5, S11}

4.4.4. Obtain surface properties (e.g., area, perimeter, bounded volume) {M4.3, M4.4, M5, S2, S3, S8, S10, S11}

4.4.5. Obtain mass properties data (e.g., moments of inertia, centroids) {S2, S3, S8, S9, S11}

4.5. CADD PRODUCTIVITY AND WORK HABITS 4.5.1. Perform customization to improve productivity (e.g., customize menus, function keys, script files, macros) {C8, C10, C11, S11}

4.5.2. Manipulate associated non-graphical data {C8, C10, C11, S11}

4.5.3. Use template and library files to establish drawing standard presets {C8, C10, C11, S11}

4.5.4. Develop geometry using parametric programs {S2, S3, S8, S11}

SUPPLEMENTS

Related Academic Skills -- Communication {C} Skill -- Math {M} Skills -- Science {S}

Skills Employability Skills Recommended Tools And Equipment for CADD Training

Recommended Hours of Instruction Recommended Qualifications of a CADD Instructor

Measurable Skills

A. The recommended list of related academic skills contains academic knowledge

necessary for a CADD user to be proficient. With the acquisition of these skills, it is

assumed that the user has writing capabilities, a technical vocabulary, can use the

algebraic order of operations to solve problems and generate conclusions, and can use

computers to process information for mathematical applications and problem solving.

B. The principal source of the related academic skills section is "The Basic Taxonomy of Skills" by Lester Synder.

C. The list of employability skills is considered desirable for a CADD user in order to become a better worker.

D. The principal source of employability skills section is the document produced by the SCANS Commission (Secretary's Commission on Achieving Necessary Skills).

E. The recommendations concerning tools and equipment, hours of instruction, and CADD instructor qualifications were made by a committee of technical experts from organizations on our coalition. These recommendations serve only as guidelines for training programs.

RELATED ACADDEMIC SKILLS

COMMUNICATION SKILLS

Assumption of basic reading skills. Assumption of basic keyboard skills

C1 Compose and edit using correct punctuation C1.1 sentences C1.2 paragraphs C1.3 written drafts C1.4 oral drafts

C2 Compose and edit sentences or paragraphs for completeness/irregular expressions/modifiers/cause and effect relationships/ paragraph coherence/paragraph transitions

C3 Compose and edit reports, essays, information requests, persuasive text, proofs and revisions, summaries, social communications and business letters

C4 Compose and edit general forms or documents

C5 Compose and edit audio-visual aids

C6 Compose and edit notes

C7 Spelling and vocabulary C7.1 compose and edit sentences using correct spelling C7.2 identify information and written abbreviations C7.3 apply and use definitions

C8 Use text resource table of contents, resource glossaries, resource indexes

C9 Collect, organize, and research oral and written information

C10 Use reference books, manufacturers' manuals, library resources, and trade publications

C11 Read and comprehend written information C11.1 the main idea C11.2 the purpose C11.3 the conclusion

C15 Evaluate written facts and opinions

C16 Identify written information when reading

C17 Adapt strategic listening by adhering to directions, tasks, nonverbal and verbal cues

C18 Apply informal oral communications from employee to supervisor, supervisor to employee, peer to peer, with customers and others

C19 Adapt communication techniques to cultural differences

C20 Use library resource card catalogs

C21 Use library resource guides

C22 Collect and organize information to adapt to strategy writing for oral and written presentations

C23 Comprehend information when reading

C24 Adapt listening skills and attend verbal and nonverbal cues

C25 Evaluate information when listening for clarity and appropriateness

C26 Present speech for formal and/or informal information request

MATH SKILLS

M1 Basic arithmetic operations - compute addition, subtraction, multiplication, division (mentally and/or calculator) for the following categories: whole numbers, decimals, fractions, and mixed numbers

M2 Basic arithmetic operations - conversions: units, square units, identify English measures length/volume/weight, convert units metric/English, convert units and time

M3 Basic arithmetic operations - probability and statistics: interpret charts/tables/graphs

M4 Geometry - reasoning and logic: M4.1 understand definitions, conditions M4.2 formulate and verifies conclusions M4.3 solve problems, generate conclusions, deductive reasoning M4.4 calculate and evaluate reasoning- invalidate arguments

M5 Geometry - calculate and evaluate geometric figures: M5.1 perimeter M5.2 circumference M5.3 area M5.4 surface M5.5 volume M5.6 congruent triangles

M6 Geometry - construct geometric figures: lines, angles, congruent angles, congruent segments, angle bisectors, parallel/perpendicular, geometric figures, and three dimensional figures

M7 Geometry - measurement: M7.1 measure direct - distance M7.2 calculate and evaluate measurement precisely, M7.3 formulate and verify angles - acute/obtuse/right M7.4 measure direct angles M7.5 estimate and round M7.6 classify triangles by sides and angles

M8 Geometry - identify geometric figures and symbols: M8.1 interpret symbols M8.2 identify lines M8.3 identify lines - vertical/horizontal M8.4 identify lines-parallel/perpendicular M8.5 identify lines - ray/segment M8.6 distinguish angles/circle/arcs M8.7 identify geometric figures circles/angles/arcs/polygons M8.8 identify geometric figures M8.9 understand geometric figures: visual perception

M9 Algebra - graphing: calculate and evaluate Cartesian midpoints

M10 Algebra - graphing: solve problems - coordinate geometry and conic sections

M11 Algebra - graphing: solve problems - coordinate geometry and distance formula

M12 Trigonometry - use calculator to compute trigonometric functions (e.g., cosines/sines/tangents)

M13 Convert decimals/fractions/ratios/percentages

SCIENCE SKILLS

S1 Apply and use mASP/charts/tables/graphs

S2 Convert measurement units

S3 Measure direct distance and/or length

S4 Measure direct angles

S5 Describe and explain color in general, related to blindness, cones, pigmentation, rainbows, rods, and spectra

S6 Describe and explain lenses including concave, convex, and focal length

S7 Describe and explain light including angle of incidence and reflection, critical angle -- fiber optics, diffraction, electromagnetic radiation, electromagnetic spectrum, fluorescent, incandescent, lasers, opaque, photoelectric, photons, polarization, refraction, speed, translucent and transparent, and ultraviolet

S8 Identify measurement units

S9 Measure mass and weight

S10 Measure volume including liquids and solids

S11 Use computers to process information, for mathematical applications and problem solving

EMPLOYABILITY SKILLS

These are defined as skills and behaviors that are known, valued, and practiced in the workplace.

RESOURCES: -- Identify, organize, plan, and allocate resources;

-- Select drawing relevant activity, allocate time, keep records and follow schedule; and

-- Use company resources responsibly (e.g., supplies, equipment).

INTERPERSONAL: -- Work with others;

-- Participate as member of team (e.g., following instructions, providing feedback, cooperating with established team goals);

-- Serve Clients/Customers - work to satisfy customers' expectations (internal and external customers);

-- Maintain professional respect for co-workers and customers without prejudice;

-- Understand how the structure of the organization works and work effectively within it;

-- Communicate effectively with work related personnel; and

-- Provide job-related instruction to others.

INFORMATION: -- Acquire and use information; -- Acquire and evaluate job-related documents; -- Organize and maintain files; -- Interpret and communicate job-related information; and -- Use computers to process information in the work environment.

SYSTEMS: -- Understand complex terminology;

-- Is familiar with inter-relationships used in the profession;

-- Understand the technical aspects of everyday life on the job and the tools that relate to the profession; and

-- Suggest modifications to existing processes and develop new or alternative methodologies to improve performance .

TECHNOLOGY: -- Work with a variety of technologies; and -- Apply current and appropriate technology to specific tasks .

THINKING SKILLS: -- Think creatively;

-- Make intelligent decisions;

-- Solve problems;

-- Visualize, organize and process symbols, pictures, graphs, objects, and other information;

-- Use efficient learning techniques to acquire and apply new knowledge and skills; and

-- Practice deductive and inductive reasoning skills .

PERSONAL QUALITIES: -- Practice individual responsibility;

-- Have good self-esteem, believe in own self-worth, and maintain a positive view of self;

-- Relate well to others;

-- Set personal goals, monitor progress, and exhibit self- control;

-- Possess integrity;

-- Maintain a professional image;

-- Demonstrate dependability;

-- Demonstrate a good work ethic;

-- Demonstrate willingness to learn;

-- Provide constructive praise or criticism;

-- Demonstrate flexibility;

-- Work safely; and

-- Balance work, family, and personal life.

GENERAL KNOWLEDGE OF THE INDUSTRY:

-- Know the scope of the industry and how parts interrelate;

-- Understand the economics pertinent to the department (e.g., supply costs, productivity, business financial decisions); and

-- Read, analyze and interpret examples of industry reports and specifications and standards.

TOOLS and EQUIPMENT for CADD TRAINING

Recommendation

CADD software is designed to run on a wide range of hardware platforms such as personal computers, engineering workstations, mini-computers or mainframes. Most CADD software can be run on a variety of hardware platforms, each of which has advantages and disadvantages in terms of price and performance. Due to the rapidly evolving computer technology and related software capabilities, specific component designations must be made on an individual basis. The key factor to success is to match

needs with abilities, performance, and cost. Considering these factors, the following guidelines are provided.

CADD system hardware selection will have to consider the following components in the selection process:

-- CPU (e.g. processor, RAM); -- Display system (e.g. monitor, graphic cards); -- Input peripherals (e.g. mouse, graphics tablet); -- Output peripherals (e.g. plotter, laser printer); -- Mass storage devices (e.g. floppy disk, hard disk); -- Back-up devices (e.g. tape drive, WORM drive); -- Accessories (e.g. CD-ROM drive, UPS, modem); -- Network (e.g. data); and -- Training accessories (e.g. video network, projection devices).

The recommended process for selecting a CADD system is:

1. Review the Core CADD Skills document and determine the CADD skills to be learned.

2. Investigate/choose the CADD software that will best accomplish the learning of these skills selected.

3. Select appropriate computer hardware for the CADD software selected. Thus, the hardware should always be selected LAST.

The ideal training environment will have one learner per work station.

HOURS of INSTRUCTION

Recommendation

The following is an estimate of the number of hours required to teach the different segments of each core CADD technical skill area, excluding the related aCADDemic skills. Portions of these areas can be taught concurrently. Hours include lab and classroom hours.

SECTION RANGE HOURS OF INSTRUCTION MIN to MAX

Fundamental Drafting Skills 80 to 130 hours Fundamental Computer Skills 10 to 30 hours Basic CADD Skills 80 to 130 hours Advanced CADD Skills 120 to 220 hours

QUALIFICATIONS of a CADD INSTRUCTOR

Recommendation

These guidelines are informational only. It is understood that some instructors may be

qualified with less than minimum recommended criteria; and some instructors may be

unqualified regardless of education or experience.

Guidelines for Qualifications of a CADD Instructor

-- Must demonstrate a mastery of content as outlined by the CADD skill standards
document. Mastery can be demonstrated by passing the national voluntary CADD test;

-- Demonstrate the ability to teach using curriculum and lesson planning guide;

-- Be able to update experience through internship, software training, etc.; and

-- A related degree or equivalent work experience according to chart below.

No Degree - 8 yrs of related work experience with 2 years being recent CADD
experience

AS Degree - 4 years of related work experience with 2 years being recent CADD
experience

BS/MS/PhD - 2 years of related work experience with 2 years being recent CADD
experience

MEASURABLE SKILLS

To add more value to the CADD Skill Standards, work was done by committee members
to make the skills measurable. In other words, it was determined to what extent each skill
should be accomplished. The measurable skills supplement needs to be finalized but is
available now in working draft form.

APPENDIX B

HUMAN PARTICIPANTS REVIEW

INFORMED CONSENT

UNIVERSITY OF NORTHERN IOWA

HUMAN PARTICIPANTS REVIEW

INFORMED CONSENT

Project Title: (PERCEIVED IMPORTANCE OF NATIONAL OCCUPATION CADD SKILLS AMONG FACULTY OF NAIT ACCREDITED INSTITUTIONS)

Name of Investigator: Ronald Shava

Invitation to Participate: You are invited to participate in a dissertation research project conducted through the University of Northern Iowa. The University requires that you give your signed agreement to participate in this project. The following information is provided to help you make an informed decision whether or not to participate.

Nature and Purpose: The purpose of this study is to provide NAIT accredited institutions, professionals, and affiliated organizations a reflection of CADD standards developed, adopted, and practiced by NAIT accredited institutions in relation to National Occupational CADD Skill Standards. Knowledge gained from this study can be used as measurable means of influencing and standardizing CADD programs within NAIT accredited institutions. Results from this study can provide useful information in identifying variations in CADD standards adopted by different Industrial Technology programs within NAIT. NAIT accredited institutions can use findings from this study to review, improve, and update current CADD curricula within the different Industrial Technology programs. Findings from this study can also provide useful information to potential employers in determining basic and fundamental CADD skills/competencies, and credentials from college graduates from NAIT accredited institutions.

Explanation of Procedures: Participants are expected to click in the radio boxes or check boxes provided next to the survey question items to select choices. Please click on the **Submit** button provided at the end of each section to proceed to subsequent sections. Completion of the survey instrument will take a maximum of 10 minutes. Data from survey will be destroyed at the end of research project. Participants interested in the survey results are free to contact the investigator through the email address(s) <rs432210@uni.edu> or<ronshava@yahoo.com>. Each survey instrument will be treated confidentially and is coded so as not to reveal information of the respondent upon submission. Please try to complete and submit the web survey questionnaire by July 15, 2004.

Discomfort and Risks: It assumed that participants will not face any physical, psychological, social, legal, and/or economic risk(s) or cost(s) resulting from this project. Any discomfort or inconvenience is sincerely regretted.

Benefits: Participants will not get any direct benefit(s) that may result from the study.

Confidentiality: Information obtained during this study which could identify you will be kept confidential. The summarized findings with no identifying information of the participants may be published in an aCADDemic journal or presented at a scholarly conference. No encryption of survey responses will be used during transmission and complete confidentiality cannot be guaranteed beyond that typically provided in an electronic communication such as email.

Right to Refuse or Withdraw: Your participation is completely voluntary. You are free to withdraw from participation at any time or to choose not to participate at all, and by doing so, you will not be penalized or lose benefits to which you are otherwise entitled.

Questions: If you have questions about the study or desire information in the future regarding your participation or the study generally, you can contact (investigator) at 319-222-5941 or (if appropriate) the project investigator's faculty advisor **Dr. A. Kashef** at the Department of Industrial Technology, University of Northern Iowa 319-273-2596, you can also contact the office of the Human Participants Coordinator, University of Northern Iowa, at 319-273-2748, for answers to questions about rights of research participants and the participant review process.

Agreement: I am fully aware of the nature and extent of my participation in this project as stated above and the possible risks arising from it. By clicking on the submit button provided below, I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement. I am 18 years of age or older.

Ronald Shava   Dr. A. Kashef
Doctoral Candidate   Graduate Committee- Chair

I have read this informed consent and understand all risks and benefits involved in this study.

I agree to particpate.

APPENDIX C

SURVEY INSTRUMENT

PERCEIVED IMPORTANCE OF NATIONAL OCCUPATIONAL CADD SKILL STANDARDS

AMONG FACULTY OF NAIT ACCREDITED INSTITUTIONS

(Survey of faculty teaching CADD courses in NAIT accredited programs)

This survey instrument has been designed to elicit opinion and attitude data from experts/professors/instructors teaching CADD courses in various Industrial Technology programs offered by NAIT accredited institutions in the United States of America. The purpose of the study is to ascertain the importance of generic National Occupational CADD Skill Standards to CADD Skill Standards pertinent to CADD courses within and among Industrial Technology programs offered by NAIT accredited institutions. The survey instrument is split into five parts: I Demographics, II Fundamental Drafting Skills, III Fundamental Computer Skills, IV Basic CADD Skills, and V Advanced CADD Skills.

Part I: DEMOGRAPHICS

Please answer every item to the best of your ability

Purpose: To gather demographic data about the selected participants completing the survey
instrument.

Click once in radio boxes provided next to questions/items to indicate your choices:

1. Number of years teaching CADD:

0-3 year ☐   4-6 years ☐   7-10 years ☐   10+ years ☐

2. Present rank:

Lecturer: ☐   Instructor ☐   Assistant Professor ☐   Associate Professor ☐   Professor ☐

3. Highest degree attained:

Bachelor : ☐   Masters: ☐   Doctorate: ☐

Check in appropriate boxes to select your choices

4. Indicate Industrial Technology program(s) in which you are teaching CADD courses (one can select more than one choice):

☐ Manufacturing		☐ Construction	
☐ Electronics		☐ CIM	
☐ Design/Graphics		☐ Computer Technology	
☐ Communication Technology		☐ Industrial Technology	
☐ Aerospace		☐ Industrial Management	
☐ Occupational Safety		☐ Production Planning/Control	
☐ Packaging-Automotive		☐ Digital Communication	
☐ Printing Management		☐ Quality Control-Plastics	
☐ Instrumentation		☐ Bio-Medical	
☐ Fashion & Graphic Arts		☐ Telecommunication	
☐ Technology Management		☐ Facility Management	
☐ Aviation Management			

5. Faculty Age:

20-24 ☐ 25-29 ☐ 30-34 ☐ 35-39 ☐ 40-44 ☐ 45-49 ☐

50-54 ☐ 55-59 ☐ 60-64 ☐ 65-79 ☐ 80+ ☐

[Submit]

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Part II: FUNDAMENTAL DRAFTING SKILLS

Click once in radio boxes provided next to questions/items to indicate your choice: Response Codes: 1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

The following CADD skill standards are important to the CADD courses in Industrial Technology the faculty is teaching:

1(a) Drafting Skills:

Skill	Scale				
	SD	D	N	A	SA
1. Use drawing media and related materials. (vellum, pens, plotting pens and toner cartridges)	☐	☐	☐	☐	☐
2. Use basic measurement systems. (Metric and English units, fractions, decimals, degrees, radians, area, perimeter, circumference, mass, and volume)	☐	☐	☐	☐	☐
3. Add correct annotation to drawing. (Notes, proportional symbols, GD&T symbols, Electrical symbols, and welding symbols)	☐	☐	☐	☐	☐
4. Identify line type and weights. (object line, center line, phantom line, hidden line, section line, cut plane line, dimension line, extension line, stitch line, chain line, and visible line)	☐	☐	☐	☐	☐
5. Prepare separate title blocks and other drafting formats. (title block, scale, sheet size, text size, text location and justification, revision list, approval block, and schedules)	☐	☐	☐	☐	☐
6. Identify and use appropriate standard symbols. (surface finish symbols, electrical/electronic, welding, GD&T, machining tool and architectural symbols)	☐	☐	☐	☐	☐
7. Reproduction of originals using different methods. (photo copiers, diazos, and original output devices, and plotted drawings)	☐	☐	☐	☐	☐
8. Create freehand sketch. (orthographic, pictorial, schematic and diagram sketches)	☐	☐	☐	☐	☐

1(b) Orthographic Projection

Skill	Scale				
	SD	D	N	A	SA
1. Identify, create and place appropriate orthographic views. (frontal, end elevations, plan views, hidden lines/surfaces, and 1st/3rd angle projection)	☐	☐	☐	☐	☐
2. Identify, create, and place appropriate orthographic views. (create primary and secondary auxiliary views with proper size and location)	☐	☐	☐	☐	☐
3. Identify, create, and place appropriate section views. (full sections, rib section, half section, foreshortened parts, rod, tubes, bars, wood, freaks, broken sections, and cutting plane lines)	☐	☐	☐	☐	☐

1(c) Pictorial Drawings

Skill	Scale				
	SD	D	N	A	SA
1. Identify and create axonometric drawings. (isometric, diametric, trimetric and exploded drawings)	☐	☐	☐	☐	☐
2. Identify and create oblique drawings. (cabinet and cavalier drawings using proper size and angles)	☐	☐	☐	☐	☐
3. Identify perspective drawings. (1, 2, and 3-point views; evaluating different types of perspective drawings)	☐	☐	☐	☐	☐

1(d) Dimensioning:

Skill	Scale				
	SD	D	N	A	SA
1. Apply dimension rules correctly. (rules on extension, dimension, and leader lines; spacing, crossing lines, and redundant dimensions)	☐	☐	☐	☐	☐
2. Use correct dimension line terminators. (location and size of dimension terminators, arrowheads, ticks, slashes, arcs, angle, radii, and diameters)	☐	☐	☐	☐	☐
3. Dimension objects. (proper size and location of dimensioning lines, arcs, angles, radii, and diameters)	☐	☐	☐	☐	☐
4. Dimension complex shapes. (proper size and location dimensions for spheres, cylinders, tapers, pyramids, irregular objects, and pictorial drawings)	☐	☐	☐	☐	☐
5. Dimension features from a center line. (proper size and location of center line; symmetrical features of a centerline)	☐	☐	☐	☐	☐
6. Dimension a theoretical point of intersection. (proper size and location of/to a point of theoretical point of intersection)	☐	☐	☐	☐	☐
7. Use appropriate dual dimension standards. (proper size and location of dual dimensioning using metric and inches)	☐	☐	☐	☐	☐
8. Use size and location dimension practices. (proper size and location of extension, dimension lines, and leader dimensions)	☐	☐	☐	☐	☐
9. Use various dimension styles. (proper size and location of/to Cartesian, polar, datum, and coordinate dimensioning methods)	☐	☐	☐	☐	☐
10. Place tolerance dimensions and Geometric Dimensioning and Tolerance (GD&T) on drawings where appropriate. (proper location and size of GD&T symbols)	☐	☐	☐	☐	☐

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Part III: FUNDAMENTAL COMPUTER SKILLS

Click once in radio boxes provided next to questions/items to indicate your choice:

Response Codes: **1.** Strongly Disagree (SD), **2.** Disagree (D), **3.** Neither disagree nor agree (N), **4.** Agree (A), **5.** Strongly Agree (SA)

The following CADD skill standards are important to the CADD courses in Industrial Technology the faculty is teaching:

2(a) Hardware:

Skill	Scale				
	SD	D	N	A	SA
1. Demonstrate proper care of equipment. (explain/identify standard procedures regarding care of equipment; mouse keyboard, and CPU)	☐	☐	☐	☐	☐
2. Operate and adjust input devices. (interface with the computers and software through use input devices; mouse, keyboard, tablet/digitizer)	☐	☐	☐	☐	☐
3. Operate and adjust output devices. (explain output devices plotters/printers based on standard procedures found in operators' manuals)	☐	☐	☐	☐	☐
4. Correct handling and operation of storage media. (standard techniques and procedures for the care and usage of storage media; diskettes, tapes, CDs based on manufacturer recommendations)	☐	☐	☐	☐	☐
5. Start shut down work station. (demonstrate power up with system function intact and initialization/exit procedures)	☐	☐	☐	☐	☐
6. Adjust monitor control for maximum comfort and usability. (ability to adjust monitor controls; brightness, contrast)	☐	☐	☐	☐	☐
7. Recognize availability of information services. (identify information sources and list source's services by function)	☐	☐	☐	☐	☐

2(b) Physical and Safety Needs:

Skill	Scale				
	SD	D	N	A	SA
1. Demonstrate an understanding of ergonomics consideration. (explain/identify ergonomic application)	☐	☐	☐	☐	☐
2. Demonstrate personal safety. (list and describe the OSHA and national Electrical Code safety standards; extension cords, daisy chaining, and watts usage for an outlet)	☐	☐	☐	☐	☐

(c) Operating Systems:

Scale	Scale				
	SD	**D**	**N**	**A**	**SA**
1. Start and exit a software as required. (exit an application within a software program)	☐	☐	☐	☐	☐
2. Demonstrate proper file management techniques. (copying, deleting, finding, saving, renaming; based on operating/application systems)	☐	☐	☐	☐	☐
3. Format floppy disk. (explain and demonstrate the procedure for preparation and use of floppy disks based on operating system)	☐	☐	☐	☐	☐
4. Identify, create, and use directory structure and change path. (identify, create, and apply a directory structure to organize files on a particular workstation; directories and sub-directories)	☐	☐	☐	☐	☐
5. Demonstrate proper file maintenance and backup procedures. (explain and demonstrate file back-up procedures for files and directories; based on operating/application system)	☐	☐	☐	☐	☐
6. Translate, import, and export data files between formats. (translate and explain the procedures/limitations for data files, data types based on he application system)	☐	☐	☐	☐	☐
7. Use on-line help. (use on-line help tutorials based on the application systems)	☐	☐	☐	☐	☐
8. Save drawings to storage devices. (save drawings on hard drives, floppy disks, CDs, etc based on operating system)	☐	☐	☐	☐	☐

[Submit]

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Part IV: BASIC CADD SKILLS

Click once in radio boxes provided next to questions/items to indicate your choice:

Response Codes: **1.** Strongly Disagree (SD), **2.** Disagree (D), **3.** Neither disagree nor agree (N), **4.** Agree (A), **5.** Strongly Agree (SA)

The following CADD skill standards are important to the CADD courses in Industrial Technology the faculty is teaching:

3(a) Create:

Skill	Scale				
	SD	D	N	A	SA
1. Create new drawing. (demonstrate the ability to open a drawing data file and create a drawing)	☐	☐	☐	☐	☐
2. Perform drawing set up. (identify and demonstrate the ability to perform drawing set up; sheet size, border, title block)	☐	☐	☐	☐	☐
3. Construct geometric figures. (demonstrate multiple construction techniques; line, conics, circles, splines, arcs, and polygons given size, orientation, and location specifications)	☐	☐	☐	☐	☐
4. Create text using appropriate style and size to annotate drawings. (create appropriate text annotation commands orientation, style, size, placement in CADD)	☐	☐	☐	☐	☐
5. Use and control accuracy enhancement tools. (define and apply entity positioning tools; snap, grid, and construction planes; utilizing various locating specifications and system coordinates)	☐	☐	☐	☐	☐
6. Identify, create, store, and use appropriate symbols/libraries. (demonstrate the ability to identify and create symbols; ANSI/ISO standard, company standard, and discipline oriented symbols)	☐	☐	☐	☐	☐
7. Create wireframe/solid models. (create accurate and proper 3D wireframe/solids representation for plane surfaces)	☐	☐	☐	☐	☐
8. Create objects using primitives. (create accurate and properly represented 3-D models composed of primitives)	☐	☐	☐	☐	☐
9. Create 2-D geometry from 3-D models. (extract accurate 2-D profile from 3-D frame models)	☐	☐	☐	☐	☐
10. Revolve a profile to create a 3-D object. (revolve a 2-D profile on a rotational axis to create a 3-D model)	☐	☐	☐	☐	☐
11. Create 3-D wireframe models from 2-D geometry. (extrude a 2-D profile onto a rotational axis to create a 3-D model)	☐	☐	☐	☐	☐

3 (b) Edit:

Skill	Scale				
	SD	D	N	A	SA
1. Utilize geometry editing commands. (identify and demonstrate editing commands; mirror, trim, scale, rotate, break, fillet, move, stretch, extend, copy, chamfer)	☐	☐	☐	☐	☐
2. Utilize non-geometric commands. (demonstrate editing and sizing skill using non-geometric editing commands; text sizing, editing, and orientation)	☐	☐	☐	☐	☐

3(c) Manipulate:

Skill	Scale				
	SD	D	N	A	SA
1. Control coordinates and display scale. (demonstrate the modification and selection of origin, scale, and axis orientation)	☐	☐	☐	☐	☐
2. Control entity properties. (demonstrate the modification of entity properties; color type, line type, thickness type)	☐	☐	☐	☐	☐
3. Use viewing commands. (demonstrate viewing commands; dynamic rotation, zooming, panning, change view, view names, multi-view)	☐	☐	☐	☐	☐
4. Use display commands. (apply correct uses for display commands; hidden line, no hidden line, shading, meshing, wireframe)	☐	☐	☐	☐	☐
5. Use standard parts and/or symbols. (demonstrate the location, use and creation of standard parts and symbol libraries; scale, location, entity properties)	☐	☐	☐	☐	☐
6. Plot drawing on media using correct layout and scale. (demonstrate plotting procedures; layout, scale, view, file)	☐	☐	☐	☐	☐
7. Use layering techniques. (demonstrate and apply the various layering techniques; freeze, visibility)	☐	☐	☐	☐	☐
8. Using grouping techniques. (demonstrate various grouping techniques; un-group, delete, re-group, create)	☐	☐	☐	☐	☐
9. Minimize file size. (demonstrate reduction of file size/extraneous entities and the need for file reductions)	☐	☐	☐	☐	☐

3(d) Analyze:

Skill	Scale				
	SD	D	N	A	SA
1. Use query commands to interrogate database. (apply the use of query commands ; mass properties, geometric measure, system status, entity characteristics)	☐	☐	☐	☐	☐

3(e) Dimensioning:

Skill	Scale				
	SD	D	N	A	SA
1. Use associative dimensioning correctly. (demonstrate the various descriptors of associative dimensioning; horizontal, vertical, ordinate, circular, diametrical, radial, polar)	☐	☐	☐	☐	☐

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Part V: ADVANCED CADD SKILLS

Click once in radio box provided next to questions/items to indicate your choice:

Response Codes: **1.** Strongly Disagree **(SD), 2.** Disagree **(D), 3.** Neither disagree nor agree **(N), 4.** Agree **(A), 5.** Strongly Agree **(SA)**

The following CADD skill standards are important to the CADD courses in Industrial Technology the faculty is teaching:

4(a) Create:

Skill	Scale				
	SD	**D**	**N**	**A**	**SA**
1. Create a wireframe and/or solid models. (create multiple radii fillets, sculpted surfaces, variable fillets, complex/compound wireframe or 3-D models)	☐	☐	☐	☐	☐
2. Create non-analytic surfaces using appropriate modeling (create a non-analytic accurate surface, according to size, shape, and location; NURB, B-spline, Gordon, Bezier, coons patch)	☐	☐	☐	☐	☐
3. Create analytic surfaces using modeling with planes and analytic curves. (create accurate analytic surfaces according to size, shape, and location; conics, cylinders, revolved, ruled, tabulated surfaces)	☐	☐	☐	☐	☐
4. Create offset surface. (create offset surfaces at a specified distances)	☐	☐	☐	☐	☐
5. Find an intersection of two surfaces. (develop a show of lines or curves at intersection of surfaces)	☐	☐	☐	☐	☐
6. Create joined surfaces. (create a single surface fro multiple surfaces)	☐	☐	☐	☐	☐
7. Create a fillet or blend between two surfaces. (develop filleted, rounded, chamfered and blended surfaces; size and location of trimmed/not trimmed surfaces)	☐	☐	☐	☐	☐
8. Create feature based geometry. (create various types of feature-based geometry based on size and location using; holes, slots, round, fillet, counterbores, countersink, spotfaces)	☐	☐	☐	☐	☐
9. Create cut sections. (create and show sections of various types and styles of 3-Dsolid models; full, offset, rotate, half)	☐	☐	☐	☐	☐
10. Construct and label exploded assembly drawings. (construct and label accurate drawing representations of multiple models)	☐	☐	☐	☐	☐
11. Perform Boolean operation. (demonstrate mastery of advanced Boolean operations; keep model database small; multiple union, subtraction, intersection, instancing)	☐	☐	☐	☐	☐

4(b) Edit:

Skill	Scale				
	SD	D	N	A	SA
1. Trim surface. (demonstrate mastery of skill by correctly trimming surfaces, including multiple trimmed surfaces)	☐	☐	☐	☐	☐
2. Manipulate surface normals. (demonstrate mastery of skill by manipulating surface normals, including reverse and reverse normal)	☐	☐	☐	☐	☐
3. Extend surfaces. (demonstrate mastery of skill by extending surfaces)	☐	☐	☐	☐	☐
4. Edit control points. (demonstrate skill and modify surface by moving, adding and/or removing the control point; Bezier, mesh, NURBS, Coons Patch)	☐	☐	☐	☐	☐
5. Modify geometry via Boolean operation. (demonstrate skill by deleting solid primitive)	☐	☐	☐	☐	☐
6. Edit primitive. (demonstrate skill by moving, copying, and resizing primitives)	☐	☐	☐	☐	☐

4(c) Manipulate:

Skill	Scale				
	SD	D	N	A	SA
1. Perform axis view clipping. (demonstrate skill to perform an axis view clipping using a plane to display desired pre-determined view, including hidden line removal)	☐	☐	☐	☐	☐
2. Extract wireframe data from surface/solid geometry. (demonstrate skill by using complete and accurate wireframe data to create a 3-D wireframe from a 3-D model)	☐	☐	☐	☐	☐
3. Shade/render object. (shade a rendered image of a model or object using reflectivity, opacity, lights cameras, material properties and finishes)	☐	☐	☐	☐	☐

4(d) Analyze:

Skill	Scale				
	SD	D	N	A	SA
1. Extract geometric data. (identify, valid, and usable the purposes and uses of extracting geometric data from surfaces and a wireframe)	☐	☐	☐	☐	☐
2. Extract attribute data. (demonstrate ability to completely extract lists, files, and valid and usable attribute data from part lists, bills of material)	☐	☐	☐	☐	☐
3. Identify gASP in non-intersecting surfaces. (demonstrate mastery skill by locating and querying surface to surface gASP)	☐	☐	☐	☐	☐
4. Obtain surface properties. (demonstrate mastery skill by extracting different surface properties, perimeter, normals)	☐	☐	☐	☐	☐
5. Obtain mass properties data. (demonstrate mastery of skill by extracting mass properties such as moments of inertia, centroids, volume, mass)	☐	☐	☐	☐	☐

4 (e) Productivity and Work Habits:

Skill	Scale				
	SD	D	N	A	SA
1. Perform customization to improve productivity. (demonstrate results from applying customization techniques to menus, key assignments, scripts, and macros)	☐	☐	☐	☐	☐
2. Manipulate associate non-graphical data. (demonstrate skill by manipulating non-graphical data; spreadsheets, text files, engineering output files)	☐	☐	☐	☐	☐
3. Use template and library files to establish drawing standard presents. (demonstrate skill by using template and library system defaults to create drawing standard presents)	☐	☐	☐	☐	☐
4. Develop geometry using parametric programs. (construct geometry graphics using parametrically controlled programs)	☐	☐	☐	☐	☐

Submit

Thank you very much for participating in this survey. Your input is heartily appreciated.

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PERCEIVED IMPORTANCE OF NATIONAL OCCUPATIONAL CADD SKILL STANDARDS
AMONG FACULTY OF NAIT ACCREDITED INSTITUTIONS
(Survey of faculty teaching CADD courses in NAIT accredited programs)

This survey instrument has been designed to elicit opinion and attitude data from experts/professors/instructors teaching CADD courses in various Industrial Technology programs offered by NAIT accredited institutions in the United States of America. The purpose of the study is to ascertain the levels of relevance of generic National Occupational CADD Skill Standards to CADD Skill Standards pertinent to CADD courses within and among Industrial Technology programs offered by NAIT accredited institutions. The survey instrument is split into five parts: I Demographics, II Fundamental Drafting Skills, III Fundamental Computer Skills, IV Basic CADD Skills, and V Advanced CADD Skills. Please feel free to express your opinions and attitude as candidly as possible.

Part I: DEMOGRAPHICS
Please answer every item to the best of your ability

Purpose: To gather demographic data about the selected participants completing the survey
         instrument.
Click once in text box provided next to questions and type in [X] to indicate your choices.

1. Number of years on faculty teaching CADD:

2. Present rank:

Lecturer: ( )   Instructor: ( )   Assistant Professor: ( )

Associate Professor: ( )   Professor: ( )

3. Highest degree attained:

Bachelor: ( )   Masters: ( )   Doctorate: ( )

5. Industrial program in which faculty is teaching CADD courses:

( ) Manufacturing: ( ) Construction:
( ) Electronics: ( ) CIM:
( ) Design/Graphics: ( ) Computer Technology:
( ) Communication Technology: ( ) Industrial Technology:
( ) Aerospace: ( ) Industrial Management:
( ) Occupational Safety: ( ) Production Planning/Control:
( ) Packaging-Automotive: ( ) Digital Communication:
( ) Printing Management: ( ) Quality Control-Plastics:
( ) Instrumentation: ( ) Bio-Medical:
( ) Fashion & Graphic Arts: ( ) Telecommunication:
( ) Technology Management: ( ) Facility Management:
( ) Aviation Management:

6. Age:

20-24 ( )	25-29 ( )	30-34 ( )	35-39 ( )	40-44 ( )	45-49 ( )
50-54 ( )	55-69 ( )	60-64 ( )	65-79 ( )	80+ ( )	

Part II: FUNDAMENTAL DRAFTING SKILLS
Click in the appropriate box next to the question items to indicate your choice and type [X].

Response Codes:
1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

The following CADD skill standards are relevant and important to the CADD courses in Industrial Technology the faculty is teaching:

1(a) Drafting Skills:

Scale		SD	D	N	A	SA
1.	Use drawing media and related materials. (vellum, pens, plotting pens and toner cartridges)	( )	( )	( )	( )	( )
2.	Use basic measurement systems. (Metric and English units, fractions, decimals, degrees, radians, area, perimeter, circumference, mass, and volume)	( )	( )	( )	( )	( )
3.	Add correct annotation to drawing. (Notes, proportional symbols, GD&T symbols, Electrical symbols, and welding symbols)	( )	( )	( )	( )	( )
4.	Identify line type and weights. (object line, center line, phantom line, hidden line, section line, cut plane line, dimension line, extension line, stitch line, chain line, and visible line)	( )	( )	( )	( )	( )
5.	Prepare separate title blocks and other drafting formats. (title block, scale, sheet size, text size, text location and justification, revision list, approval block, and schedules)	( )	( )	( )	( )	( )
6.	Identify and use appropriate standard symbols. (surface finish symbols, electrical/electronic, welding, GD&T, machining tool and architectural symbols)	( )	( )	( )	( )	( )
7.	Reproduction of originals using different methods. (photo copiers, diazos, and original output devices, and plotted drawings)	( )	( )	( )	( )	( )
8.	Create freehand sketch. (orthographic, pictorial, schematic and diagram sketches)	( )	( )	( )	( )	( )

1(b) Orthographic Projection

Scale		SD	D	N	A	SA
1.	Identify, create and place appropriate orthographic views. (frontal, end elevations, plan views, hidden lines/surfaces, and $1^{st}/3^{rd}$ angle projection)	( )	( )	( )	( )	( )
2.	Identify, create, and place appropriate orthographic views. (create primary and secondary auxiliary views with proper size and location)	( )	( )	( )	( )	( )
3.	Identify, create, and place appropriate section views. (full sections, rib section, half section, foreshortened parts, rod, tubes, bars, wood, freaks, broken sections, and cutting plane lines)	( )	( )	( )	( )	( )

1(c) Pictorial Drawings

Scale		SD	D	N	A	SA
1.	Identify and create axonometric drawings. (isometric, diametric, trimetric and exploded drawings)	( )	( )	( )	( )	( )
2.	Identify and create oblique drawings. (cabinet and cavalier drawings using proper size and angles)	( )	( )	( )	( )	( )
3.	Identify perspective drawings. (1, 2, and 3-point views; evaluating different types of perspective drawings)	( )	( )	( )	( )	( )

Part II: FUNDAMENTAL DRAFTING SKILLS

Response Codes:
1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

1(d) Dimensioning:

Scale		SD	D	N	A	SA
1.	Apply dimension rules correctly. (rules on extension, dimension, and leader lines; spacing, crossing lines, and redundant dimensions)	( )	( )	( )	( )	( )
2.	Use correct dimension line terminators. (location and size of dimension terminators, arrowheads, ticks, slashes, arcs, angle, radii, and diameters)	( )	( )	( )	( )	( )
3.	Dimension objects. (proper size and location of dimensioning lines, arcs, angles, radii, and diameters)	( )	( )	( )	( )	( )
4.	Dimension complex shapes. (proper size and location dimensions for spheres, cylinders, tapers, pyramids, irregular objects, and pictorial drawings)	( )	( )	( )	( )	( )
5.	Dimension features from a center line. (proper size and location of center line; symmetrical features of a centerline)	( )	( )	( )	( )	( )
6.	Dimension a theoretical point of intersection. (proper size and location of/to a point of theoretical point of intersection)	( )	( )	( )	( )	( )
7.	Use appropriate dual dimension standards. (proper size and location of dual dimensioning using metric and inches)	( )	( )	( )	( )	( )
8.	Use size and location dimension practices. (proper size and location of extension, dimension lines, and leader dimensions)	( )	( )	( )	( )	( )
9.	Use various dimension styles. (proper size and location of/to Cartesian, polar, datum, and coordinate dimensioning methods)	( )	( )	( )	( )	( )
10.	Place tolerance dimensions and Geometric Dimensioning and Tolerance (GD&T) on drawings where appropriate. (proper location and size of GD&T symbols)	( )	( )	( )	( )	( )

Part III: FUNDAMENTAL COMPUTER SKILLS
Click in the appropriate box next to the question items to indicate your choice and type [X].

Response Codes:
1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

The following CADD skill standards are relevant and important to the CADD courses in Industrial Technology the faculty is teaching:

2(a) Hardware:

Scale		SD	D	N	A	SA
1.	Demonstrate proper care of equipment. (explain/identify standard procedures regarding care of equipment; mouse keyboard, and CPU)	( )	( )	( )	( )	( )
2.	Operate and adjust input devices. (interface with the computers and software through use input devices; mouse, keyboard, tablet/digitizer)	( )	( )	( )	( )	( )
3.	Operate and adjust output devices. (explain output devices plotters/printers based on standard procedures found in operators' manuals)	( )	( )	( )	( )	( )
4.	Correct handling and operation of storage media. (standard techniques and procedures for the care and usage of storage media; diskettes, tapes, CDs based on manufacturer recommendations)	( )	( )	( )	( )	( )
5.	Start shut down work station. (demonstrate power up with system function intact and initialization/exit procedures)	( )	( )	( )	( )	( )

6. Adjust monitor control for maximum comfort and usability. (ability to adjust monitor controls; brightness, contrast)   ( )   ( ) ( ) ( ) ( )

7. Recognize availability of information services. (identify information sources and list source's services by function)   ( )   ( ) ( ) ( ) ( )

Part III: FUNDAMENTAL COMPUTER SKILLS
Click in the appropriate box next to the question items to indicate your choice and type [X].

Response Codes:
1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

The following CADD skill standards are relevant and important to the CADD courses in Industrial Technology the faculty is teaching:

2(b) Physical and Safety Needs:

Scale		SD	D	N	A	SA
1.	Demonstrate an understanding of ergonomics consideration. (explain/identify ergonomic application)	( )	( )	( )	( )	( )
2.	Demonstrate personal safety. (list and describe the OSHA and national Electrical Code safety standards; extension cords, daisy chaining, and watts usage for an outlet)	( )	( )	( )	( )	( )

2(c) Operating Systems:

Scale		SD	D	N	A	SA
1.	Start and exit a software as required. (exit an application within a software program)	( )	( )	( )	( )	( )
2.						
3.	Demonstrate proper file management techniques. (copying, deleting, finding, saving, renaming; based on operating/application systems)	( )	( )	( )	( )	( )
4.	Format floppy disk. (explain and demonstrate the procedure for preparation and use of floppy disks based on operating system)	( )	( )	( )	( )	( )
5.	Identify, create, and use directory structure and change path. (identify, create, and apply a directory structure to organize files on a particular workstation; directories and sub-directories)	( )	( )	( )	( )	( )
6.	Demonstrate proper file maintenance and backup procedures. (explain and demonstrate file back-up procedures for files and directories; based on operating/application system)	( )	( )	( )	( )	( )
7.	Translate, import, and export data files between formats. (translate and explain the procedures/limitations for data files, data types based on he application system)	( )	( )	( )	( )	( )
8.	Use on-line help. (use on-line help tutorials based on the application systems)	( )	( )	( )	( )	( )
9.	Save drawings to storage devices. (save drawings on hard drives, floppy disks, CDs, etc based on operating system)	( )	( )	( )	( )	( )

<u>Part IV: BASIC CADD SKILLS</u>
Click in the appropriate box next to the question items to indicate your choice and type [X].

Response Codes:
1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

The following CADD skill standards are relevant and important to the CADD courses in Industrial Technology the faculty is teaching:

3(a) Create:

Scale		SD	D	N	A	SA
1.	Create new drawing. (demonstrate the ability to open a drawing data file and create a drawing)	( )	( )	( )	( )	( )
2.	Perform drawing set up. (identify and demonstrate the ability to perform drawing set up; sheet size, border, title block)	( )	( )	( )	( )	( )
3.	Construct geometric figures. (demonstrate multiple construction techniques; line, conics, circles, splines, arcs, and polygons given size, orientation, and location specifications)	( )	( )	( )	( )	( )
4.	Create text using appropriate style and size to annotate drawings. (create appropriate text annotation commands orientation, style, size, placement in CADD)	( )	( )	( )	( )	( )
5.	Use and control accuracy enhancement tools. (define and apply entity positioning tools; snap, grid, and construction planes; utilizing various locating specifications and system coordinates)	( )	( )	( )	( )	( )
6.	Identify, create, store, and use appropriate symbols/libraries. (demonstrate the ability to identify and create symbols; ANSI/ISO standard, company standard, and discipline oriented symbols)	( )	( )	( )	( )	( )
7.	Create wireframe/solid models. (create accurate and proper 3D wireframe/solids representation for plane surfaces)	( )	( )	( )	( )	( )
8.	.Create objects using primitives. (create accurate and properly represented 3-D models composed of primitives)	( )	( )	( )	( )	( )
9.	Create 2-D geometry from 3-D models. (extract accurate 2-D profile from 3-D frame models)	( )	( )	( )	( )	( )
10.	Revolve a profile to create a 3-D object. (revolve a 2-D profile on a rotational axis to create a 3-D model)	( )	( )	( )	( )	( )
11.	Create 3-D wireframe models from 2-D geometry. (extrude a 2-D profile onto a rotational axis to create a 3-D model)	( )	( )	( )	( )	( )

(b) Edit:

Scale		SD	D	N	A	SA
1.	Utilize geometry editing commands. (identify and demonstrate editing commands; mirror, trim, scale, rotate, break, fillet, move, stretch, extend, copy, chamfer)	( )	( )	( )	( )	( )
2.	Utilize non-geometric commands. (demonstrate editing and sizing skill using non-geometric editing commands; text sizing, editing, and orientation)	( )	( )	( )	( )	( )

3(c) Manipulate:

Scale		SD	D	N	A	SA
1.	Control coordinates and display scale. (demonstrate the modification and selection of origin, scale, and axis orientation)	( )	( )	( )	( )	( )
2.	Control entity properties. (demonstrate the modification of entity properties; color type, line type, thickness type)	( )	( )	( )	( )	( )
3.	Use viewing commands. (demonstrate viewing commands; dynamic rotation, zooming, panning, change view, view names, multi-view)	( )	( )	( )	( )	( )

4. Use display commands. (apply correct uses for display commands; hidden line, no hidden line, shading, meshing, wireframe)   ( )   ( )   ( )   ( )   ( )

5. Use standard parts and/or symbols. (demonstrate the location, use and creation of standard parts and symbol libraries; scale, location, entity properties)   ( )   ( )   ( )   ( )   ( )

6. Plot drawing on media using correct layout and scale. (demonstrate plotting procedures; layout, scale, view, file)   ( )   ( )   ( )   ( )   ( )

7. Use layering techniques. (demonstrate and apply the various layering techniques; freeze, visibility)   ( )   ( )   ( )   ( )   ( )

8. Using grouping techniques. (demonstrate various grouping techniques; un-group, delete, re-group, create)   ( )   ( )   ( )   ( )   ( )

9. Minimize file size. (demonstrate reduction of file size/extraneous entities and the need for file reductions)   ( )   ( )   ( )   ( )   ( )

3(d) Analyze:

Scale		SD	D	N	A	SA
1.	Use query commands to interrogate database. (apply the use of query commands ; mass properties, geometric measure, system status, entity characteristics)	( )	( )	( )	( )	( )

3(e) Dimensioning:

Scale		SD	D	N	A	SA
1.	Use associative dimensioning correctly. (demonstrate the various descriptors of associative dimensioning; horizontal, vertical, ordinate, circular, diametrical, radial, polar)	( )	( )	( )	( )	( )

Part V: ADVANCED CADD SKILLS

Click in the appropriate box next to the question items to indicate your choice and type [X].

Response Codes:
1. Strongly Disagree (SD), 2. Disagree (D), 3. Neither disagree nor agree (N), 4. Agree (A), 5. Strongly Agree (SA)

The following CADD skill standards are relevant and important to the CADD courses in Industrial Technology the faculty is teaching:

4(a) Create:

Scale		SD	D	N	A	SA
1.	Create a wireframe and/or solid models. (create multiple radii fillets, sculpted surfaces, variable fillets, complex/compound wireframe or 3-D models)	( )	( )	( )	( )	( )
2.	Create non-analytic surfaces using appropriate modeling (create a non-analytic accurate surface, according to size, shape, and location; NURB, B-spline, Gordon, Bezier, coons patch)	( )	( )	( )	( )	( )
3.	Create analytic surfaces using modeling with planes and analytic curves. (create accurate analytic surfaces according to size, shape, and location; conics, cylinders, revolved, ruled, tabulated surfaces)	( )	( )	( )	( )	( )
4.	Create offset surface. (create offset surfaces at a specified distances)	( )	( )	( )	( )	( )
5.	Find an intersection of two surfaces. (develop a show of lines or curves at intersection of surfaces)	( )	( )	( )	( )	( )
6.	Create joined surfaces. (create a single surface fro multiple surfaces)	( )	( )	( )	( )	( )
7.	Create a fillet or blend between two surfaces. (develop filleted, rounded, chamfered and blended surfaces; size and location of trimmed/not trimmed surfaces)	( )	( )	( )	( )	( )
8.	Create feature based geometry. (create various types of feature-based geometry	( )	( )	( )	( )	( )

based on size and location using; holes, slots, round, fillet, counterbores, countersink, spotfaces)

		SD	D	N	A	SA
9.	Create cut sections. (create and show sections of various types and styles of 3-Dsolid models; full, offset, rotate, half)	( )	( )	( )	( )	( )
10.	Construct and label exploded assembly drawings. (construct and label accurate drawing representations of multiple models)	( )	( )	( )	( )	( )
11.	Perform Boolean operation. (demonstrate mastery of advanced Boolean operations; keep model database small; multiple union, subtraction, intersection, instancing)	( )	( )	( )	( )	( )

4(b) Edit:

Scale		SD	D	N	A	SA
1.	Trim surface. (demonstrate mastery of skill by correctly trimming surfaces, including multiple trimmed surfaces)	( )	( )	( )	( )	( )
2.	Manipulate surface normals. (demonstrate mastery of skill by manipulating surface normals, including reverse and reverse normal)	( )	( )	( )	( )	( )
3.	Extend surfaces. (demonstrate mastery of skill by extending surfaces)	( )	( )	( )	( )	( )
4.	Edit control points. (demonstrate skill and modify surface by moving, adding and/or removing the control point; Bezier, mesh, NURBS, Coons Patch)	( )	( )	( )	( )	( )
5.	Modify geometry via Boolean operation. (demonstrate skill by deleting solid primitive)	( )	( )	( )	( )	( )
6.	Edit primitive. (demonstrate skill by moving, copying, and resizing primitives)	( )	( )	( )	( )	( )

4(c) Manipulate:

Scale		SD	D	N	A	SA
1.	Perform axis view clipping. (demonstrate skill to perform an axis view clipping using a plane to display desired pre-determined view, including hidden line removal)	( )	( )	( )	( )	( )
2.	Extract wireframe data from surface/solid geometry. (demonstrate skill by using complete and accurate wireframe data to create a 3-D wireframe from a 3-D model)	( )	( )	( )	( )	( )
3.	Shade/render object. (shade a rendered image of a model or object using reflectivity, opacity, lights cameras, material properties and finishes)	( )	( )	( )	( )	( )

(d) Analyze:

Scale		SD	D	N	A	SA
1.	Extract geometric data. (identify, valid, and usable the purposes and uses of extracting geometric data from surfaces and a wireframe)	( )	( )	( )	( )	( )
2.	Extract attribute data. (demonstrate ability to completely extract lists, files, and valid and usable attribute data from part lists, bills of material)	( )	( )	( )	( )	( )
3.	Identify gASP in non-intersecting surfaces. (demonstrate mastery skill by locating and querying surface to surface gASP)	( )	( )	( )	( )	( )
4.	Obtain surface properties. (demonstrate mastery skill by extracting different surface properties, perimeter, normals)	( )	( )	( )	( )	( )
5.	Obtain mass properties data. (demonstrate mastery of skill by extracting mass properties such as moments of inertia, centroids, volume, mass)	( )	( )	( )	( )	( )

4(d) Productivity and Work Habits:

Scale		SD	D	N	A	SA
1.	Perform customization to improve productivity. (demonstrate results from applying customization techniques to menus, key assignments, scripts, and	( )	( )	( )	( )	( )

macros)

2. Manipulate associate non-graphical data. (demonstrate skill by manipulating non-graphical data; spreadsheets, text files, engineering output files)   ( )   ( )   ( )   ( )   ( )

3. Use template and library files to establish drawing standard presents. (demonstrate skill by using template and library system defaults to create drawing standard presents)   ( )   ( )   ( )   ( )   ( )

4. Develop geometry using parametric programs. (construct geometry graphics using parametrically controlled programs)   ( )   ( )   ( )   ( )   ( )

Thank you very much for participating in this survey. Your input is heartily appreciated.