An Analysis of Electromechanical Competences by Business and Industry within the Chippewa Valley Area

By

Gary W. Johnson

A Research Paper

Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
With a Major in

Career and Technical Education

Approved: 2 Semester Credits

Investigation Advisor

The Graduate School

University of Wisconsin-Stout

August, 2008

The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: **Johnson, Gary W.**

Title: ***An Analysis of Electromechanical Competences by Business and Industry in the Chippewa Valley Area***

Graduate Degree/ Major: MS Career and Technical Education

Research Adviser: **Dr. Howard D. Lee**

Month/Year: **August, 2008**

Number of Pages: **69**

Style Manual Used: **American Psychological Association, 5th edition**

ABSTRACT

The purpose of this investigation is to collect data on what types of technologies manufacturing and industry are using in the Chippewa Valley and compare this data with the competences that are presently taught in the Electromechanical Technology (EM) program at Chippewa Valley Technical College (CVTC).

The Electromechanical program at CVTC relies on an advisory committee for input on what subjects and materials should be taught to meet the needs of industry in the Chippewa Valley. The advisory committee is made up of a limited number of individuals that may not be representative of the Chippewa Valley as a whole. That is why this study was undertaken to determine if the technology being pursued and taught is being used in the Chippewa Valley and to what extent it is meeting the needs of the area. The results of the study confirmed that the needs of the Chippewa Valley were the same as the advisory committee with some exceptions. The data confirmed that the brands and types of PLCs,

operator interfaces, sensors and control and power circuits were the same as those used by industry in the Chippewa Valley. Data from the study confirmed that manufacturing in the Chippewa Valley employees electromechanical graduates. The study determined the frequency that specific forms of energy were used in the manufacturing operations for the movement of components and product. The data indicated what types of motors and drives were used most often in the manufacturing operation. There were areas of training that need to be reviewed to determine if further action should be taken to modify curriculum.

The Graduate School

University of Wisconsin-Stout

Menomonie, WI

Acknowledgments

I would like to thank Dr. Howard Lee for his help and encouragement. I would also like to thank my wife, Kathy for her support and confidence in me.

TABLE OF CONTENTS

List of Tables

Chapter I: Introduction

Background Information

> Chippewa Valley Technical College is a dynamic community, focused on learning and dedicated to success. Chippewa Valley Technical College is an open door, nonresidential institution granting associate degrees, technical diplomas, and certificates. CVTC also provides customized training to business and industry. CVTC student enrollment exceeds more than 6,000 credit students per year. The eleven county district served by CVTC includes 250,000 residents. Eau Claire, Wisconsin is 85 miles east of St. Paul, Minnesota. Since the mid-90s, CVTC has increased the flexibility of its offerings to full-time students, working adults, and anyone in need of technical education. Distance learning including Internet, Instructional Television Networks (ITV), and computer assisted instruction and other modes of instruction are an emphasis. Placement of graduates has averaged more than 95% since the mid-1990s. (Nation Job Network, 2007)

The Electromechanical (EM) program at Chippewa Valley Technical College (CVTC) supplies graduates to business and industry in the Chippewa Valley (CV) area. The Chippewa Valley is made up of the following counties: Chippewa, Dunn, Eau Claire, and Pepin. Each of these counties contains the following towns or municipalities. In Chippewa County there are the towns of Bloomer, Boyd, Cadott, Chippewa Falls, Cornell, Lake Hallie, New Auburn, and Stanley. In Dunn County there are the towns of Menomonie, Colfax, Boyceville, Elk Mound, Knapp, Wheeler, Downing, and Ridgeland. In Eau Claire County there are the towns of Altoona, Augusta, Eau Claire, Fairchild, and

Fall Creek. In Pepin County there are the towns of Durand and the Village of Pepin. (www.chippewavalley.org) Graduates of the Electromechanical program at CVTC develop competences in pneumatic/hydraulics, programmable logic controllers (PLC), industrial electronics, robotics, computer hardware, machine tool, instrumentation/process control, motion control, and automated machine troubleshooting. The EM graduates have obtained employment and have received the following titles dependent on the company employing them and the type of work that the EM graduates are performing: electromechanical technician, maintenance mechanic, field service technician, debug technician, automated machine technician, manufacturing support technician, project maintenance technician, electrician, facilities technician, controls technician, and automation specialist (CVTC EM Placement, 1996–2002).

Even though there has been a steady decline in manufacturing jobs, the EM graduates are in high demand. Manufacturing jobs have declined swiftly since 2000; 1.9 million manufacturing jobs have been eliminated or about 10% of the manufacturing workforce (Hagenbaugh, n.d.). The companies that are still producing manufactured products are surviving by using creativity, increased automation, and modern technology. Alexander M. Cutler, CEO and chairman of Eaton Corporation, a diversified industrial manufacturer with sales of $12.4 billion in 2006, made the following statement:

> Manufacturing today is very much misunderstood. Think of agriculture over the generations; fewer and fewer people are directly employed in farming, yet production is always setting records. Manufacturing output here is higher then ever. Yet employment in the industry sector continues to decline percentage – wise due to incredible productivity growth, Cutler explained. In other words,

> manufacturing in America has been "extraordinarily successful" but amazing productivity growth based upon capital investments in modern technologies ranging from software to the latest in machine tools has meant lower and lower plant – floor employee levels. (Weimer, 2004, p. 38)

The reality of manufacturing today is less production workers and the workers who remain need to have higher levels of technical knowledge to be able to operate and maintain the modern technologies that are now being used in the manufacturing environment. Barry Matherly, the executive director of the Lincoln Economic Development Association of North Carolina made a similar statement:

> Many of the new manufacturers use technology that requires higher paid workers – but fewer of them – than industries of old. 'You are not going to see the thousand- person textile mills coming back anytime soon,' Matherly says. 'What we are seeing is higher-tech manufacturing, more sophisticated machinery and equipment. You might have 50 to 100 people in a large facility' (Speizer, 2007, n. p.).

Both of these statements help to explain why EM graduates are in demand in the Chippewa Valley. According to the Bureau of Labor Statistics there will be an increase in job openings nation wide for electromechanical technicians of "3% to 6%" projected from 2006 – 2016 (http://online.onetcenter.org/link/summary/17-3024.00). Projections in Wisconsin during the period of 2004-2014 there will be a 12% increase in job openings for electromechanical technicians (http://worknet.wisconsin.gov/worknet/daoccprj.aspx?menuselection=da),

higher tech manufacturing, more sophisticated machinery (Speizer, 2007) and capital investments in modern technologies (Weimer, 2004).

The competences that the EM graduates receive at CVTC give the graduates of the EM program the ability and knowledge to install, maintain, and troubleshoot the high-tech systems driving the manufacturing processes (Brutlag, n.d.). To stay current with the latest technologies being used by business and industry in the Chippewa Valley, the EM program at CVTC has a board of advisors. The advisory board is composed of maintenance managers and supervisory personnel who are responsible for maintaining and upgrading the manufacturing equipment and the hiring and training of technicians. The advisory board for the EM program has a total of nine representatives from this limited group. There are three advisors who are from Eau Claire, three advisors who are from Menomonie, two advisors who are from Chippewa Falls, and one from Augusta. The advisory board meets bi-monthly and the issue of the changing needs has been a theme.

Because of the changing technology and changing needs of business and industry, it seems reasonable that the EM competency list be updated. What are the needs of business and industry in the Chippewa Valley area in relation to the competences the EM graduates are receiving at CVTC? A larger sampling of the population, engineering and maintenance managers from business and industry in the Chippewa Valley, should establish a more precise picture of the competences that the EM graduates need in order to keep the businesses and industries competitive in a global market.

Statement of the Problem

Because of the changing technology and changing needs of business and industry, it seems reasonable that the EM competency list be updated. What are the needs of business and industry in the Chippewa Valley area in relation to the competences the EM graduates are receiving at CVTC?

Purpose of the Study

The purpose of this study is to determine how the present competences taught at Chippewa Valley Technical College in the electromechanical program matches with the data collected from Engineering and Maintenance Managers in business and industry in the Chippewa Valley. This research will identify if the present competencies are still meeting the needs of the Electromechanical graduates and thus meeting the business and industry needs of the Chippewa Valley. This study will be conducted in the spring of 2008 using a survey that will be created by the researcher for this purpose.

Research Objectives

The following research objectives will guide the study:

1. Determine what technologies are presently being used in business and industry in the Chippewa Valley area.
2. Determine what technologies are going to be implemented in industry in the next five years according to engineering and maintenance managers in business and industry.
3. Compare present technologies taught to EM graduates with technologies being used in business and industry.
4. Identify what competences are of the least value to business and industry.

5. Identify what competences have the most value to business and industry.

Importance of the Study

This research is important for the following reasons:

Wisconsin has always boasted the best trained and educated workers in the world, but we need to ensure that the next generation is prepared to compete and win in the global marketplace (Doyle, n.d.).

1. This study may provide information to meet the manufacturer needs. For manufacturers in the Chippewa Valley to be competitive in a global market they need to have a highly trained technical work force.
2. This research may produce results that will enable business and industry in the Chippewa Valley to reduce cost by supplying students with competences that are more closely aligned with the technologies that are being used. It may reduce the need for additional training for "new hirers".
3. This study would increase the knowledge of faculty at CVTC as to what competences are needed in the Chippewa Valley. This in turn will ensure that students enrolled in the electromechanical program have up to date competencies.
4. Along with the identification of electromechanical competencies, the results of this research will help focus what budget items need to be purchased now and in the future for the electromechanical program.
5. This study should give business and industry in the Chippewa Valley incentive to take a more active roll in the planning and implementation of competences taught at Chippewa Valley Technical College.

Limitations of the Study

The following items have been identified as potential limitations of the study:

1. Time is a limitation, the study will need to be conducted and the results determined in the next 12 months to meet the program needs. Because of the limited amount of time within which the study must be completed and analyzed, limitations to the study exist (Owen, 2005).
2. The study will be limited to the data that is collected from respondents who complete and return the survey. All efforts will be made to get a representative sample of the population.
3. Companies must maintain and stay current with the latest technological innovations in their industry to be competitive in a global market. Because of this competition, the technologies that are discussed in this study will have a limited life and therefore they will only have limited significance.
4. The study will be limited to the effectiveness of the method and instrument, the instrument has been developed by the researcher and may contain errors, misinterpretations, or omissions not intended by the researcher.
5. The study will also be limited by the personal interpretations, due to work experience, education, and the demands of the engineering and maintenance managers in business and industry who complete the survey.
6. The instrument for this study has been developed by the researcher and there are no measures of validity or reliability documented for this study.

7. Because this sample is both limited in size and geographic location, it may not be representative of the technologies being used and the competences that are needed by EM graduates outside of the Chippewa Valley.

Definition of Terms

Regarding this study the following terms have been defined to add clarity:

Competences. A competency is a major skill, knowledge, attitude, or ability needed to perform a task effectively and efficiently. Competencies are the intended outcomes of learning experiences (WIDS 7 1990-2000 Microsoft corp.).

*Computer Hardware. T*he physical part of a computer, including the digital circuitry (Wikipedia, 2007).

Electromechanical Technology. Electromechanical Technology (EM) is a two year program that prepares students to service, install, and repair automated equipment (www.cvtc.edu).

Programmable Logic Controllers. An electronic device used for automation of industrial processes, such as control of machinery on factory assembly lines (Wikipedia, 2007).

Motion Control. A sub-field of automation, in which the position and or velocity of machines are controlled using some type of device such as a hydraulic pump, linear actuator, or an electric motor, generally a servo. Motion control is an important part of robotics and CNC machine tools (Wikipedia, 2007).

World Wide Instructional Design System (WIDS.- Learner centered curriculum and training (www.wids.com, 2007).

Chapter II: Literature Review

Introduction

The purpose of this study was to determine the competences needed by electromechanical graduates to help maintain a competitive edge for business and industry in the Chippewa Valley. This study will start with a broad look at the importance of manufacturing and the need for a technically trained work force. It will then proceed to focus on the competencies needed in manufacturing for electromechanical students.

The Importance of Manufacturing

Manufacturing is the ability to transform raw materials of low value into finished products of a higher value. Manufacturing is the wealth producing segment of the economy, as where the service industry does not produce wealth, it just moves it from one point to another.

According to the National Association of Manufactures (2007), manufacturing is the engine that drives American prosperity. It is central to our economic security and national security. Manufacturing:

1. Grows the economy. Every $1.00 in manufactured goods generates an additional $1.37 worth of additional economic activity – more than any other economic sector.
2. Invents the future. Manufacturers are responsible for more than 70% of all business R&D, which ultimately benefits other manufacturing and non-manufacturing activities.

3. Competes internationally. The United States is the world's second largest exporter; 61% of all United States exports are manufactured goods, double the level of 10 years ago.
4. Generates productivity increases. Over the past two decades manufacturing productivity gains have been more than double (actual figure 2.5 times) that of other economic sectors. These gains enable Americans to do more with less, increase our ability to compete and facilitate higher wages for all employees.
5. Provides more rewarding employment. Manufacturing compensation averages more than $65,000, the highest in the private sector, and manufacturers are leaders in employee training.
6. Pays the taxes. Business has been an important contributor to economic growth and tax receipts at all levels of government, contributing 43% of all corporate taxes collected by state and local governments.

Manufacturing is crucial to the United States economy. Every individual and industry depends on manufactured goods. In addition, innovations and productivity gains in the manufacturing sector provide benefits far beyond the products themselves.

There is no dispute over the significant contribution that manufacturing makes to the United States economy and to America's standard of living. The sector continues to account for 14% of United States GDP and 11% of total United States employment. Those statistics, however, do not adequately convey the importance of the manufacturing sector to the United States economy and to America's future. Manufacturing is an integral part of a web of inter-industry relationships that create a stronger economy.

Manufacturing sells goods to other sectors in the economy and, in turn, buys products and services from them.

> Manufacturing spurs demand for everything from raw materials to intermediate components to software to financial, legal, health, accounting, transportation, and other services in the course of doing business. According to the Bureau of Economic Analysis, every $1 of final demand spent for a manufactured good generates $0.55 of GDP in the manufacturing sector and $0.45 of GDP in non-manufacturing sectors. (U.S. Department of Commerce, 2004, p. 16)

The availability of many foreign-made products on store shelves across America has given some the impression that domestic manufacturing is vanishing. This is a misperception not based on the facts of today's manufacturing. In 2005, the United States manufacturing sector, in terms of GDP, was close to $1.5 trillion. More goods are made in the United States today than at any time in United States history. If United States manufacturing was a country by itself, it would be the eighth largest economy in the world. Japan, Germany and China are the next largest economies in the world, but their GDP is significantly smaller than United States manufacturing, comprising 53% of China's total GDP (NAM Importance of Manufacturing Overview, 2005).

Manufacturing's geographic distribution in the United States has shifted in recent decades, with more manufacturing taking place outside of the traditional centers in the Northeast and Midwest. This broadening of the manufacturing base has raised its importance to all regional economies. Another way to look at manufacturing's role in state economies is to understand how much of the state economy depends on the manufacturing sector. In this context, the largest manufacturing states are Indiana, Iowa

and Wisconsin, Ohio, Kentucky, North Carolina and Arkansas tie for fourth place, followed by Michigan and Oregon (Economic Analysis of the United States Department of Commerce, 2004).

The recession earlier in this decade hammered manufacturing employment more than any other sector. Nearly 3 million jobs were lost between 2000 and 2003 because of rising interest rates, a large decline in United States exports prompted by a rising United States dollar, spikes in the price of natural gas, manufacturing's basic fuel, and rising productivity. The manufacturing recovery has not generated a large number of new jobs because of ongoing price pressures from global competition, rising costs and high productivity levels. Still manufacturing employs 14.3 million workers in the United States and another 6 million in related industries such as wholesaling and finance. Nearly every state has a sizeable manufacturing workforce (Bureau of Statistics, 2005).

To the surprise of many, manufacturing accounted for 15% of economic growth – real GDP adjusted for inflation – between 2001 and 2005. Manufacturing contributed more to growth than any other single sector. This follows a similar pattern of manufacturing economic leadership during the boom years of the 1990s. From 2001 to 2005, manufacturing GDP growth averaged 4% a year, compared with 3.5% growth for the overall economy. It is generally underreported that manufacturing has played such an important role in the current expansion (NAM Importance of Manufacturing Overview, 2005).

Federal Reserve Chairman Ben Bernanke has said that productivity growth is "perhaps the single most important determinant for average living standards." Manufacturing productivity consistently outpaces productivity growth in other sectors.

Between 1987 and 2005, manufacturing productivity grew by 94%, roughly two and a half times faster than the 38% increase in productivity in the rest of the business sector.

While manufacturing made up, on average, only 15% of GDP during this time, it was responsible for roughly a quarter of overall United States productivity growth between 1987 and 2005. Rising productivity translates into low inflation in the economy and rising wages for those in the most productive sectors.

Long term sustainable economic growth is based on increases in the labor force and productivity growth will be the major source of economic growth, as more and more baby boomers leave the workforce. Since manufacturing is the country's productivity powerhouse, a strong and vibrant manufacturing sector is a critical component in our country's long – term economic future.

Today's manufacturing employees earn higher wages and receive more generous benefits than other working Americans. In 2004, manufacturing employees earned an average of nearly $65,000 a year in wages and benefits, while employees in the remainder of the economy earned about $53,000. That's a 23% premium for working in manufacturing. Because manufacturers provide a higher level of health care support for their employees, the benefits portion of manufacturing compensation has been rising rapidly with the price of health care itself. Between 2000 and 2004, the rise in benefits accounted for more than half (57%) of the increase in manufacturing compensation. For some manufacturers, rising health care costs are making these generous benefits unsustainable.

Manufacturing has direct and substantial links to other sectors of the economy. These links work backward – to mining and construction – and forward, to the transportation, finance and wholesale trade sectors that help deliver goods to final consumers. Thus, as manufacturing grows, it requires more of these inputs from other sectors and in turn spurs the creation of jobs, investments and innovations in those non-manufacturing sectors. This effect is known as the multiplier effect and it shows how much additional output is generated by a dollar's worth of demand for manufactured products. Specifically, every dollar in final sales of manufactured products supports $1.37 in other sectors of the economy. Manufacturing has the largest multiplier of all sectors, with only agriculture, forestry, fishing and hunting coming close. The wholesale and finance sectors have the lowest multipliers, by contrast, with roughly 50 cents to every dollar of economic activity they generate themselves.

> More than one in six United States private sector jobs depends on the United States manufacturing base. This is because the manufacturing sector supports millions of employees who make things in America, and a large number of employees in other sectors of the economy through the multiplier effect. Specifically, manufacturing supported more then 20 million jobs in the United States in 2006: 14.2 million jobs directly within manufacturing and more than 6 million jobs in sectors outside of manufacturing such as accounting, wholesaling, agriculture, transportation and F.I.R.E. (finance, insurance and real estate). (NAM Importance of Manufacturing Overview, 2005)

The Need for Technically Trained Work force

The importance of maintaining and staying current with the skills and technology used in manufacturing in a global economy is directly related to the needs of the Chippewa Valley and the competences of the EM graduates.

In the past 30 years, the United States has lost almost 5 million manufacturing jobs. The nation's workforce employed in this sector has dropped sharply, from 20% in 1979 to about 11% today. This decline in the workforce is the result of increases in productivity and competition in labor-intensive goods production from lower-cost foreign manufacturers. While the United States manufacturing sector has contracted sharply since the early 1980s, employment in high-skill manufacturing occupations has risen by an impressive 37% (Deitz & Orr, 2006).

According to a study at Clemson University by Evanciew and Wither (2004) made the following statement:

> The manufacturing industry has used and continues to use a variety of strategies to increase productivity and decrease production costs. One requirement for success noted in these initiatives is to ensure reliable equipment. The formulas and plans for the proposed initiatives assume the equipment will run as designed each and every time it is needed. The formulas in these initiatives range from how to eliminate waste in the process to how to run the equipment at the customer demand rates, such as lean manufacturing. But what if the manufacturer begins a production run and the equipment does not operate correctly? What if, during a production run to supply a just-in-time process, the equipment fails? The work behind the formulas and scenarios that are used in these productivity initiatives

> then fails to produce, due to lack of reliable equipment. It is apparent that manufacturing needs people with the skills to maintain equipment in such a way as to ensure operability and reliability. These required maintenance skills are not easily found in today's workforce. (n. p.)

Manufactures regarded education as crucial. Manufacturers are extremely interested in addressing the shortcomings of the United States educational system. Roundtable participants underscored that the evolving nature of the manufacturing sector relies on individuals entering the workforce with greater problem solving abilities. These workers must continually sharpen their skills through lifelong learning. In addition, roundtable participants expressed concern that the United States risks losing an innovation infrastructure if the nation fails to produce scientists and engineers. Manufacturers seek a renewed emphasis from all levels of government to invest in educational and training institutions (U.S. Department of Commerce, 2004).

Are industries really in need of skilled maintenance employees? A survey conducted by Jasinowski (2001) for the National Association of Manufacturers revealed these findings. "In 2001 more than 80% of manufacturers (in the survey) reported a shortage of qualified job candidates despite the recession in manufacturing and the economic downturn overall" (p. 1). Jasinowski further indicated that "demographic experts predict we will need up to 12 million skilled workers before 2020, despite an increase in 18-24 year olds through 2015" (p. 21).

The Manufacturing Skill Standards Council (MSSC) (2002) has also indicated a projected need for skilled maintenance workers. The mission of the MSSC is to develop a national skill standards system for manufacturing in response to industry's growing need

to find skilled workers. The MSSC system, skill standards, assessments, and certifications, is designed to give manufacturers a yardstick to measure, improve, and profit from a workforce trained in cutting-edge manufacturing skills. The MSSC provided the following projections.

The Big Three United States automakers will need some 250,000 mostly skilled new workers by the year 2005. In the same time frame, more than one million technicians will be needed to meet the requirements of the information technology industry. The semiconductor industry is conducting a national campaign to train and attract 40,000 manufacturing technicians over the next 5 years (1999 through 2003. p. 1).

More than 80% of respondents to the NAM's 2005 Skills Gap Survey stated that they could not find qualified workers to fill their job openings right now. Ninety percent (90%) said they could not find enough skilled production workers and 65% said they could not find enough scientists and engineers. What do you want to be when you grow up? Most ninth graders cannot answer that question. Their knowledge of the real world and where the jobs are now and in the future is very limited. Overwhelmingly the message that they received is that to get a good job one must get a college degree. Almost 30% of ninth graders indicate that they are headed for a four year college after high school graduation. But what they do not know is that only about 20% of the jobs will be in areas requiring a four year college degree. More that 30% of ninth graders indicate that they will enter an associate degree program. It is estimated that approximately 65% of future jobs will require or need a person with an associate degree (NAM Engine of Innovation).

Competencies Needed in Manufacturing for Electromechanical Students

The competencies, that the electromechanical students need, to be productive and successful technicians in manufacturing in the Chippewa Valley, is the purpose of this study. To help determine what those competencies should be, listed below are what employers in other parts of the United States are looking for:

Company Name: Think Energy Group

Location: Camarillo, CA:

Program, maintain, troubleshoot, and repair the mechanical and electrical systems for pick and place robots. Perform predictive and preventive maintenance, assist in installation and commissioning of new robots. Should also be able to alter and to write programs for PLC's. (www.nationjob.com)

Company Name: The Tri-M Group LLC

Location: Kennett Square, PA

Independent field hardware and software support on building automation systems including, but not limited to HVAC control systems, security systems, and life safety support systems. Additional responsibilities include: 1) Performing field preventative maintenance checks on electronic systems. 2) Providing field hardware support on electronic controllers, control devices, and pneumatic systems. 3) Providing on-site and front-end software assistance and support to customers including 24-hour on-call hardware and software service availability, and 4) Serving as a lead technician on projects. (www.gojobs.come)

Company Name: Koch Business Solutions

Location: Corpus Christi, TX:

Programming / configuring PLC's, installing and maintaining electrical starters and switch gear from 480 VAC through 4160 VAC. 2 months experience working on all types of industrial electrical and electronic equipment including but not limited to motors, valves, actuators, meters, transmitters, flow computers and PLC equipment. 12 months experience in electrical safety, OSHA and NFPA 70E

General mechanical skills

Good verbal and written communication skills

Computer skills, specifically the ability to use Microsoft, Outlook, Excel, and ability to learn to use proprietary databases (www.koch.hrdpt.com)

Company Name: Boston Science

Location: Osseo, MN

Tests, calibrates, adjusts, and maintains electromechanical, mechanical, optical, pneumatic, hydro mechanical, and pressure-type measuring and indicating instruments to conform to set standards. Disassembles, cleans, repairs, and replaces defective parts of test equipment such as pressure gauges and tension meters. May monitor and verify quality in accordance with statistical process or other control procedures. (www.ju2jobs.com)

Maricopa Community Colleges list the following competencies for their Electromechanical Graduates:

1. Interpret technical drawings common to manufacturing.
2. Set up and operate CAD system to generate drawings.
3. Apply Ohm's and Kirchoff's laws to the solution of DC circuits and networks.

4. Apply small signal analysis to bipolar and field-effect transistor circuits, and multistage amplifiers.
5. To graphically model manufacturing simulations.
6. Describe the operation of industrial electronic circuits containing thyristors, photoelectric devices, relays or servomechanisms.
7. Properly use standard electronic test equipment in the laboratory environment.
8. Identify the processes of machining, forming, casting, joining (assembly), and conditioning as they relate to the conversion of materials to finished products.
9. Develop an appreciation of safe work habits.
10. Identify and apply the fundamental laws, principles, and applications of hydraulic and pneumatic devices.
11. Describe the operation and application of various electromechanical devices.
12. Identify the use of automated systems including CIM, N/C and CAD/CAM in manufacturing environment.
13. Apply the scientific method of inquiry and deduction relating the laws, theories, and axioms of electronics to specific laboratory experiments.
14. Apply timers, counters, latches, etc., to sequential process control.
15. Apply industrial automation networking to automation systems.

(5-22-07)

From the Occupational Information Network they list the following competencies/tasks for Electro-Mechanical Technicians (2006):

1. Test performance of electromechanical assemblies, using test instruments such as oscilloscopes, electronic voltmeters, and bridges.

2. Read blueprints, schematics, diagrams, and technical orders to determine methods and sequences of assembly.
3. Install electrical and electronic parts and hardware in housings or assemblies, using soldering equipment and hand tools.
4. Align, fit, and assemble component parts, using hand tools, power tools, fixtures, templates, and microscopes.
5. Inspect parts for surface defects.
6. Analyze and record test results, and prepare written testing documentation.
7. Verify dimensions and clearances of parts to ensure conformance to specifications, using precision measuring instruments.
8. Operate metalworking machines to fabricate housings, jigs, fittings, and fixtures.
9. Repair, rework, and calibrate hydraulic and pneumatic assemblies and systems to meet operational specifications and tolerances.
10. Train others to install, use, and maintain robots.

Chapter III: Methodology

Introduction

The purpose of this study is to determine the competences needed by electromechanical graduates to help maintain a competitive edge for business and industry in the Chippewa Valley. The information that is presented in this chapter will include the population and the sample selection and description, instrumentation used, how the data was collected, data analysis, and limitations of the methodology used for the survey.

Selection and Description of Participants

The population consisted of the manufacturing facilities located in the Chippewa Valley area. This will consist of the following counties: Chippewa, Dunn, Eau Claire, and Pepin. Each of these counties contains the following towns or municipalities. In Chippewa County there are the towns of Bloomer, Boyd, Cadott, Chippewa Falls, Cornell, Lake Hallie, New Auburn, and Stanley. In Dunn County there are the towns of Menomonie, Colfax, Boyceville, Elk Mound, Knapp, Wheeler, Downing, and Ridgeland. In Eau Claire County there are the towns of Altoona, Augusta, Eau Claire, Fairchild, and Fall Creek. In Pepin County there are the towns of Durand and the Village of Pepin (Momentum Chippewa Valley, 2007).

According to the Wisconsin Manufacturers Directory (2003), there are at this time 342 manufacturers in the Chippewa Valley. From this population there will be a stratified random sample taken.

The sample will be focused on manufactures that would employ graduates of the electromechanical program and are classified by the following Standard Industrial Classification (SIC) codes.

14 – Mining & quarrying

20 – Food and kindred products

22 – Textile mill products

23 – Apparel & textile products made from fabrics

24 – Lumber & wood products except furniture

25 – Furniture & fixture

26 – Paper and allied products

27 – Printing, publishing & allied industries

28 – Chemicals & allied products

29 – Petroleum refining & related industries

30 – Rubber & miscellaneous plastic products

31 – Leather & leather products

33 – Primary metal industries

34 – Fabricated metal products, except machinery & transportation equipment

35 – Machinery, except electrical

36 – Electrical & electronic machinery, equipment, supplies

37 – Transportation Equipment

38 – Measuring, analyzing, controlling instruments

39 – Misc. manufacturing industries

For each county it was desirable to obtain a 20% representation of the population. It was felt that 20% would more precisely represent the target group due to the limited number of manufacturing facilities in the Chippewa Valley and the time available. Based on this decision, Chippewa County would have 26 participants, Dunn County would have 14 participants, Eau Claire County would have 27 participants and Pepin County would have 3 participants. To get the stratified random sample of the population for each county the total population was divided by the total number needed for that county. An example of this would be; Chippewa County has a total population 129 divided by 26 equals 4.96 rounded to 5 every fifth company would be selected for the sample. Each of the county's was further divided by the number of cities located in them again the information was found in the 2003 Wisconsin Manufacturers Directory. For each city was listed several company profiles that gave the companies address, product description, number of employees, annual sales, and key personnel. This information was used to compile a mailing list. Some of the manufacturers listed had as few as 2 employees it was decided that a company needed to have at least 20 employees to be considered for the sample. The number 20 was just an arbitrary number chosen by the researcher, it was felt that a manufacturer with less than this number would not have as great a possibility of employing an electromechanical graduate. Because of the versatility of employment for the electromechanical graduates no single manufacturing occupation was targeted for this sample selection.

Instrumentation

The instrument that was used was a survey (Appendix A) created by the researcher so there are no measures of validity, and reliability documented for this

survey. The survey was developed with the purpose of determining what competences are needed for electromechanical graduates in the Chippewa Valley by business and industry. Since the research was not limited to just those businesses that employed electromechanical graduates. The survey was created to collect specific information about the physical operation of manufacturing in the Chippewa Valley. This was accomplished with questions that would gain information about what types and brands of equipment were used by manufacturing. This was also accomplished by determining what the most frequently used types of prime movers were; pneumatics, hydraulics, DC, and AC electricity, by manufacturing in the Chippewa Valley. The first six questions were to gain background information on the company so that comparisons could be made of the sample population.

Survey Questions

1. What is your position in the organization?
2. How many people are employed full time, 32 hours per week, at your company?
3. Do you have your own maintenance department?
4. How many people are employed full time, 32 hours per week, in your maintenance department?
5. Do you employ electromechanical technicians?
6. Do you contract with the equipment vendors to maintain your equipment?

These comparisons were useful in targeting specific companies for possible further correspondence at a later date. The answers to these questions were also compared with

information that was contained in the 2003 Wisconsin Manufacturers Directory to determine possible trends in employment.

Questions 7, 8, 11, 12 and 14 were to gain information on what brands and types of equipment are most prevalent among the sample group of manufactures.

Survey Questions

7. Please rank which types of motors are used in your manufacturing operation, with 1 being the most frequently used 2 the next most frequently used etc.
8. Please place a check mark in the box next to or circle which type of Programmable Logic Controllers' (PLC) are used at your company. Please check as many as apply.
11. What brands of Servo motors and drives do you use in your process?
12. Do you use "flat panels" for your operators to interface with your equipment? If you use "flat panels" which brands and models do you use?
14. Do you use any form of robotics in you manufacturing process?

This information will allow future changes in curriculum to be tailored to match the brands that are being used in manufacturing in the Chippewa Valley.

Questions 9, 10, 15, and 16 were used to determine what were the most prevent forms of transmission of power used in manufacturing in the Chippewa Valley.

Survey Questions

9. What percentage of your process requires pneumatics as the prime movement source for the operation?
10. What percentage of your process requires hydraulics as the prime movement source for the operation?

15. What percentage of your manufacturing operation uses AC motors and frequency drives?

16. What percentage of your manufacturing operation uses DC motors and drives?

Questions 19 and 20 were used to determine voltage types and values used in control and power circuits. In conjunction with questions 19 and 20 are questions 13, 17, and 18 which have given a greater insight into what types of control devices are used in manufacturing in the Chippewa Valley.

Survey Questions

13. In you manufacturing operation do you use a vision system to:

17. What percentage of your manufacturing operation uses proximity sensors (non-contact)?

18. What percentage of your manufacturing operation uses electro/mechanical type sensors (physical contact)?

19. What type and level of voltage do you use for your control circuits?

20. What type and level of voltage do your use for your power circuits?

With the combined information from questions 7 through 20 the researcher was able to collect information that will be used to focus the electromechanical program at Chippewa Valley Technical College to better meet the competencies needed by business and industry in the Chippewa Valley. Included with the survey was a letter explaining the purpose of the survey (Appendix B is a copy of the letter of explanation), how it would impact the Electromechanical program at CVTC, and the benefits to the manufacturing businesses in the Chippewa Valley. Along with the Survey and the letter of explanation there was included in the packet a self-addressed stamped envelope which would

facilitate the return of the completed survey to the researcher. The survey was designed to be completed by an Engineering Manager, Maintenance Manager, Supervisor, Training Director, Human Resources Director, or an individual holding a similar position of authority. The survey packet consists of two 8 1/2"x 11" sheets of paper, there are 20 questions that chosen sample participants are asked to reply to. Feedback was obtained for the instrument from instructors of the Electromechanical Program at Chippewa Valley Technical College. This led to the following changes to the instrument: Question 7 had space added where a number could be placed to rank the use of the different motors. Questions 9 and 10 were reworded to clarify the intention of the questions.

Data Collection

A copy of the survey was sent through the United States Postal Service to the businesses chosen in the stratified random sample. There was a self-address section on the survey along with the required postage so that the survey could be returned to the researcher.

Data Analysis

There were a total of 70 surveys that were mailed to the participants of the stratified, random sample. Each of the survey questions were placed into a spread sheet and evaluated using a Likert scale the data collected was nominal and ordinal in nature and was analyzed to determine the frequencies and percentages of the primary objectives of the study. There was a one week time frame in which the sample group was given to respond to the instrument. There was no follow up done to increase the response rate. But there was incentive built into the instrument for the sample group to respond on time. This was achieved by placing those that did respond within the set time parameter into a

drawing where one of the respondents would be chosen randomly to win $100 if their name was drawn.

Limitations

The limitations at this point will be in the return rate of the surveys, the sample group that returns the survey answered the question truthfully. That the survey measured what it was supposed to measure. The motivation of the sample group to answer the questions whether to give insight into their operations or if they were motivated just to have the opportunity to be placed in a drawing to possibly win money.

Chapter IV: Results

In order to determine if the competences that are being taught to Chippewa Valley Technical College graduates of the electromechanical program a needs assessment survey was conducted of business and industry in the Chippewa Valley. The survey was mailed to a random sample group of manufactures in the Chippewa Valley, chosen from the 2003 Wisconsin Manufacturers Directory. Of the 70 surveys sent to manufactures selected in the random sample 22 surveys were returned. This is a 31% return rate on the survey, but six of the surveys were returned by the post office being labeled "return to sender not deliverable as addressed unable to forward". Therefore the effective response rate for the survey was 23%. Each of the questions will be discussed and the corresponding data placed into a table with the number of responses for each choice and the percentage of the response verses the total responses for that question.

Data Analysis

The first six questions were used to gain back ground information on companies. The surveys were filled out by persons with the title engineer/maintenance manager being the largest group at 50% and the next largest group would be those persons with the title of supervisor with 19%. It was important that anyone with maintenance with the company experience respond because of the implications of the program at CVTC.

Table 1

Position Held in the Organization

Item Response	Frequency (N=16)	Percentage
Owner	1	6%
President/CEO	1	6%
Electrical Manager	1	6%
Engineer/Maintenance Manager	8	50%
Supervisor	3	19%
Training Director	0	0%
Human Resources Director	0	0%
Other	2	13%
Total	16	100%

The largest percentage of full time employees listed for a company was the category of over - 201 employees at 38%. The next two categories were 0 - 50 and 101 - 150 employees at 31% and 25% respectively.

Table 2

People Employed Full Time, 32 Hours Per Week

Item Response	Frequency (N=16)	Percentage
0-50	5	31%
51-100	1	6%
101-150	4	25%
151-200	0	0%
Over 201	6	38%
Total	16	100%

Question three had 94% of the respondents affirming that they had some form of maintenance department for their manufacturing facility. This question was important because it established the need for electromechanical graduates in the Chippewa Valley.

Table 3

Maintenance Department Within Facility

Item Response	Frequency (N=16)	Percentage
Yes	15	94%
No	1	6%
Total	16	100%

Question four asked how many employees were in their maintenance department. There were 38% of the respondents that stated that they had 0-5 people in their

maintenance department followed by 6-10 and over – 21 maintenance employees both indicated with having 25%.

Table 4

People Employed Full Time, 32 Hours Per Week, in Your Maintenance Department

Item Response	Frequency (N=16)	Percentage
0-5	6	38%
6-10	4	25%
11-15	2	12%
16-20	0	0%
Over 21	4	25%
Not applicable	0	0%
Total	16	100%

Since electromechanical competencies were of importance in the CVTC program, question five asked about the electromechanical technicians employed. Sixty three percent of respondents stated that they did have employees that they referred to as electromechanical technicians.

Table 5

Electromechanical Technicians Employed

Item Response	Frequency (N=16)	Percentage
Yes	10	63%
No	6	37%
Total	16	100%

To determine if the companies were outsourcing there maintenance question six asked respondents if they contracted with equipment vendors. Sixty three percent of respondents stated that they did not have any form of contractual agreement with equipment vendors to maintain their equipment.

Table 6

Contracts With Equipment Vendors to Maintain Equipment

Item Response	Frequency (N=15)	Percentage
Yes	5	33%
No	10	67%
Total	15	100%

One respondent checked both yes and no on their survey their answers were not included. To determine what type of motor was used in manufacturing question seven was asked. Three phase AC motors were the most common motor in use with 79% of those surveyed ranking it as number 1.

Table 7

Types of Motors Used in Manufacturing Operation

Item response	Frequency (N=14)	Frequency (N=14)	Frequency (N=12)	Frequency (N=9)	Frequency (N=4)
Rank	1	2	3	4	5
Servo	2	4	3	2	0
Percent	14%	29%	25%	22%	0%
Stepper	0	0	2	1	3
Percent	0	0	17%	11%	75%
DC	1	3	5	3	1
Percent	7%	21%	42%	33%	25%
AC single phase	0	6	0	3	0
Percent	0%	43%	0%	33%	0%
AC three phase	11	1	2	0	0
Percent	79%	7%	16%	0%	0%
None	0	0	0	0	0
Percent	0%	0%	0%	0%	0%
Other	0	0	0	0	0
Percent	0%	0%	0%	0%	0%
Total	100%	100%	100%	99%=100%	100%

(1=Most frequently used, 2=Next most frequently used, etc.)

Two respondents marked DC, single phase AC, and three phase AC motors as being used but did not rank them.

To determine what brands of PLCs were used in the Chippewa Valley question eight was asked. Allen Bradley PLC's were listed by the respondents as the brand that they use at 94%, Siemens was listed in second place at 37%.

Table 8

Programmable Logic Controller/s (PLC) Used at Company

Item response	Frequency (N=16)	Percentage
Allen Bradley	15	94%
Automation Direct	1	6%
Siemens	6	37%
Mitsubishi	0	0%
Cutler Hammer	2	12%
GE	1	6%
None	1	6%
Other*	4	25%

*(The following brands were listed in row under "other" Fanuc was listed twice, Modicon and Elau were both listed once.)

To determine the need for competencies in pneumatic question 9 asked what percentage of the respondents operation used pneumatics. Sixty nine percent (69%) of respondents listed less then 40% of pneumatics systems were used as the prime source of movement for their manufacturing operation. Nineteen percent (19%) stated that they

used pneumatics for 50/60% of their operation and 12% listed that they used pneumatics for their prime source of movement over 70% of the time.

Table 9

Percentage Process Requires Pneumatics as the Prime Movement Source for the Operation

Item response	Frequency (N=16)	Percentage
Over 70%	2	12%
50/60%	3	19%
Less then 40%	11	69%

To determine the competencies needed in hydraulics question 10 asked what percentage hydraulics were used in their operation. Eighty one percent (81%) of respondents listed hydraulics as being used less then 40% as the prime source for movement of components in their manufacturing operation. Nineteen percent (19%) listed that they used hydraulics for their primary source of movement in their manufacturing operation 50/60% of the time. There were no respondents that listed hydraulics as their prime source of movement at over 70% of the time.

Table 10

Percentage Process Requires Hydraulics as the Prime Movement Source for the Operation

Item Response	Frequency (N=16)	Percentage
Over 70%	0	0%
50/60%	3	19%
Less then 40%	13	81%

To determine what brands of Servo motors and drive should be focused on in the electromechanical program question 11 asked respondents what they used in their operation. Of the 16 respondents there were 50% that listed Allen Bradley as their brand of servo system that they used in their manufacturing operation. Nineteen percent (19%) of respondents listed that they did not use any servo motors and drives in their operation.

Table 11

Brand of Servo Motors and Drives Used in Process

Item Response	Frequency (N=16)	Percentage
Allen Bradley	8	50%
Automation Direct	0	0%
Teknic	2	12%
Rexroth	0	0%
Parker	1	6%
None	3	19%
Other*	7	44%

*(Dan Foss, Control Techniques, Elav, Yashawa, Yawaskawa, Panasonic, and one respondent marked other but did not list a servo drive).

Question 12 was created to determine what brand of machine interface was most commonly used in the Chippewa Valley. Allen Bradley was listed as the brand used most by the respondents at 81% for a flat panel interface device for their operators in the manufacturing operation. Automation Direct was listed as the next most common brand of flat panel interface device for operators at 12%. Also at 12% the respondents listed that they did not use any type of flat panel device for operator interface.

Table 12

"Flat Panels" Brands and Models, If Used

Item Response	Frequency (N=16)	Percentage
Allen Bradley	13	81%
Automation Direct	2	12%
Nematron	1	6%
Nortech	0	0%
None	2	12%
Other*	4	25%

*(Modicon, Siemans, CTC, and GE Fanuc)

Question 13 was used to determine the need for competencies in the use of vision system. Fifty six percent (56%) indicated that they did not use any type of vision system with 38% indicating that they used a vision system for detection of defective parts.

Table 13

Manufacturing Operation Vision System Use

Item Response	Frequency (N=16)	Percentage
Detect defective parts	6	38%
Part identification	2	12%
Product counting	1	6%
Do not use a vision system	9	56%

Some of the respondents used their vision systems for multiple functions.

Question 14 determined the need for robotics competencies in the electromechanical program. Fifty six percent of respondents indicated that they did not use robotics in their manufacturing process, with Fanuc robots used by 25% of respondents.

Table 14

Form of Robotics Used in Manufacturing Process

Item Response	Frequency (N=16)	Percentage
Fanuc	4	25%
GMF	0	0%
Kawasaki	1	6%
ABB	1	6%
Kuka	0	0%
None	9	56%
Other*	4	25%

*(Amaco, Electric 80, Adept, and Staubli)

To determine the extent of the use of AC frequency drives in manufacturing question 15 was created. Sixty three percent of respondents indicated that more then 50% of their manufacturing operation used AC motors and frequency drives.

Table 15

Percentage Manufacturing Operation Use of AC Motors and Frequency Drives

Item Response	Frequency (N=16)	Percentage
0 – 10%	2	12%
15% - 20%	2	12%
25% - 40%	2	12%
More than 50%	10	63%

Question 16 was use to determine the percentage of use of DC motors and drives in the Chippewa Valley. Fifty six percent of respondents indicated 0-10% of their manufacturing operation used DC motors and drives.

Table 16

Percentage Manufacturing Operation Use of DC Motors and Drives

Item Response	Frequency (N=16)	Percentage
0 – 10%	9	56%
15% - 20%	4	25%
25% - 40%	1	6%
More than 50%	2	12%

Question 17 was used to determine what percent of the manufacturing operation uses proximity sensor. Fifty six percent (56%) of respondents indicated that more than 50% of their operation uses proximity sensors.

Table 17

Percentage Manufacturing Operation Use of Proximity Sensors (Non Contact)

Item Response	Frequency (N=16)	Percentage
0 – 10%	3	19%
15% - 20%	2	12%
25% - 40%	2	12%
More than 50%	9	56%

Question 18 was used to determine the percentage of use of electro/mechanical sensors. Mechanical type sensors were indicated at 31% for three of the four rows 0-10%, 15-20%, and 25-40%.

Table 18

Percentage of Manufacturing Operation Use of Electro/Mechanical Type Sensors (Physical Contact)

Item Response	Frequency (N=16)	Percentage
0 – 10%	5	31%
15% - 20%	5	31%
25% - 40%	5	31%
More than 50%	1	6%

Question 19 determined what type and level of voltages were used for control circuits. Respondents marked more then one type and level of voltage being used for control voltage. Eighty eight percent (88%) of the respondents listed 100-120 volts AC as

the control voltage that is used most often with 63% of respondents listing 10-30 volts DC as the second most used control voltage.

Table 19

Type and Level of Voltage Used for Control Circuits

Item Response	Frequency (N=16)	Percentage
0 – 10 volts AC	1	6%
10 – 30 volts AC	7	44%
100 – 120 volts AC	14	88%
Over 120 volts AC	1	6%
0 – 10 volts DC	2	12%
10 – 30 volts DC	10	63%
Over 30 volts DC	2	12%

Question 20 was used to determine what types and voltage levels were used for power circuits. Respondents listed as more then one type and level of voltage being used for their power circuit. 94% of respondents listed their power circuit voltage as 240 – 480 volts three phase AC with 38% indicating 0-50 volts DC as the second most used voltage.

Table 20

Type and Level of Voltage Used for Power Circuits

Item Response	Frequency (N=16)	Percentage
0 – 120 volts AC 1 phase	5	31%
240–480 volts AC 3 phase	15	94%
2400-4200volts AC 3 phase	2	12%
Other	0	0%
0 -50 volts DC	6	38%
51 – 90 volts DC	3	19%
100 – 250 volts DC	2	12%
Over – 251 volts DC	2	12%

Chapter V: Summary, Conclusions and Recommendations

Introduction

In this chapter the information from the survey will be summarized and conclusions will be made based on the results of the survey. Recommendations will be the final step in this chapter which will be made based on the summary and conclusions.

Summary

The purpose of this study was to determine if the competences taught the electromechanical students at Chippewa Valley Technical College meet the needs of business and industry in the Chippewa Valley. This study used a survey sent through the United States Postal Service to a stratified random sample of manufactures in the Chippewa Valley area. There were 70 surveys sent out with 22 surveys being returned for a 31% return rate. Of the 22 surveys that were returned 6 surveys were returned do to the postal service being unable to deliver them. This gave the survey an effective response rate of 23%. There were 20 survey questions that the sample group was asked to respond to. Each of those questions will be restated and conclusions will be made for each of them.

1. What is your position in the organization? Eight of the 16 respondents or 50% used the title of Engineer/Maintenance Manager with the next largest group three respondents or 19% listing Supervisor as their title. One each or 6% used one of the following titles Owner, President/CEO, or Electrical Manager. The final two respondents or 13% listed other for their title. The significance of this question is that future correspondence will need to be directed at persons with the title of Engineer/Maintenance Manager to get the greatest response.

2. How many people are employed full time, 32 hours per week, at your company? Of the 16 respondents to the survey six or 38% had over – 201 employees, five or 31% had 0-50 employees, four or 25% had 101-150 employees, and one or 6% responded that they employed a total of from 51-100 employees. This indicates that the survey data is going to be biased toward those employers 63% that employee 100 or more employees.

3. Do you have your own maintenance department? Fifteen of the 16 respondents or 94% answered yes to this question with only one person or 6% who answered this question with no. The respondent that answered no to this question had indicated in question two of the survey that they only have from 0-50 full time employees. The same responded also answered question 4 with 0-5 maintenance department employees. In question five they answered no and in question 6 they answered yes, no they do not have any electromechanical technicians, and yes they do contract with equipment vendors for their maintenance needs.

4. How many people are employed full time, 32 hours per week, in your maintenance department? The largest number of respondents six or 38% indicated that they had from 0-5 maintenance employees followed by 6-10 and over-21 both with 25% each. Two respondents or 12% indicated that they employee from 11-15 maintenance workers.

The response to this question again may be biased toward the larger companies when you consider that 62% of the respondents indicated that they had six or more maintenance employees.

5. Do you employ electromechanical technicians? Ten of the 16 respondents or 63% answered this question with a yes indicating that they do employee electromechanical technicians. Six or 37% stated that they did not employee electromechanical technicians. The percentages in this question match closely with the percentages in questions two and four which could be an indication that larger companies have more employees and hire EM techs.

6. Do you contract with the equipment vendors to maintain your equipment? Ten or 67% of the 15 respondents who answered this question stated that they did not use vendors for maintenance of their equipment. This left five or 33% who indicated that they did use vendors for maintenance of their equipment. This question was answered yes by both small and large companies so size (determined by the number of employees they employed) did not seem to be a factor.

7. Please rank which types of motors are used in your manufacturing operation, with 1 being the most frequently used 2 the next most frequently used etc... Eleven or 79% of the 14 respondents indicated that their number one choice was an AC three phase motor. The motors most often chosen as second choice were single phase AC motors with a 43% or 6 out of 14 choosing them. Third choice was DC motors with 42% or 5 of 12 people choosing them. Fourth choice was split between DC motors and single phase AC motors chosen by 33% or 3 out of 9 people choosing each of them. Coming in last at fifth place were chosen stepper motors with 75% or three out of four respondents indicating them. With 79% choosing three phase AC motor as their first choice corresponds with question 20 where 94% of respondents use 240-480 volts AC 3 phase for their power circuits.

8. Please place a check mark in the box next to or circle which type of Programmable Logic Controller/s (PLC) are used at your company. Please check as many as apply. Allen Bradley PLCs were used most often by manufacturing in the Chippewa Valley with 94% or 15 out of 16 indicating it. Siemens PLCs were the second most used with 37% or six out of sixteen indicating there use. This information does not give a specific model of Allen Bradley or Siemens PLCs but it does substantiate CVTC using Allen Bradley PLCs in their electromechanical program.

9. What percentage of your process requires pneumatics as the prime movement source for the operation? The largest group of respondents 69% indicated that they used less then 40% of pneumatics as their prime energy source for their operation.

10. What percentage of your process requires hydraulics as the prime movement source for the operation? Eighty one percent (81%) stated that they used hydraulics less then 40% of the time for their prime source of energy for movement of components and products. With respondents answering both questions 9 and 10 indicating that employers in the Chippewa Valley use less then 40% of pneumatic or hydraulics for their prime energy source for movement CVTCs' electromechanical program students receive a sixteen week course called "Fluid Power" where they learn the basics of pneumatics and hydraulics should meet this need.

11. What brand of Servo motors and drives do you use in your process? Eight out of 16 respondents or 50% indicated Allen Bradley as the most frequently used servo motor and drive package. The electromechanical program has six Allen Bradley servo drives and motor that were purchased last year.

12. If you use "flat panels" for your operators to interface with your equipment, which brands and models do you use? Thirteen out of 16 or 81% chose Allen Bradley interfaces as the most frequently used flat panel. Automation Direct was second with 12% or two out of sixteen choosing it. The electromechanical program has a course called EM System Interfacing which uses Allen Bradley Panel View 1000 for an interface device.

13. In your manufacturing operation do you use a vision system to: Nine out of 16 respondents or 56% indicated that they did not use a vision system. Six out 16 or 38% indicated that they used a vision system to detect defective parts. The electromechanical program at CVTC has one vision system that is not being used in a course on a consistent basis; this would not help the 38% that use a vision system to detect defective parts.

14. Do you use any form of robotics in your manufacturing process? Nine out of 16 or 56% indicated that they did not use any type of robotics system. Four out of 16 or 25% indicated that they used Fanuc brand robotics in their manufacturing operation. Thirty seven percent (37%) listed some other brand of robotics that they used. The electromechanical program at CVTC has a course Industrial Robotics Systems that instructs students on Fanuc, CRS, and GMF robots. This would be of value to the 25% that do have Fanuc robots and the other 37% would gain employees that have a basic understanding of robotics.

15. What percentage of your manufacturing operation uses AC motors and frequency drives? Ten out 16 or 63% indicated that they used AC motors and frequency drives more then 50% verses other motors and drives for their manufacturing operation.

The electromechanical program at CVTC has a course called Motion Control where the students are taught to program, wire, and control AC motors and drives.

*16. What percentage of your manufacturing operation uses DC motors and drives?*Nine out of 16 or 56% of respondents indicated that they only use DC motors and drives from 0-10% for their manufacturing operation. Four out of 16 or 25% indicated that they used DC motor and drives for 25% of their manufacturing operation. One respondent indicated that they used DC motors and drives 25-40% of their manufacturing operation with two respondents indicating that they use DC motors and drive for more then 50% of their manufacturing operation. The Motion Control course at CVTC educates the students about DC motor and drives.

17. What percentage of your manufacturing operation uses proximity sensors (non-contact)? Nine out of 16 or 56% indicated that they use proximity sensors in their manufacturing operation more than 50% of the time. There were two respondents each for both the 15-20% row and the 25-40% row for the use of proximity sensors in their manufacturing operation. There were three out of 16 respondents or 19% that use proximity sensors 0-10% for their manufacturing operation. CVTC has a course called Sensors and Servo Systems that instruct students on the operation and use of different types of proximity sensors.

18. What percentage of your manufacturing operation uses electromechanical type sensors (physical contact)? There were five responded for each of the three rows 0-10%, 15-20%, and 25-40% that use electro/mechanical type sensors. One respondent indicated that their manufacturing operation has more then 50% electro/mechanical

sensors in use in their operation. Electro/mechanical sensor are taught and used in both the Industrial 1 and Industrial 2 course at CVTC.

19. What type and level of voltage do you use for your control circuits? Fourteen out of sixteen or 88% chose 100-120 volts AC as the most frequently used control voltage. The second most common voltage used was 10-30 volts DC indicated by ten out of 16 or 63% of respondents. The two most common control voltages used at CVTC are 120 volts AC and 5 volts DC.

20. What type and level of voltage do you use for your power circuits? Fifteen out 16 or 94% indicated that 240-480 volts AC was the most common voltage used in power circuits. The second most common voltage used in power circuits was 0-50 volts DC which was indicated by six out of 16 or 38% of the respondents. The two most common voltages used for power circuit voltage at CVTC are 208-480 volts AC 3 phase and 12 volts DC.

Conclusions

There were five research objectives that were sought. Each of those objectives are restated here with the results from the survey.

Research Objective 1. Determine what technologies are presently being used in business and industry in the Chippewa Valley area. The study determined that three phase AC motors were used most often in manufacturing at 79%. Allen Bradley was the most common brand of with PLCs used 94% of the time, servo motors and drives used 50% of the time, and operator interfaces used 81% of the time. AC motors and frequency drives were used in more then 50% of the manufacturing operations. Fifty six percent

(56%) of the sample group use proximity sensors in more then 50% of their manufacturing operation.

Research Objective 2. Determine what technologies are going to be implemented in industry in the next five years according to engineering and maintenance managers in business and industry. This question was not addressed in the study and needs to be used in a future study.

Research Objective 3. Compare present technologies taught to EM graduates with technologies being used in business and industry. Graduates of the EM program have 16 weeks of PLC intro., 16 weeks of PLC application with both courses using Allen Bradley software and hardware components. They have a 16 week course in motion control that uses Allen Bradley frequency drives. They are taught a course called em system interfacing that runs for 16 weeks that uses Allen Bradley panel view 1000 for them to train on. And there is a course called Sensors and Servos where they learn about different type of proximity sensors that is 16 weeks in duration.

Research Objective 4. Identify what competences are of the least value to business and industry. When the sample group was asked about their use of a vision system in their manufacturing operation 56% stated that they did not use a vision system. Another competence that needs to be looked at is the use of robotic systems 56% of the sample group indicated that they did not use a robotic system in their manufacturing operation.

Research Objective 5. Identify what competences have the most value to business and industry. The competences that have the most value to business and industry are the students learning to program, wire, and troubleshoot PLCs, frequency drives and motors, AC three phase motors, servo motors, and proximity sensors.

Recommendations

The following recommendations determined from this study are as follows:

Response rate

- Future correspondence with manufacturing companies will need to address their correspondence to persons with the title of Engineer/Maintenance Managers if they hope to get the greatest return rate.
- To get the best response to future enquires it was found that the greatest return rate of surveys came from companies that employed 100 or more employees.
- The drawing that was included in the survey to help increase the return rate of the surveys only had five of the 16 or 31% that participated in the drawing that means that 69% were not moved to participate do to any type of financial inducement. This was not as affect as I had hoped in increasing the return rate but it .

Survey modification

- That three of questions on the survey could have been combined so that if the respondents answer no to question three; *Do you have your own maintenance department?* they could have skipped questions four; *How many people are employed full time, 32hrs per week, in your maintenance department?* and question five; *Do you employ electromechanical technicians?*
- One of the objectives of the survey was over looked and should be used in a possible follow up survey. *Determine what technologies are going to be implemented in industry in the next five years according to engineering and maintenance managers in business and industry.*

Check the findings of the present survey

- With 69% of respondents indicating that they used pneumatics for less then 40% of their operation and 81% of respondents indicating that they used hydraulics for less then 40% of their operation. Further study is needed to determine how accurate this information is.

The results of the survey

- The information from this study will be presented to the department chair and the instructors in the electromechanical program at Chippewa Valley Technical College to determine what further action should be taken.

References

Brutlag, J. (2005). *Electromechanical flyer.*

CVTC. (2007). *Electromechanical technology.* Retrieved June 18, 2007, from: www.cvtc.edu

CVTC. (1990-2000). *Microsoft WIDS 7: This is about competences.* Eau Claire, WI: Chippewa Valley Technical College.

CVTC EM Placement. (1996-2002). (Available from: Chippewa Valley Technical College, Electromechanical Program- Eau Claire Wisconsin)

Deitz, & Orr. (2006, February/March) A leaner, more skilled U.S. manufacturing workforce. *Economics and Finance, 12*(2).

Doyle, J. (2007). *Investing in manufacturing and high tech business.* Retrieved June 20, 2007, from: www.wisgov.state.wi.us/docview.asp?docid=9687

Evanciew, C., & Wither, S. (2004, Spring). Replacing technically skilled workers: Challenges and suggestions. *Journal of Industrial Teacher Education, 41*(1).

Go Jobs. (2007). *Electromechanical.* Retrieved January, 2008: www.gojob.com

Hagenbaugh, B. (2002). *U.S. manufacturing jobs fading away fast.* Retrieved June 18, 2007, from: www.USA Today, 12-12-2002.

Koch Careers. (2007). *Electrical Engineer Technician.* Retrieved January, 2008: http//koch.hrdpt.com/chi-bin/c/jobsearch_all.cgi

Maricopa Community College. (December, 2006). *Electromechanical automation Technology.* Retrieved May, 2007: www.maricopa.edu/programs/index.php

Momentum Chippewa Valley. (2007). *Chippewa Valley area.* Retrieved June 18, 2007, from: www.chippewavalley.org/

Nation Job. (2007). Engineer/Electromechanical.Retrieved January, 2008: www.nationjob.com.

Nation Job Network. (2007). *CVTC background information.* Retrieved June 19, 2007, from: www.nationfob.com /company/chvt

National Association of Manufacturers. (2007). *Why manufacturing is essential* Retrieved July 1, 2007 from: www.nam.org/s_nam/sec.asp?CID=201648&/DID=230169

National Association of Manufacturers. (2005, October). *The importance of manufacturing overview* Retrieved July 1, 2007 from: www.nam.org/s_nam/sec.asp?CID=201648&/DID=230169

National Association of Manufacturers. (2005, October). *Manufacturing: Engine of U.S. innovation.* Retrieved July 1, 2007 from: www.nam.org/s_nam/bin.asp?CID=201507&/DID=227165&DOC=FILE.PDF

O*net Online. (2007) *Summary report for: 17-3024.00 –electro-mechanical technicians* Retrieved June 18, 2007 from: http://online.onetcenter.org/link/summary/17-3024.00

O*Net On Line. (2006). *Electro-mechanical technicians.* Retrieved May, 2007: http://online.onetcenter.org/link/summary/17-3024.00

Owen, P. (2005). *An assessment of business and industry training trends in the Chippewa Valley Technical College district.* Unpublished master's thesis, University of Wisconsin-Stout, Menomonie.

Speizer, I. (2007, February). Factories find future is what you make it. *Business,* North Carolina (np).

Weimer, G. (2004, December). Manufacturing needs creativity, not hand-wringing, *Material Handling Management, 59*(13), 38.

Wikipedia. (2007, June 18). *Computer hardware.* Retrieved June 18, 2007 from: www.wikipedia.org/wiki/Computer_hardware

Wikipedia. (2007). *Programmable logic controllers.* Retrieved June 18, 2007 from: www.wikipedia.org/wiki/Programmable_Logic_Controller

Wikipedia. (2007). *Motion control.* Retrieved June 18, 2007, from: www.wikipedia.org/wiki/Motion_control

WIDS. (2007). *World wide Instructional Design Systems (WIDS),* Retrieved June 18, 2007 from: http://www.wids.com

Worknet. (2007). *Occupation projections results.* Retrieved June 20, 2007 from: htttp//worknet.wisconsin.gov/worknet/daoccprj.aspx?menuselsction=da

U.S. Department of Commerce. (2004, January) *Manufacturing in America: A comprehensive strategy to address the challenges to U.S. manufacturers.* Retrieved January, 2008 from: www.ita,doc,gov/media/publications/text/manuam0104_final.txt

Appendix A

Survey

The purpose of this survey is to determine what competences are needed for electromechanical graduates by Business and Industry within the Chippewa Valley Area. This is to be accomplished by determining what equipment and technologies are being used in manufacturing in the Chippewa Valley. Since there are so many different brands and types of manufacturing equipment available it would be virtually an in exhaustible supply to attempt to list them all. So to narrow this survey down to a more manageable size for those questions that have the word "Other" listed as a choice please fill in the blank line with the brand or device that your company is using if it is not listed.

1. What is your position in the organization?
   - ☐ Owner
   - ☐ President / CEO
   - ☐ Electrical Manager
   - ☐ Engineer / Maintenance Manager
   - ☐ Supervisor
   - ☐ Training Director
   - ☐ Human Resources Director
   - ☐ Other

2. How many people are employed full time, 32hrs per week, at your company?
   - ☐ 0-50
   - ☐ 51-100
   - ☐ 101 – 150
   - ☐ 151 – 200
   - ☐ Over - 201

3. Do you have your own maintenance department?
   - ☐ Yes
   - ☐ No

4. How many people are employed full time, 32 hrs per week, in your maintenance department?
   - ☐ 0-5
   - ☐ 6-10
   - ☐ 11 – 15
   - ☐ 16 - 20
   - ☐ Over – 21
   - ☐ Not applicable

5. Do you employ electromechanical technicians?
   - ☐ Yes
   - ☐ No

6. Do you contract with the equipment vendors to maintain your equipment?
   - ☐ Yes
   - ☐ No

7. Please rank which types of motors are used in your manufacturing operation, with 1 being the most frequently used 2 the next most frequently used etc....

- ☐ _____Servo
- ☐ _____Stepper
- ☐ _____DC
- ☐ _____AC single phase
- ☐ _____AC three phase
- ☐ None
- ☐ Other _____

8. Please place a check mark in the box next to or circle which type of Programmable Logic Controller/s (PLC) are used at your company. Please check as many as apply.

- ☐ Allen Bradley
- ☐ Automation Direct
- ☐ Siemens
- ☐ Mitsubishi
- ☐ Cutler Hammer
- ☐ GE
- ☐ None
- ☐ Other _____

9. What percentage of your process requires pneumatics as the prime movement source for the operation?

- ☐ Over 70%
- ☐ 50/60%
- ☐ Less then 40%

10. What percentage of your process requires hydraulics as the prime movement source for the operation?

- ☐ Over 70%
- ☐ 50/60%
- ☐ Less then 40%

11. What brands of Servo motors and drives do you use in your process?

- ☐ Allen Bradley
- ☐ Automation Direct
- ☐ Teknic
- ☐ Rexroth
- ☐ Parker
- ☐ None
- ☐ Other _____

12. If you use "flat panels" for your operators to interface with your equipment, which brands and models do you use?

- ☐ Allen Bradley
- ☐ Automation Direct
- ☐ Nematron
- ☐ Nortech
- ☐ None
- ☐ Other _____

13. In your manufacturing operation do you use a vision system to:

- ☐ Detect defective parts
- ☐ Part identification
- ☐ Product counting
- ☐ Do not use a vision system

14. Do you use any form of robotics in your manufacturing process?
- ☐ Fanuc
- ☐ GMF
- ☐ Kawasaki
- ☐ ABB
- ☐ Kuka
- ☐ None
- ☐ Other _____

15. What percentage of your manufacturing operation uses AC motors and frequency drives?
- ☐ 0 - 10%
- ☐ 15% - 20%
- ☐ 25% - 40%
- ☐ More then 50%

16. What percentage of your manufacturing operation uses DC motors and drives?
- ☐ 0 - 10%
- ☐ 15% - 20%
- ☐ 25% - 40%
- ☐ More then 50%

17. What percentage of your manufacturing operation uses proximity sensors (non contact).
- ☐ 0 - 10%
- ☐ 15% - 20%
- ☐ 25% - 40%
- ☐ More then 50%

18. What percentage of your manufacturing operation uses electro/mechanical type sensors (physical contact).
- ☐ 0 - 10%
- ☐ 15% - 20%
- ☐ 25% - 40%
- ☐ More then 50%

19. What type and level of voltage do you use for your control circuits?

AC
- ☐ 0-10 volts
- ☐ 10-30 volts
- ☐ 100-120 volts
- ☐ Over 120 volts

DC
- ☐ 0-10 volts
- ☐ 10 -30 volts
- ☐ Over 30 volts

20. What type and level of voltage do you use for your power circuits?

AC
- ☐ 0 - 120 volts single phase
- ☐ 240 - 480 volts three phase
- ☐ 2400 – 4200 volts three phase
- ☐ Other _____

DC
- ☐ 0 - 50 volts
- ☐ 51 - 90 volts
- ☐ 100 – 250 volts
- ☐ Over – 251 volts

Appendix B

Consent to Participate in UW-Stout Approved Research
An Analysis of Electromechanical Competences by
Business and Industry within the
Chippewa Valley Area

The objective of this research is to aquire knowledge of; technologies used, types and levels of voltage used for contol and power circuits, the primary source of motion contol, and transmission of power used by manufacturing in the Chippewa Valley.

The benefits of this research will be to match the Electromechanical programs competences to the needs of the manufactures in the Chippewa Valley. Which will give the employers in the Chippewa Valley a supply of technicians that will require less additional training thus making Electromechanical graduates more sought-after for employment locally. By returning this survey, you are giving your informed consent as a participating volunteer in this study. Confidentiality will be maintained and at no point will a respondent be identified when the results are published. The potential risks of this survey are minimal, and your participation in this study is entirely voluntary.

The amount of time required to complete this survey is approximately 20 minutes. I have enclosed with this survey a self addressed, postage paid envelope for you to return the survey in once it is completed. I am hoping to receive the surveys no later then July 18, 2008 so that I can process the information. If someone else would be more appropriate to answer the questions on this survey in your organization please forward the survey to that person.

To increase the return rate of surveys, those people that return the survey on time will have their name placed in a drawing to possibly win $100 dollars. If you would like to have your name placed in the drawing please include a signed slip of paper with your name and phone number with the survey before you send it back.

This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact Gary Johnson the researcher at (715)834-6406 or gjohnson@cvtc.edu or Dr. Howard Lee the advisor at (715)232-1251 or leeh@uwstout.edu. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB administrator Sue Foxwell, Director, Research Services,152 Vocational Rehabilitation Bldg., UW-Stout, Menomonie, WI 54751, phone (715)232-2477, foxwells@uwstout.edu

Thank you,