

AN ASSESSMENT OF EMPLOYER REQUIREMENTS
OF COMPETENCIES OF MECHANICAL DESIGN STUDENTS
AT WISCONSIN INDIANHEAD TECHNICAL COLLEGE

by

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ABSTRACT

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AN ASSESSMENT OF EMPLOYER REQUIREMENTS OF COMPETENCIES OF
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This study examined mechanical design competency requirements from an employer's point of view. Prior studies have been conducted that solicited input from engineering professionals on a national level. This study was unique in that it targeted manufacturing firms in the Wisconsin Indianhead Technical College region and surveyed their competency requirements from entry-level employees.

This research also provided WITC with a specific database of information about products being manufactured in our region. Analysis of the research provided WITC with information that validated program competencies or indicated potential areas of program modification for the region.

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CHAPTER 1

Introduction

Background

The competencies for an Associate Degree in Mechanical Design are specified by the state of Wisconsin. These competencies are uniform throughout the state no matter what “types” of industry are prevalent in each of the sixteen districts. The purpose of this study is to determine the most important competencies required by *employers* of entry level designers from the Mechanical Design Technician program at Wisconsin Indianhead Technical College (WITC), primarily in Northern Wisconsin and Eastern Minnesota (Twin Cities metro).

The topic for this thesis was proposed to the Dean of this researcher’s program, who immediately backed it enthusiastically. He felt that it would provide WITC with a better “feel” for what subject matter to emphasize within the Mechanical Design Technician program. At the same time, it would help WITC de-emphasize other material not being utilized by employers in the region. Many graduates of the WITC Mechanical Design Technician program are now in supervisory positions in their respective companies and completed the survey. They achieved these positions through hard work to be sure, but it was also because of competencies gained through technical education. They are in a unique position to aid WITC with their “insider” knowledge of the Mechanical Design Technician program and their knowledge of what was required of them when they graduated.

What WITC has heard repeatedly in advisory meetings and in conversations with area manufacturers is that employers are looking for a “whole” employee. Companies

want employees that are not only technically skilled, but have refined “people skills” as well. Employers want graduates who can communicate at a high level the first day on the job.

Mechanical designers are often at the “hub” of the manufacturing and assembly processes. They must communicate their designs to machinists, quality control, vendors, customers, sales personnel, and upper management. Mechanical designers use drawings as their main tool of communication, but often need to supplement these with verbal and written communications. Although an assembly drawing may be 24” x 36”, over half of this space may be devoted to written directions on how to assemble the product and the order in which to assemble it. Consequently, highly developed written communications skills are also required.

The Internet has only accentuated this need. In recent years, mechanical designers often communicate with customers and vendors via email, hence the need for professional business communication skills and etiquette. To be sure that the survey addressed an employer’s need for a multifaceted employee, questions in the survey were directed towards engineering skills, people skills, and computer technology skills as well.

The study is significant because it will assess “real world” competency requirements from an *employer’s* point of view. This will give WITC an opportunity to better meet the needs of regional manufacturers by emphasizing competencies deemed most important by the survey results. In turn, graduates will benefit from this knowledge because they will feel prepared and confident to enter the regional job market knowing that they have skills sought after by manufacturers in the region.

Statement of the Problem

To date, there has not been a study conducted that identifies industries in the region and their engineering requirements from graduates of the Mechanical Design Technician Program. Valuable information is received from advisory council members, but this does not reflect all interests district-wide and beyond. This study surveys regional employers who utilize graduates from the Mechanical Design Technician Program at the Rice Lake campus. The study assesses and compares skills learned at WITC with skills used on the job.

Research Objectives

There are five research questions this study will answer; they are:

1. What attributes/skills/knowledge do regional employers utilize most from entry level employees from the Mechanical Design Technician program?
2. What skills now being emphasized in coursework do regional employers consider least important?
3. Is there a gap between what is being taught in the program and what regional employers desire?
4. What products are being designed and built in the region?
5. What mechanical design software is prevalent in the region?

Definition of terms

In order to understand this research paper, it is necessary to define terms commonly used in a design/manufacturing environment. The following (in alphabetical order) are

commonly used terms in this research paper and on a daily basis in manufacturing industries.

AutoCAD – Mechanical design software (primarily 2D)

Computer-Aided-Design (CAD) - The use of computers and specialized graphic software to accurately depict the geometry of a manufactured product.

Geometric Dimensioning and Tolerancing, (GD&T) – A method of defining part shape using geometric constraints.

Machine elements – gears, cams, springs, fasteners, sprockets, chains, pulleys, belts, etc,

Pro/Engineer – Mechanical design software (3D solid modeling)

Strength of Materials – The study of loads and stresses in manufacturing and how they affect materials used to build products.

Wisconsin Indianhead Technical College (WITC), - State of Wisconsin Technical College - Rice Lake campus

Assumptions

It is assumed that all surveyed participants are employed in a function that has contact with an engineering design department on a daily basis. It is also assumed that subjects have a basic understanding of terms listed above in the “Definition of terms” section.

Limitations of the Study

The researcher is not aware of any direct limitations on this study. Of course, the percentage of surveys returned always has a direct impact on any study of this nature. However, it is in an employer's best interest to return the survey because the results will have a direct impact on areas of emphasis in the mechanical design program. This will have an impact on future employees in the employer's design department.

CHAPTER 2

Literature Review

Introduction

This review of literature will examine core competencies for mechanical designers in college-level coursework. Associate degree competencies of other colleges will be analyzed and compared to those already in place in the Wisconsin Technical College System. This research will validate current WITC competencies or serve as a rationale for program modification, if necessary.

There are many specific competencies taught by engineering colleges nationally and internationally. This review will focus on those agreed upon by most mechanical engineering programs. This will provide a common “core” of comparison to competencies and standards applied at WITC.

History of Mechanical Design

To attempt to summarize the history of mechanical design, one would be constrained to predate the wheel, for levered objects were used to provide a mechanical advantage from time immemorial. Early man used an apparatus called an atlatl to provide higher velocity and more distance (wisely) to a spear when slaying mastodons. A mortar and pestle were used to grind grains, while deadfall traps lay in hiding for unsuspecting mammals to trigger. Massive blocks of stone were somehow moved and stacked to build the pyramids. The rocks at Stonehenge were slid 50 miles before being tilted on end to pinpoint the solstices. Burstall, (1965), states that the use of the wheel for mechanical movement dates to approximately 3500 BC. Wheels that rotate within bearings on an axle were used in transportation applications, such as a cart drawn by a beast of burden,

and in the ceramic trade, where potters wheels were an early application of rotary mechanical movement to create a product.

Burstall further states that of particular importance to Western civilization is the invention and subsequent production of the printing press. It was arguably the greatest invention of the Renaissance. By 1500, 1075 printing presses were estimated to be in use in Europe alone. Although the mechanics of the printing press are primitive by today's standards, it enabled the dissemination of knowledge to a massive audience, hungry for the written word.

The history of modern American mechanical design, and related inventions, traces its lineage to Ben Franklin, inventor of bifocals, the lightning rod, Franklin stove, and odometer (attached to the wheel of his carriage). According to The Franklin Institute (2003), he was one of the first serious students of electricity. It was Franklins' curiosity that gave birth to scientific discoveries and subsequent inventions based on his findings.

Franklin was a great reader but had poor eyesight. He grew annoyed at having to remove his glasses to work, and to put them back on when he wanted to read. He had two pairs of eyeglasses cut in half and glued them into one frame, enabling him to see both near and far – hence the bifocal lens. Franklin was followed by the likes of Eli Whitney, Cyrus McCormick, John Deere, Alexander Bell, and Thomas Edison. Their mechanical/electrical innovations, coupled with Ford's methods of mass production, brought affordable mechanical automation to the working public.

As we near 100 years of flight, the mechanical genius of the Wright brothers becomes ever more apparent. According to the Wright Experience On-line (2003), the Wright brothers rightly believed that a heavier-than-air object could stay aloft under its

own power for extended periods of time. The “Model B Flyer” was over 900 pounds *without* the pilot! The Wrights used brown postal paper to reinforce joints on wing ribs, a practice that is considered a forerunner of today’s composite construction technology.

According to the Southwest Educational Development Laboratory (1996), formal mechanical design begins with recognition of a problem. For example, the problem could be automating a repetitive task, or a designing a remote sensor that detects dangerous levels of airborne chemicals. Alternative solutions are discussed and tested. The “best” solution is chosen for the development of a prototype.

A prototype is tested under conditions that the product would normally be subjected to in everyday use. Testing the prototype is a way to determine which materials are best suited to manufacture the product so that it functions properly and can be sold at a profit. Thus, the discipline of mechanical design encompasses not only mechanical components and movements, but also manufacturing processes, materials, quality control, functionality, styling, and price.

Essential Competencies

To determine competencies to be included on the survey, a review was made of state and national colleges with similar mechanical design programs. Advisory board members were consulted, as well as other private sector engineering personnel. Standards outlined by the American Society of Mechanical Engineers (ASME) were included in the list of competencies. ASME is a national organization that is considered the premier authority on engineering standards in the United States. The survey design also reflected input from administrators, mechanical design instructors, and last but far

from least, graduates of the mechanical design technician program now working in industry.

Careful review of national and local engineering competencies has led this researcher to summarize the following essentials. Graduates of the mechanical design technician program must :

1. Demonstrate freehand sketching, visualization techniques, proportion, and projection.
2. Demonstrate proper use of ANSI standards pertaining to dimensions, tolerances, geometric construction, and auxiliary and sectional drawing views.
3. Demonstrate the ability to define design intent and determine manufacturability by correctly reading a print.
4. Describe engineering materials in terms of strength and feasibility of use.
5. Create 2D part drawings and assemblies consisting of multiple views, dimensions, tolerances, geometric tolerances, and bills of material.
6. Specify materials and parts from vendor catalogs to satisfy design intent.
7. Work as a design team to accomplish departmental project goals.
8. Demonstrate advanced 3D solid modeling techniques, creating parts and assemblies utilizing parametric 3D CAD software.
9. Demonstrate proficiency using precision measuring devices and gages.
10. Demonstrate knowledge of machine elements including, but not limited to; gears, cams, chains, belts, clutches, brakes, bearings, and fasteners.

American Society of Mechanical Engineers (2001), Dunwoody College of Technology (2003), Penn State University (2003), Pima Community College (2003)

Program Review Procedures of the Wisconsin Technical College System

The Wisconsin Technical College System (WTCS) is comprised of sixteen regional districts. There are 342 program titles statewide. Some programs are unique to a district, while many are common to all districts.

The Wisconsin Technical College System (2003) states that each district is responsible for evaluating all programs currently being offered. There are three phases to each evaluation. Phase I monitors operational factors such as job placement, enrollment, and student retention. Phase II is an exact in-depth analysis of a program based on analysis of Phase I. In other words, if Phase I revealed problems in any operational factor, Phase II seeks to define causes and effects. A synopsis of Phase II procedures includes review of the following:

1. Demographics, graduation and placement rates, student recruitment efforts
2. Curriculum – Relevant content and delivery methods (classroom, ITC, Internet, flexlab)
3. Expertise, experience, and certification of program instructors
4. Student Services support (financial aid, job placement)
5. Student organization (clubs, professional organization affiliation)
6. Advisory Committee input
7. Facilities and equipment
8. Equity and access

Also taken into account are changes in the technology of a program. This can significantly increase (or decrease) the level of skill needed to perform a particular job

function. Most districts have an in-house program review team that accomplishes the task of self-study and subsequent recommendations.

Phase III is the district response to recommendations from Phase II. An action plan details responses and related timelines for program improvement. The results of the program review are then shared with employers, community groups, students, faculty, and advisory board members. This process ensures accountability to the district taxpayer and the community at-large.

Program Effectiveness Worksheets

Programs are reviewed at a district level utilizing an instrument called a “Program Effectiveness Worksheet”. In each category reviewed, a program is ranked with a numeric score of (3) outstanding, (2) acceptable, or (0) unacceptable. The worksheets encompass external (employer satisfaction) and internal competency standards.

Examples of the categories included in the WTCS program evaluations include:

1. Headcount availability – percentage of capacity filled
2. Employer satisfaction- percentage of employers that indicate satisfaction
3. Staff Development opportunities
4. Delivery options (i.e. classroom, Internet, ITV, weekend/evening, etc.)
5. Student/graduate satisfaction

A total score is computed and compared to a possible score to evaluate overall program effectiveness.

WITC Programming Evaluation

The “WITC Programming – Board Monitoring and Screening Report” (2003) is a comprehensive document that details the effectiveness of the college as a whole. While

individual programs are cited, the report documents curriculum quality, delivery options, headcount, range of offerings and faculty credentials on a college-wide basis. The report documents transfer agreements with high schools, technical colleges, and universities. In addition, the report documents accreditation and certification of individual programs by national organizations.

The Board Monitoring and Screening Report projects trends and future programming initiatives based on current program effectiveness and industry movements. Future trends are identified in the Business and Marketing, Health, Emergency Services, Personal Services, and Trade and Technical Divisions. From these future trends, full-time programming initiatives are identified and developed. An Executive Summary provides a synopsis of the data presented in the report.

Graduate Follow-Up

The Wisconsin Indianhead Technical College *Graduate Follow-up Report of 2000-2001 Graduates* (2002) surveyed 1153 graduates from 49 different programs. Response rate in Trade and Technical programs (including mechanical design) was 78%. The report provides analysis of statistics in the following categories:

Employment location by campus

Average monthly salary by campus and division

Placement rate

Satisfaction with training

The data presented in the *Graduate Follow-up Report* is a tool for analysis of program effectiveness within the Wisconsin Indianhead Technical College district.

CHAPTER 3

Methodology

Introduction

This study compares regional employer requirements for entry-level mechanical designers with competencies taught in the mechanical design technician program at WITC-Rice Lake. The survey assists the researcher to determine which competencies currently being taught are most valuable to regional employers. The study is important and significant because there has not been a study of mechanical design competencies at WITC since the advent of computer-aided-design. The study also helps WITC tailor coursework towards the needs of regional employers. In addition, WITC graduates will be better prepared for their engineering careers if competencies reflect the needs of regional employers.

Subject Selection and Description

The sample of subjects is from the Northern Wisconsin and Eastern Minnesota (Twin Cities metro) regions. This is where most WITC graduates find employment. Many graduates choose to stay in Northern Wisconsin even though they might earn more money in a larger metropolitan area. The sample is not gender specific although most of our graduates are male (90+%).

The survey participants were closely affiliated with engineering departments with regional employers. Many were WITC graduates who have moved up to “team leader” or management status. Their “insider” knowledge of the engineering profession, as well as knowledge of the mechanical design technician program made their insight especially welcome. Many of the participants are designers, who perform engineering functions on

a daily basis. Human resource specialists were included in the subject selection because they are often the first people to see a candidate's resume. Therefore, human resource specialists are acutely aware of the minimum requirements for an engineering position. They also recruit for open positions in an engineering department and must communicate job requirements to prospective employees.

Surveys were sent to seventy-five potential participants. Of these, fifty surveys were returned by the deadline specified in the cover letter. Fifty-four percent of the returned surveys were from graduates of WITC. Of these, seventy-four percent graduated in the past five years (1997-2002). The remaining twenty-six percent graduated between 1968-1994. This is significant, because three out of four graduates who returned surveys have been trained in modern CAD technology and engineering methods at WITC, and can relate the relevance of their training directly to their experiences as entry-level employees.

Instrumentation

The design of the questions in the survey was based on content areas in the mechanical design technician program at WITC. The survey instrument was designed on a Likert scale. Participants were asked to rate job competencies in the following order: 5= Extremely Important, 4= Very Important, 3=Important, 2= Not Essential, 1= Not Important

Survey questions also requested information on the type of CAD software being used and products being manufactured. In addition, a comment section was included where participants could elaborate on issues relative to competencies in the mechanical design program. The survey was designed specifically for this study.

Survey questions were developed after a thorough review of competencies currently being taught in the mechanical design technician program. The questions and competencies were then sent to the researchers' supervisor, Michael Boyle, Dean of Instruction, Trade and Technical Department, WITC, for suggestions and approval. His input was critical because he is ultimately responsible for the mechanical design technician program at WITC, Rice Lake. Questions and competencies were also shared with John Schroeffer and Glenn Sokolowski, co-instructors in the mechanical design technician program, for suggestions and validation. They have day-to-day contact with both mechanical design students and representatives from industry, giving them insight into the job duties normally ascribed to entry-level employees. Mechanical design program advisory board members, many employed by local industry, contributed knowledgeable input to the survey from a regional manufacturing viewpoint.

The survey results assist in determining which competencies are deemed most important to regional industries on a day-to-day basis. Lesson plans and emphasis can then be redirected to meet these needs. Equipment and software may also have to be purchased to meet the needs of regional companies, based on survey responses.

Surveys were mailed in envelopes to the recipients. A cover letter (Appendix "A") explained the intent and content of the survey. The survey (Appendix "B") was three pages long. An "Informed Consent Form" explained risks to participants and their right to refuse participation in the study. Section two gathered demographic information from participants. Section three (28 questions) assessed competencies related to engineering skills. Section four (9 questions) assessed competencies in "people skills" and team orientation. Section five (13 questions) assessed competencies in computer and

office hardware skills. Sections three through five were ranked on a Likert scale to determine relative importance to other competencies in each respective section. Finally, section six solicited additional comments (included in Chapter 4) about required competencies in the mechanical design technician program. A stamped return envelope was supplied for mailing the survey back to the researcher for recording and analyzing.

The survey was kept simple, straightforward, and short to ensure a maximum response rate. The survey was mailed to participants on May 9, 2003. A deadline was specified for the surveys to be returned by May 31, 2003. It was explained in the cover letter that the time frame was limited so results could be used to determine coursework for fall semester of 2003. Because of the high return rate, reminders to participants were not necessary.

Data Collection and Recording

A survey was mailed to seventy-five companies from the Northern Wisconsin and Eastern Minnesota (metropolitan Twin Cities) area. The companies surveyed were manufacturing concerns with mechanical design departments, or consulting engineering firms. The survey gathered information from a wide array of position “types” including, but not limited to, engineering supervisors, designers, mechanical engineers, drafters, contract engineering recruiters, detailers, and human resource specialists. This was done in order to gather the broadest spectrum of information from people who have daily contact with engineering personnel and are integral in hiring entry-level mechanical design graduates.

The survey was easy to complete, easy to mail, and asked questions that made the recipient feel that they were providing valuable input to their own field of endeavor.

Seventy-five surveys were mailed to regional manufacturers and engineering companies. Fifty surveys were completed and mailed back to the researcher for a sixty-seven percent return rate.

Limitations

The survey was limited in scope to the region of Northwest Wisconsin and the Minneapolis-St. Paul metro area. It does not reflect opinions from manufacturers in Eastern Wisconsin or the Fox Valley region, both of which are rich in manufacturing industries. Another limitation is that in Northern Wisconsin and the metropolitan Twin Cities, mechanical engineering is a male-dominated field. Therefore, survey results are unavoidably from a predominately male point of view.

Data Analysis

Data analysis was completed in June and July of 2003. Data was entered from the fifty surveys onto an Excel spreadsheet. The data from the fifty surveys was exported from the spreadsheet into SPSS software for descriptive statistics. Data analysis focused on the research objectives below:

1. What attributes/skills/knowledge do regional employers utilize most from entry level employees from the Mechanical Design Technician program?
2. What skills now being emphasized in coursework do regional employers consider least important?
3. Is there a gap between what is being taught in the program and what regional employers desire?
4. What products are being designed and built in the region?
5. What mechanical design software is prevalent in the region?

Data analysis and recommendations are to be sent to the management staff at WITC, including the Dean of Trade and Industry and the Campus Administrator. Results will be made available to survey participants, advisory council members, mechanical design faculty, and mechanical design program students. Significant findings will be weighed against present course competencies to determine what program changes need to be made or areas of emphasis revised.

CHAPTER 4

Results and Analysis of Data

Introduction

The purpose of this study is to determine, on a regional basis, which specific competencies taught at WITC are most sought after in entry-level employees. In addition, the survey examines the relative importance of virtually all of the competencies taught in the mechanical design technician program. Surveyed competencies are broken down into three major groups: engineering skills, people skills, and computer and office hardware skills.

Competencies considered “extremely important” or “very important” by the highest number of companies are deemed most valuable to those respective companies. These must be compared to the relative weight given to them in the mechanical design technician program to determine whether more or less emphasis is warranted in the coursework.

Seventy-five surveys were sent to manufacturing firms in WITC’s typical employment region. This region can be best described as encompassing Northwest Wisconsin and the Twin Cities metro region. Fifty surveys were returned from participants yielding a return rate of 67%.

The five research questions this study answers are:

1. What attributes/skills/knowledge do regional employers utilize most from entry level employees from the Mechanical Design Technician program?
6. What skills now being emphasized in coursework do regional employers consider least important?

7. Is there a gap between what is being taught in the program and what regional employers desire?
8. What products are being designed and built in the region?
9. What mechanical design software is prevalent in the region?

Job Titles and Education of Study Participants

The respondents in the sample were asked to indicate their job title. Participants were asked to choose one of the following categories: “Human Resources”, Engineering Manager”, “Designer”, and “Other”. “Designer” proved to be the largest category with 24 (48%). “Engineering Manager” was checked by 20 respondents for 40% of the sample. “Human Resources” was checked by 2 participants or 4% of the sample. The category “Other” was chosen by 4 or 8% of the sample.

The survey asked whether the participant is a graduate of WITC and the education level attained. Of the 50 respondents to the survey, 27 (54%) are graduates of WITC. The other 23 respondents’ (46%) educational level ranged from “high school” to various bachelor degrees. Also included was an EDS (Education Specialist) degree and one MBA (Master’s of Business Administration). The MBA also held a mechanical engineering degree (BSME). Of the twenty participants listing themselves as engineering managers, eight held bachelors degrees or higher. Three graduates (6% of the sample) of WITC listed themselves as engineering managers. See Table 1 for tabulated data and percentages.

Table 1Job Titles of Participants

Position	N	Percent
Human Resources	2	4
Engineering Manager	20	40
Designer	24	48
Other	4	8
Total	50	100

Table 2Highest Education Level Attained by Participants

Degree Attained	N	Percent
High School	1	2
Associates Degree	39	78
Bachelor's Degree	8	16
Master's Degree	1	2
Ed. Specialist/Ph.D.	1	2
Total	50	100

Graduation Date of WITC Respondents

Participants that were graduates of WITC were asked to list their year of graduation. A breakdown on the results follows in Table 3. Graduation dates are significant, because the technology of the discipline has changed radically in the past 15 years. Most respondents (94%), graduated in the age of CAD graphics, indicating that a familiarity of computers was inherent in participants of the study.

Table 3

Graduation Date of Respondents

<u>Graduation Date</u>	N	Percent
1965-70	1	2
1971-75	0	0
1976-80	1	2
1981-85	1	2
1986-90	1	2
1991-95	3	6
1996-2000	12	24
2001-2002	8	16
Total	50	100

Scale Used to Calculate Means for Competencies

Competencies were arranged in three categories: Engineering skills, People skills, and Computer/office hardware technology skills. Participants were asked to rank each competency based on the following scale: Extremely Important, Very Important, Important, Not Essential, Not Important. Table 4 shows the point scale used to calculate the means.

Table 4

Scale Used to Calculate Means of Competency Rankings

Response	Number of Points
Extremely Important	5
Very Important	4
Important	3
Not Essential	2
Not Important	1

The following sections present the findings for each category of the survey. Engineering skills are discussed first, followed by people skills, and then computer/office hardware technology skills.

Engineering Skills

Respondents were asked to indicate the importance of 28 engineering competencies. The competencies were derived from input by advisory council members, mechanical design instructors, deans in the trade and technical division, and statewide

mechanical design curriculum as outlined in the Wisconsin Instructional Design System (WIDS) format. The means for each competency, ranked in order from highest (most important) to lowest (least important) are shown in Table 5.

Table 5

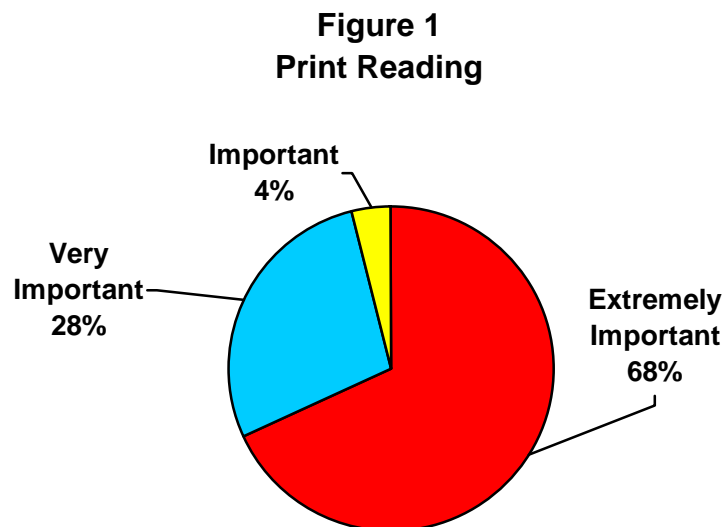
Mean Scores for Engineering Skills

COMPETENCY	MEAN		
		Jig and fixture drawings	3.24
Print reading	4.64	Weld processes and symbols	3.14
Creating working drawings	4.52	Sheetmetal forming & calcs	3.10
Creating assembly drawings	4.46	Geometric dim. & tolerancing	3.08
CAD proficiency 3D solids	4.32	Stress/strain calculations	3.04
Sketching and visualization	4.26	Metric fluency	3.00
Mechanical problem solving	4.04	Force systems/free body diag.	2.76
CAD proficiency 2D	3.98	Rapid Prototyping expertise	2.61
Creating bills of material	3.92	Beam deflection calculations	2.58
Precision measurement	3.58	Torque & horsepower calcs	2.45
Fastener knowledge	3.58	Gear calculations and design	2.30
Reverse engineering of parts	3.54	Belts and chains	2.22
Specifying parts from catalogs	3.44	Clutches and brakes	2.20
Manufacturing processes	3.30	Cam design	2.14
Metal properties	3.28		

Engineering skills can be sub-categorized into four groups to gain a clearer picture of the competencies. They are:

1. Design and visualization
2. Bill of materials – part specification
3. Machine elements
4. Physics calculations of properties of materials

Employers ranked design and visualization skills as the most desired in entry-level employees. In fact, the highest ranked engineering skill is “Print Reading” with 96% of respondents giving it a value of “Extremely Important” or “Very Important.” “Print reading” is the only engineering skill with zero responses of “Not Important” or “Not Essential.” See Figure 1 for a graphic representation of the results for “Print Reading.”



Respondents also indicated that “Creating working drawings” and “Creating assembly drawings” are also highly prized competencies. “Creating working drawings” is rated as “Extremely important” or “Very important” by 92% of the respondents. “Creating assembly drawings” is the next highest skill, with 90%.

Respondents indicated that “proficiency in 3D modeling skills” is important to their companies; 82% ranked 3D skills as “Very Important” or “Extremely Important.” Only 6% said that 3D skills are “Not Essential,” and no one said 3D skills are “Not Important.” There has been a marked trend from 2D CAD software to 3D modeling, so this percentage underscores that trend. However, 88% indicated that 2D skills were at least “Important,” reflecting the legacy data and designs still utilized by regional companies.

Closely related to CAD proficiency are “Sketching and visualization” skills. Only one respondent indicated that this is “Not important” for graduates, and 82% said sketching and visualization skills are “Extremely Important” or “Very Important.”

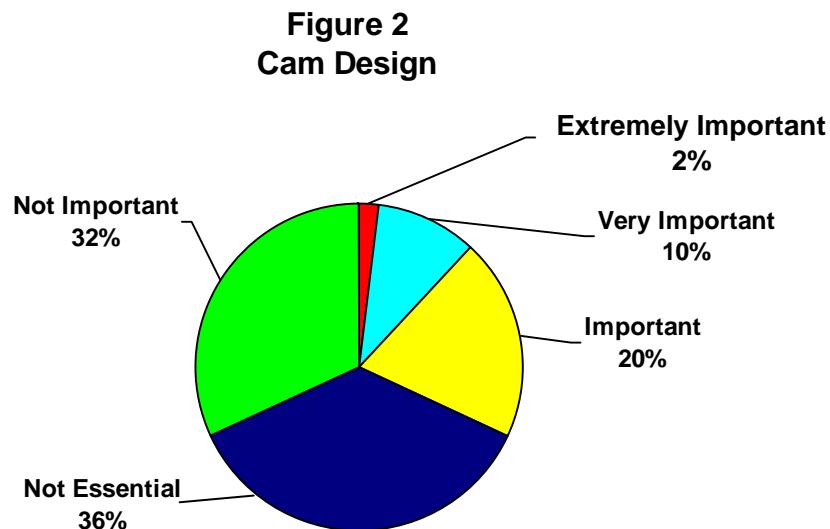
Employers ranked bill of material and part specification as being important competencies to possess. They indicated through the survey that graduates should know how to specify parts from the Internet and part catalogs to solve a mechanical problem. They should also possess the knowledge of building a complete bill of material for a product assembly. Closely related is skill in reverse engineering a part or assembly using precision measuring equipment.

Knowledge of machine elements is the third group of engineering skills considered in this research. Machine element competencies include gear and cam design along with knowledge of belts and chains, motors, clutches and brakes, etc. Employers

input was mixed on these competencies based on the nature of their products. For example, if their product did not include the use of a certain machine element, (cams for example) there was a tendency to rank it as a less desired competency.

Competencies in the physics and properties of materials sub-category were ranked lowest of all engineering skills. Many companies employ mechanical engineers with a BSME who must certify, for safety reasons, that calculations are correct. Therefore, they invariably perform the calculations themselves. Nonetheless, it is this researcher's opinion that graduates should learn the mathematical concepts of design, and physical properties of materials when subjected to a load. This will aid them in specifying correct materials for a design. In addition, they will have a good understanding of strength of materials concepts when working in the field with mechanical engineers.

The lowest ranked engineering skill for graduates is cam design. Figure 2 shows the percentages of employers' responses.



People Skills

Respondents were asked to indicate the importance of nine “people” skills. The means, ranked in order from highest (most important) to lowest (least important) are shown in Figure 3.

Table 6

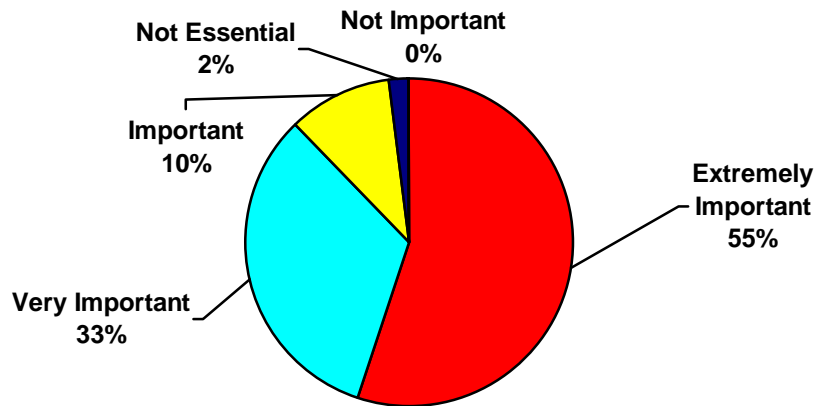
Mean Scores for People Skills

Ranked Highest to Lowest

Competency	Mean
Team Orientation	4.41
Oral communication skills	4.26
Written communication skills	4.14
Professional demeanor	3.98
Shop safety	3.96
Phone skills	3.84
Customer contact	3.76
Internet/email skills and etiquette	3.66
Professional attire	3.04

The highest ranked people skill is “Team orientation” with 98% of respondents giving it a value of “Extremely Important,” “Very Important,” or “Important.” No one indicated that team orientation is not important. See Figure 4 for results.

Figure 3
Team Orientation



Respondents indicated that oral communication and written communication are essential skills. Almost all (98%) of employers said that communication skills are at least “Important.” This finding is reinforced by employment ads that list “excellent communication skills” as a position requirement.

A relatively casual dress code is reflected by “professional attire” having the lowest mean score of all of the people skills. However, only 24% of the respondents indicated that professional attire is “not important” or “not essential,” so most of the employers who responded to the survey still place some importance on dress. This is generally judged on the amount of customer contact an employee may have. The more

customer contact, professional attire is ranked higher. Less customer contact means a lesser degree of importance attached to attire.

Computer and Office Hardware Skills

Respondents were asked to indicate the importance of 13 computer and office hardware skills. The means, ranked in order from highest (most important) to lowest (least important) are shown in Table 7.

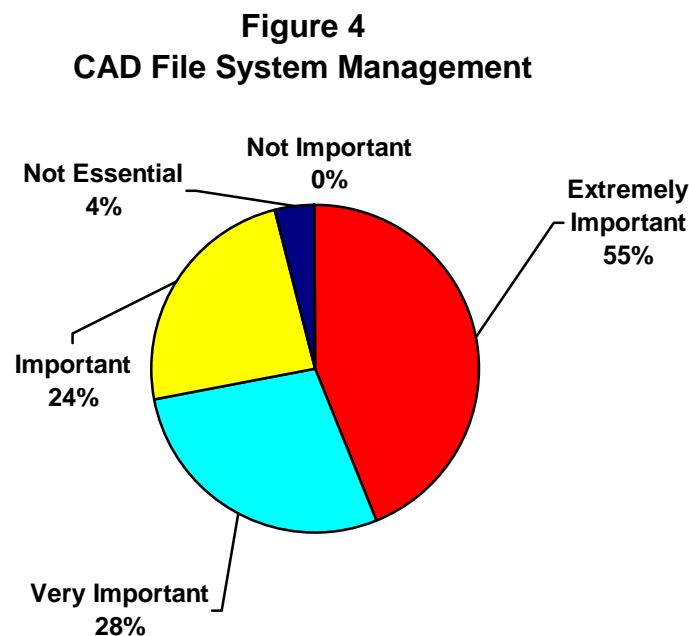
Table 7

Mean Scores for Computer and Office Hardware Skills

Ranked Highest to Lowest

Competency	Mean
CAD file system management	4.12
Word Processing	3.76
Spreadsheet setup and data entry	3.64
Printer	3.48
Plotter	3.44
Backup and restoration of CAD data	3.36
Image creation, editing, file type knowledge	3.24
Fax	3.14
Digital camera	2.76
Scanner	2.64
Power Point presentations	2.48
Web page creation and/or editing	2.08
Digital projector	2.04

The highest ranked computer skill is “CAD file system management” with 96% of respondents giving it a value of “extremely important,” “very important,” or “important.” No one indicated that the skill is not important. See Figure 6 for a graphic representation of results.



That CAD file system management was ranked high is of no surprise to this researcher, having worked in the private sector as a CAD systems administrator. However, relatively little time is devoted to this competency in the mechanical design program due to the volume of other material being taught. File structure and computer hardware knowledge has been considered incidental to traditional program outcomes, almost as if the computer simply “replaced” the drawing board without the need for further training. The survey results will underscore the need to have more time and resources allotted to this critical subject area.

Currently, students in the mechanical design technician program are encouraged to take an elective called “Information Resources.” This course teaches the basics of computer file systems, the Internet, email, and MS office applications. In light of this research, more emphasis should be given to the computer file structure portion of the course.

Also ranked high among desirable skills are a knowledge of word processing and spreadsheet applications. As designers, graduates will need to use their software skills when communicating with customers, vendors, and other departments within the company. This is often in the form of email communication but may also be in the form of a hard copy memo. This skill is stressed in the previously mentioned “Information Resources” course.

Employers ranked spreadsheet skills at 3.64, indicating that students need to come to work well versed in the setup of this versatile software. In “Information Resources,” students set up various spreadsheets and learn how to use formulas within the cells. They input data from the keyboard and download it from the Internet in various exercises in the course. In addition, students use spreadsheets in the course “Design of Machine Elements” to calculate stress and strain on an aluminum specimen that has been subjected to a tensile load. Images are downloaded from CAD software and inserted into the spreadsheet for a more complete explanation of the calculations. (See Appendix ?)

Employers considered a knowledge of printers and plotters to be important for entry-level employees. Graduates should be able to “trouble shoot” a malfunctioning printer or plotter. In the mechanical design technician program, they learn to load printer cartridges, paper, and software drivers when needed from the Internet. In addition,

students learn to add roll stock to large plotters and to change yellow, cyan, magenta, and black ink cartridges when needed.

Backup and restoration of CAD data was considered important with a rank of 3.36. Many companies have network administrators that backup computer files on a nightly basis. The astute designer, however, backs up his/her own work on a daily basis in addition to the network backup. This can be done on a floppy, CD, or ZIP disk. Downloading one's own backup is easier than going through layers of network administrators who generally have their hands full. Students in the mechanical design technician program are responsible for their own backups. This is stressed from the outset of the program. The CAD data network is backed up weekly by a student worker. Any assignments inadvertently deleted in the meantime must be redone before a grade can be assigned. Heartless, but it teaches responsibility for electronic files.

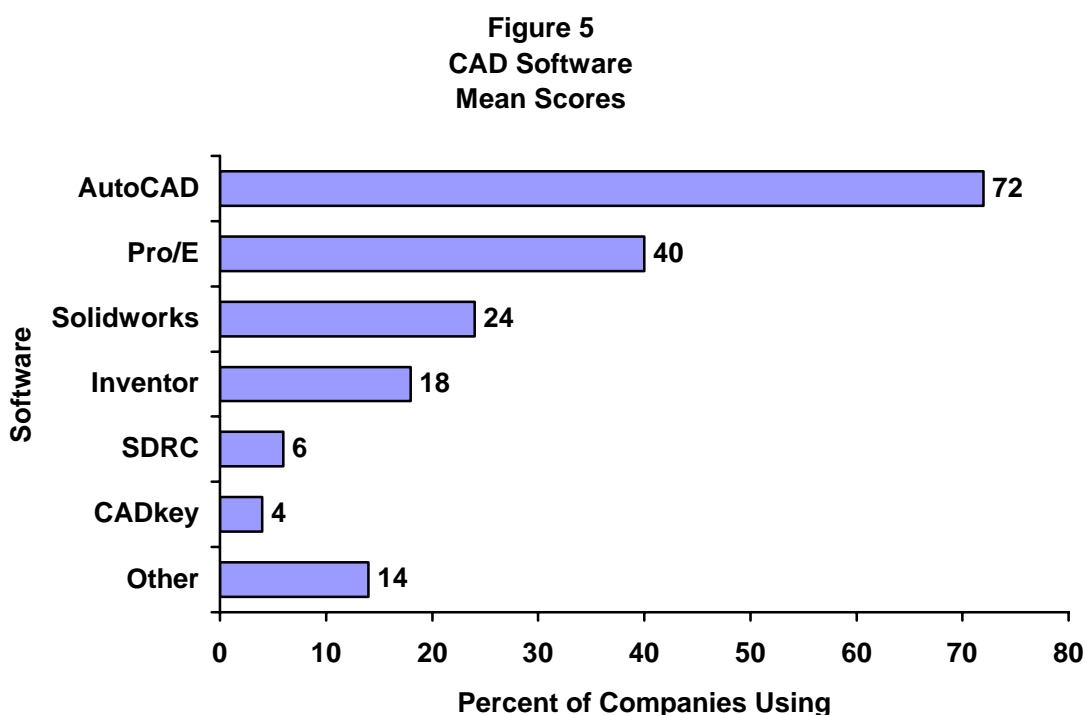
Several of the computer-related skills are of relatively low importance to respondents. Over 50% of the people who responded to the survey said the following skills are "not essential" or "not important": PowerPoint presentations; Web page creation and/or editing; and use of a digital projector.

Products and CAD software used by survey participants

This research project compiled a list of products manufactured by participants in the NW Wisconsin and Eastern Minnesota regions. "Appendix E" contains a list of products submitted by participants. Please note that some of the companies are repeated because there were multiple participants from that company. Each response reflected the individual participant's job functions.

Analysis of CAD Software Used by Respondents

Respondents were also asked what type of CAD software their company uses. The previous table shows that many companies are using more than one CAD software package. Even with multiple software systems, AutoCAD is used by 72% of the companies, followed by Pro/Engineer (40%). See Figure 5 for a percentage breakdown of CAD software being used by participants.



Many companies are using multiple CAD platforms. Some companies may be in a transition mode from 2D to 3D software. Some companies simply require both 2D and 3D for various design processes. Companies that manufacture products designed by clients are often constrained to have identical CAD software as the client. This ensures that no data will be lost in the transfer from one CAD platform to another.

WITC uses AutoCAD and Pro/E as the primary CAD software platforms in the mechanical design technician program. The research affirmed that these are the two most used platforms in our region. In addition, Pro/e is considered by many to be the premier platform for 3D solid modeling. Skills learned in this platform “transfer” over to other 3D CAD platforms as well such as Solidworks and Inventor. Advisory council members and employers have told us repeatedly to stay with Pro/E because if a student can master Pro/E, they can become proficient in any of the other 3D solid modeling CAD platforms. This has proved true in recent student hirings onto 3D CAD platforms other than Pro/E.

In this researcher’s opinion, the field of CAD platforms will stabilize in the coming years. Employers, once they have made a choice of a platform, will continue to use the platform to produce drawings and data for manufacturing. It is very difficult to switch CAD platforms. Many companies use their legacy data to generate new designs rather than “reinvent the wheel.” Most legacy data is not transferable to a new platform. Therefore, platform changes must be carefully considered before making a change.

Participant Comments

A “comment” section was included at the end of the survey, where participants could state their opinions about the mechanical design technician program at Rice Lake. Twenty-seven of fifty participants chose to add comments. Below are their comments prefaced by the survey number:

#4 One area not specifically mentioned above is tolerance analysis. Designing to 3 sigma was very important in my employment at Wright Products. I felt that I was not prepared in this area, and feel that more attention could be spent there.

#5 Cannot stress enough about learning different ways to do things. This will come with time.

Never give up.

Never get frustrated.

Always learn from mistakes and do not get discouraged by them.

#6 Many of the above (competencies) are important, however the required aptitude is easily taught and we therefore ranked low.

#8 More CAD software variety.

#16 Accept the fact that your ideas are used as one of many to fulfill the total output of a project.

Have fun!

#17 Imagination – Thinking outside the box is a plus!

#18 Listen to Mike Connolly, he knows his sh..

#21 A good knowledge of basic computing is a major. I've seen too many people who can run circles around many applications, but do not understand what happens when they save a file, what a file extension is or how the extension associates with the program, or other basic computer knowledge.

#23 I think graduates should be familiar with the whole mechanical design process, from concept/sketches to prototypes and production. Also have a good grasp of geometry, trig and algebra. Also know how to solve problems, find information, get along with people, continue to learn, etc.

#24 Employers are constantly looking for people who are able to problem solve on their own. If they are needing additional help or info, they should know how to find the proper

resources to complete the task. Graduates should be able to complete basic tasks with minimal supervision.

#25 I have filled out the questionnaire as in the present – in the future some of the skills in “Computer and Office Hardware Skills” may move up on the scale of importance.

Stress communications and teamwork.

#26 * #20 and #21 (competencies) is most important

* Presenting a positive attitude and happy cooperative demeanor with all other workers.

* Organizational skills in prioritizing and completing projects.

#27 People skills category most important.

Professional demeanor #1 quality.

#29 Having greater knowledge of Microsoft Office software is why I am still working (business is extremely slow). Examples: Web design, database design, brochures and catalogs.

#30 Attention to detail; ability to work under pressure of deadlines; strong design aptitude; ability to follow processes and work procedures.

#32 Problem solving skills

Leadership skills

#33 I feel that I received a very good education at WITC and some things learned are not used at my company, but I know they are used at others.

#35 In the fast paced economy we are faced with, in my opinion, a designer has to have if not all at least some of the qualities listed below, in the order of their importance:

1) Accurate

2) Fast (productive)

3) Innovative (creative)

I consider “accurate” number one because it is fundamental for the existence and development for the next two. As we all know, mistakes slow us down because we have to go back and fix them and take away creative time.

#36 Mike, take my survey with an open mind I guess. I really want to help out but the company I currently work for is more wood components than mechanical. Any questions, email me.

#37 Being a team player is probably the most important skill. You must be a team player even if it means changing/restraining some of your personality traits.

#38 There should be an effort made to make the graduate understand that life is a continual learning process. Teamwork is becoming more important, working with the tool room, floor people, customers, and sales people is needed to get better designs for our products and processes to manufacture them.

#39 Hydraulics and linkages

#42 It helps to be flexible and able to adapt easily to changes.

#43 Multitasking is essential!

#44 A good understanding of detailed drawings is very important. Technical report writing skills also.

#45 Remember these answers are from a Product designer, not a machine designer.

#47 FAX machine really important. Also should have students contact a vendor to get specs/details just to get a feel for how the machine works. Reverse engineering is a huge part of my job. Everything marked 4-5 is something I do use on a daily basis. Overall, program is a great prep for entry-level engineering job. Currently at Stout and can do

stuff in CAD that blows students minds, shocked at what a guy can learn at Tech School!!! Keep up the good work Mike!

CHAPTER 5

Conclusions and Recommendations

Introduction

The purpose of this study was to obtain information regarding competencies currently being taught in the Mechanical Design Technician program at WITC. The information will assist in determining which program areas to emphasize based on the level of importance regional employers attached to each competency.

A major objective was to identify which competencies employers deem most important and which are least important for entry-level employees to possess. The competencies are from three major skill sets: engineering skills, people skills, and hardware/technology skills.

Conclusions

The results of the study suggest the following:

1. Regional employers attach the most importance to creating and reading working drawings. These items received the highest ranking of all competencies in the survey.

Working drawings are the backbone of the manufacturing process, and the need for accuracy cannot be understated.

2. Critical thinking and visualization are highly sought after skills. This is underscored by the trend of regional companies towards 3D CAD modeling. This requires training in 3D solid modeling CAD software. Currently, the second year of the program is devoted to 3D solid modeling using Pro/e software. Design projects in the program emphasize creative thinking and problem solving.

3. *The least utilized competencies relate to mathematical calculations on specific machine elements.* This could be partially due to the diversity of products being manufactured by the participants. Employers ranked these skills as important only if they related directly to the product being manufactured.

4. *Respondents considered people skills to be of high importance to their companies.* All competencies, except one, were ranked above 3.50 on a scale of 5.0. This reflects the opinion of many advisory council members who also rank team skills and communication skills very high. Manufacturing is a people oriented business. Team orientation ranked at the highest level of importance with a mean value of 4.41 on a scale of 5.0. Oral and written communication mean values were ranked at 4.26 and 4.14 respectively, suggesting that regional companies utilized those competencies on a daily basis.

5. *A basic knowledge of computer file systems is extremely important.* Designers need to know where their files reside on a computer network so they can retrieve them and re-save them after modification. Word processing and spreadsheet skills also ranked high on the list of desirable competencies suggesting the importance of a full range of Microsoft Office training.

6. *The least utilized office technology skills were in the realm of image usage and presentation.* The editing of digital images from scanners, digital camera, PowerPoint presentations, and the web were not considered critical skills for entry-level designers to possess.

7. *The data showed that the CAD software used most by regional companies were AutoCAD and Pro/engineer.* AutoCAD is primarily utilized as a 2D CAD software (although it has some 3D capabilities). Pro/engineer was utilized as a 3D solid modeler.

Recommendations

The following recommendations are formulated from the results of the study, and they are directed toward college administration, faculty in the discipline of mechanical design, and students.

It is recommended:

1. Include a first-semester print reading course in the mechanical design technician program. The results of the research suggest that “print reading” is the most important competency required of entry-level employees. Currently, coursework in print reading is an elective in the mechanical design program. Design students typically gain print reading skills through assignments in other coursework in the program. However, a first-semester “up front,” 1 credit course in print reading would provide a great introduction to mechanical design concepts and practices. In addition, it would introduce students to concepts they will utilize throughout their engineering careers.

2. Teach 3D solid modeling basics in the first year of the program. There is an industry-wide movement from 2D drafting to 3D solid modeling in the WITC region. Currently, the first year of the mechanical design program is primarily based on 2D CAD drafting software. The research suggests that 3D solid modeling basics should be taught in the first year, perhaps in the second semester along with traditional 2D “drafting” software.

3. Incorporate more team projects in the first year of the program. “Team orientation” and oral communication skills are extremely important in a design department.

Currently, most of the first year of the program is centered on individual projects. Most of the second year is centered on “design team” projects utilizing 2-5 members per project. The research suggests that more “team oriented” projects be undertaken earlier

in the program. Design projects of 6-10 parts maximum would provide an excellent introduction to working with others, without “dragging it out” over too long a period of time. Students learn from each other, not just from the instructor. Many of design students bring unique expertise to the table.

Team projects are a great way to share it.

Team skills are essential in the second year of the program on projects such as the 2003 high-mileage-vehicle (see photos). Students learned to work as a design team as well as communicate with other “departments” (i.e. Machine Tool,



Welding, Auto Body) to build a product for a specific purpose. This was a “real world” manufacturing project complete with a deadline. Students learned professionalism and respect for the expertise of students in other manufacturing

disciplines. On race day, the high-mileage-vehicle achieved a stunning 350 miles-per-gallon. Students achieved a greater understanding of interpersonal and professional

relationships on-the-job and what was required to attain a group goal by a specific deadline; competencies that last long after the project has ended.

4. Make Information Resources a required course in the mechanical design program.

Mechanical designers need to know the basics of computer file system management.

This is a skill that traditionally has not been emphasized in the mechanical design technician program. In the Information Resources course, students learn electronic file management in addition to the basic operation of Microsoft Word, Excel, and PowerPoint. Students also learn the basics of the Internet, search engines, email, and Internet etiquette. The research suggests that these competencies are utilized on a daily basis in most regional manufacturing companies.

5. Enhance Strength of Materials and Design of Machine Elements with web-based learning segments and team problem-solving assignments. A basic knowledge of physics, strength of materials, and machine components is essential to understand calculations made by engineers and design professionals who typically are responsible for the integrity of a manufactured product. For this reason, Strength of Materials, and Design of Machine Elements, should be enhanced by adding computer-based lesson plans and links to explanatory websites. In addition, more team problem solving should be incorporated into current lesson plans.

6. Utilize regional industry professionals to share “real world” design challenges and solutions. Regional employers utilize graduates primarily to produce working drawings, assembly drawings, and product specifications. Although these competencies are already emphasized strongly in the program, more exposure to regional design department procedures and policies would be advantageous to students. They would gain insight into

variations that occur in the discipline. This could be accomplished by a series of field trips that focus on design, rather than manufacture, of a product or machine assembly. Drawings that are considered “non-proprietary” could be solicited from regional employers. Students could then compare and contrast drawings from different manufacturers to learn how each utilizes standard drawing practices to accomplish a design goal. They would gain a familiarity with drawing practices of regional companies.

7. Provide computer-based precision measuring equipment for reverse-engineering parts and assemblies. Employers value expertise with precision measuring instruments and reverse engineering methods. Precision measurement is already incorporated into the program via training with calipers, micrometers, optical comparitor, and various gages. Additional equipment would enable WITC to better train students for precision measurement in manufacturing. Training on a CAD-based articulating CMM (coordinate measurement machine), would enhance student understanding of precision measurement and reverse engineering of parts. In addition, this machine could be for joint projects with Machine Tool, Welding, and Auto Mech programs.

8. Provide rapid-prototype (3D printer) experiences to students to add “tactile” and ergonomic integrity to designed parts and assemblies. Employers indicated that sketching, visualization, and mechanical problem solving were very high on the list of desirable skills. This researcher recommends the purchase of a rapid prototype machine (also called a 3D printer) to improve performance in these competencies. A physical object (prototype) is extremely important to provide an accurate representation of a part or assembly. Tactile “feel” is required where the ergonomics of a product are important

to its function. A physical part also provides a better sense of scale than an image on a computer screen.

Summary

The success of the mechanical design technician program at WITC is dependent upon input from companies that hire graduates as entry-level employees. It is critical therefore, that WITC stays current with industry trends and responds to the needs of the regional manufacturing community. This study was designed to determine which competencies are most important to industries in the WITC region. By doing so, WITC can respond quickly to meet their needs by preparing graduates with relevant competencies that are “in-demand.”

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APPENDIX A

Notice to Survey Participants

Wisconsin Indianhead Technical College
Trade and Technical Department
Mechanical Design Technician Program

Dear participant,

Enclosed is a survey that is designed to assess competency requirements from entry-level employees relative to engineering positions in your company. Completion of this survey will help us train graduates that meet your needs.

The informed consent signature at the top of the survey protects you from any legal ramifications or the use of your name in the study. The demographic portion helps us determine specific information about companies in our district. The competency list tells us what skills you deem important to your business.

The survey should take approximately 15 minutes. Please return it by April 30 in the enclosed business reply envelope (no postage required). Thank you for helping us better train your future employees!

Sincerely,

Michael Connolly
Mechanical Design Instructor
Wisconsin Indianhead Technical College
(715) 234-7082 ext. 5295
connolly@witic.edu

APPENDIX B

Survey**An Assessment of Employer Requirements of Competencies of Mechanical Design Technician Students at WITC**

Informed Consent Form

I understand that by returning this questionnaire, I am giving my informed consent as a participant in the study. I understand the intent of the study and agree that any personal risks are very small. I also understand that future students of the Mechanical Design Technician Program will benefit from successful completion of this study. I understand that confidentiality is guaranteed and that no personal identifiers will be contained in the study. I understand that I have the right to refuse to participate at any time during the study.

Signature of Participant: _____ Date: _____

Note: Questions or concerns about participation in the research should be addressed to Dr. Ed Biggerstaff, Professor of Psychology, UW-Stout, Menomonie WI, 54751, research advisor to this project.

Demographic Information

This survey has been developed to help us obtain information from professionals in the field. Your input is critical to our success as an educational institution. Please return the completed survey in the envelope provided by April 30. Thank you!

Michael Connolly, mechanical design instructor WITC connolly@witc.edu

- | | |
|--|---|
| <p>1. What is your job title?</p> <p><input type="checkbox"/> Human resources</p> <p><input type="checkbox"/> Engineering manager</p> <p><input type="checkbox"/> Designer</p> <p><input type="checkbox"/> Other _____</p> | <p>2. Graduate of WITC? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>3. If yes, what year did you graduate? _____</p> <p>4. If no, enter education level or degree attained:</p> |
|--|---|

Wisconsin Indianhead Technical College Mechanical Design Competency Survey

For the following categories, please circle the level of importance to your company.

5=Extremely Important	4=Very Important	3=Important
2=Not Essential	1=Not Important	

Engineering Skills (knowledge of the following)

5. Print reading	5	4	3	2	1
6. Metric fluency	5	4	3	2	1
7. Geometric dimensioning & tolerancing	5	4	3	2	1
8. Precision measuring instruments and gages	5	4	3	2	1
9. Reverse engineering of parts and assemblies	5	4	3	2	1
10. Force systems & free body diagrams	5	4	3	2	1
11. Stress/strain calculations	5	4	3	2	1
12. Beam deflection calculations	5	4	3	2	1
13. Torque and horsepower calculations	5	4	3	2	1
14. Gear calculations and design	5	4	3	2	1
15. Cam design	5	4	3	2	1
16. Fasteners	5	4	3	2	1
17. Belts and chains	5	4	3	2	1
18. Clutches and brakes	5	4	3	2	1
19. Mechanical problem solving	5	4	3	2	1
20. Sketching and visualization	5	4	3	2	1
21. CAD proficiency 2D	5	4	3	2	1
22. CAD proficiency 3D solid modeling	5	4	3	2	1
23. Creating working drawings	5	4	3	2	1
24. Creating assembly drawings	5	4	3	2	1
25. Creating jig and fixture drawings	5	4	3	2	1
26. Specifying parts from catalogs & Internet	5	4	3	2	1
27. Creating/modifying bills of materials	5	4	3	2	1
28. Metal properties (alloys, hardness, etc.)	5	4	3	2	1
29. Rapid Prototyping (RP) expertise	5	4	3	2	1
30. Sheetmetal formation and calculations	5	4	3	2	1
31. Weld processes and symbols	5	4	3	2	1
32. Manufacturing processes (i.e. casting, metal cutting, powder metallurgy, heat treating, etc.)	5	4	3	2	1

For the following categories, please circle the level of importance to your company.

5=Extremely Important	4=Very Important	3=Important
2=Not Essential	1=Not Important	

People Skills

33. Team orientation	5	4	3	2	1
34. Oral communication skills	5	4	3	2	1
35. Written communication skills	5	4	3	2	1
36. Internet/email skills and etiquette	5	4	3	2	1
37. Professional demeanor	5	4	3	2	1
38. Customer contact	5	4	3	2	1
39. Phone skills	5	4	3	2	1
40. Shop safety	5	4	3	2	1
41. Professional attire	5	4	3	2	1

Computer and Office Hardware Skills

42. Word processing	5	4	3	2	1
43. Spreadsheet setup and data entry	5	4	3	2	1
44. PowerPoint presentations	5	4	3	2	1
45. Image creation, editing, knowledge of file types	5	4	3	2	1
46. Web page creation and/or editing	5	4	3	2	1
47. CAD file system management	5	4	3	2	1
48. Backup and restoration of CAD data	5	4	3	2	1
49. Scanner	5	4	3	2	1
50. Fax	5	4	3	2	1
51. Printer	5	4	3	2	1
52. Plotter	5	4	3	2	1
53. Digital camera	5	4	3	2	1
54. Digital projector	5	4	3	2	1

55. CAD software used by your company _____

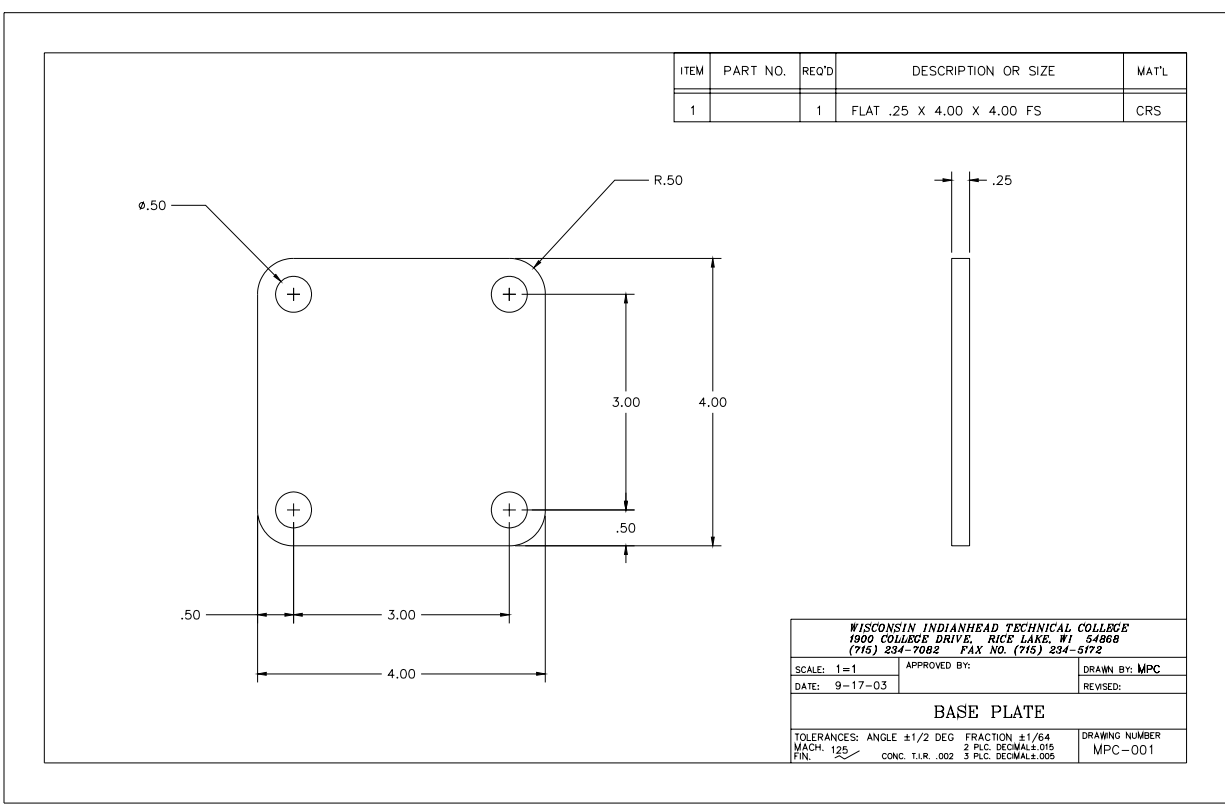
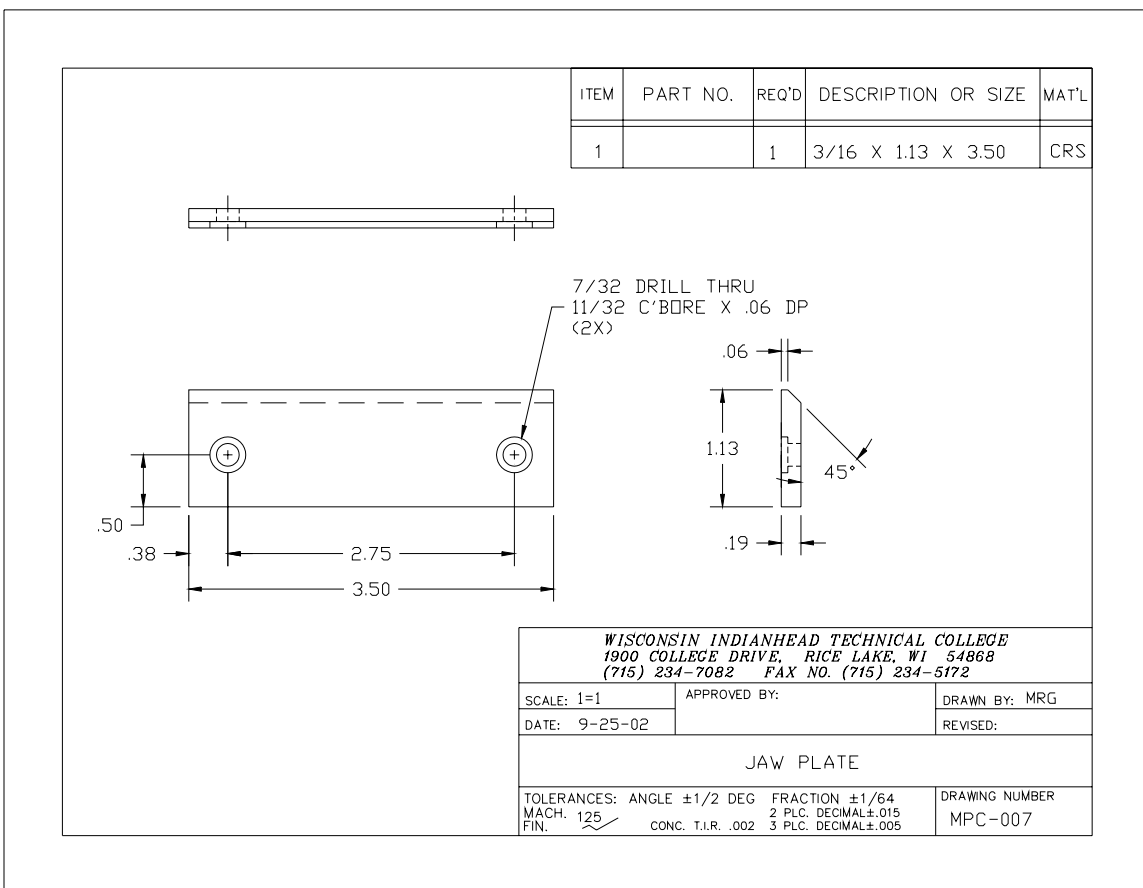
56. Primary product(s) of your company _____

Additional comments about competencies required for mechanical design graduates

Thank you for your input!

APPENDIX C

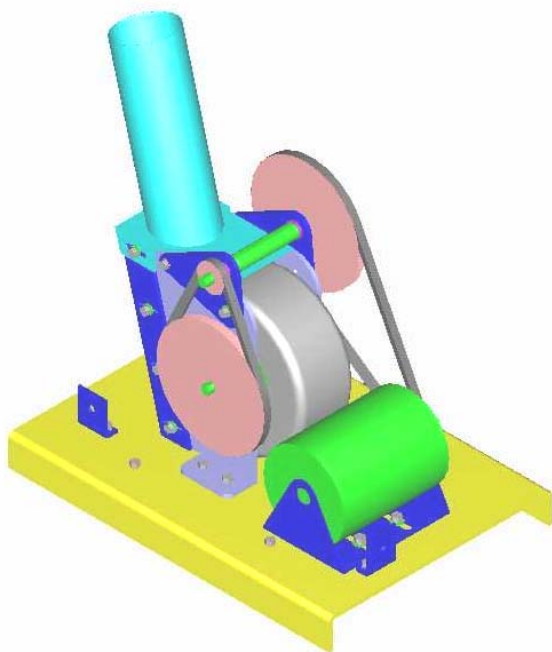
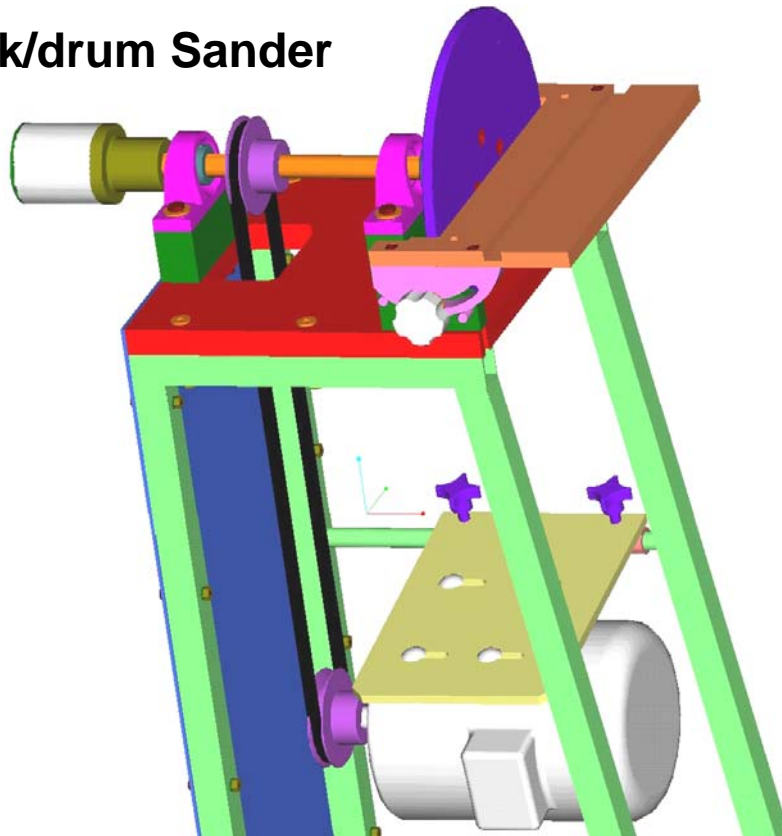
2D "Working Drawings" Created by WITC Students with AutoCAD Software



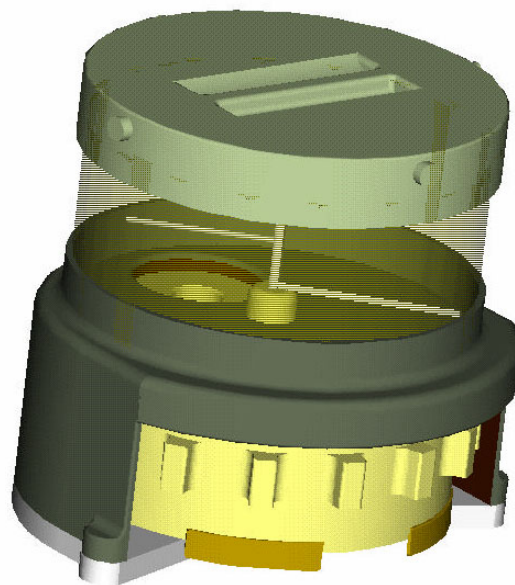
APPENDIX D

3D Models Created by WITC Students with Pro/Engineer CAD Software

Disk/drum Sander



Power Can Crusher



**Counter Mount
Precision Dispenser**

APPENDIX E

Company Products and CAD Software Used by Respondents

Company Name	Product	CAD Software Used
SGI, Inc.	Computers	Pro/e
Advanced Laser Machining	Sheet metal	AutoCAD
Oxbo Corp.	Agricultural equipment	Solidworks, Cadkey
Big Bike Parts, Inc.	Motorcycle parts	AutoCAD, Inventor
Johnson Truck Bodies, Inc.	Truck bodies	AutoCAD 2004
Big Bike Parts, Inc.	Motorcycle accessories	AutoCAD 2000
Noble Mfg.	Part washing units and military parts	AutoCAD, Inventor
Premier Dies, Inc.	Slot coating and extrusion dies	AutoCAD Mechanical, Inventor
Extrusion Dies Inc.	Extrusion dies	Pro/e
Premier Dies, Inc.	Slot coating and extrusion dies	AutoCAD Mechanical, Inventor
Rice Lake Weighing Systems	Industrial scales	AutoCAD, SDRC
Big Bike Parts, Inc.	Motorcycle accessories	AutoCAD 2000, Inventor
Polymer Technologies, Inc.	Plastic injection molding	AutoCAD, Pro/e, Solidworks
Wright Products, Inc.	Door hardware	Pro/e, AutoCAD, Mechanical Advantage
Beuthling Corp.	Compaction equipment	AutoCAD It 98
SCI-Sanmina Corp.	Plastic injection molding, alum.casting	Pro/e, SDRC, Solidworks, Cadkey
Technical Employment Inc.	Recruiting	Pro/e, AutoCAD, Solidworks
Novus Design	Machine Design, Engineering	AutoCAD LT

Company Name	Product	CAD Software Used
Owens Corning, Inc.	Acoustic wall panels	AutoCAD 2000
Wright Products, Inc.	Door hardware	Pro/e, AutoCAD
Johnson Truck Bodies, Inc.	Truck bodies	AutoCAD 2004
Ashley Furniture Industries	Residential furniture	Solidworks
W.S. Darley, Inc.	Fire pumps, apparatus, equip.	Pro/e, AutoCAD
Sterling Design, Inc.	Spray booths, HVAC solutions	AutoCAD 2004, Inventor 7
Polaris Industries, Inc	Recreational vehicles	Pro/e, Ansys FEA
Skyline Displays, Inc.	Tradeshaw displays	Pro/e, AutoCAD, Ironcad
3M	Mfg products for resale	Pro/e, Unigraphics, AutoCAD
Custom Fire Apparatus, Inc.	Fire apparatus	Pro/e, AutoCAD
T&T Tool, Inc.	Weld fixtures, specialty equip.	Pro/e, Solidworks, AutoCAD Mechanical
Ready Fixtures, Inc.	Store fixtures	AutoCAD 2004, Mastercam 9.1
SGI, Inc.	Computer hardware	Pro/e
Wright Products, Inc.	Door and window hardware	Pro/e, AutoCAD
N-Tech, Inc.	Ag equipment, skidsteer attachments	AutoCAD, Solidworks
Polymer Technologies, Inc.	Injection molded plastic parts	Pro/e, Solidworks
Thermo-king, Inc.	Transport HVAC	Pro/e
Rice Lake Weighing Systems	Scales, weights	SDRC 9, AutoCAD
Major Industries, Inc.	Skylights, translucent wall systems	AutoCAD 2002, Inventor 6
Oxbo Corp.	Agricultural harvesters	Solidworks, phasing out Cadkey

Company Name	Product	CAD Software Used
AMSCO, Inc.	Windows, doors	Solidworks 2003
Polaris Industries, Inc.	Recreational vehicles	Pro/e
WS Darley, Inc.	Water pumps, CAFS	Pro/e, AutoCAD
Marathon Electric, Inc.	Electric motors, generators	AutoCAD 2002, Solidworks 2003
CG Bretting, Inc.	Paper converting machines	AutoCAD 2002, Solidworks
WS Darley, Inc.	Pumps	Pro/e, AutoCAD