

Mind the Gap: Training the Manufacturing Workforce of Tomorrow

An Interactive Qualifying Project

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WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

in Mechanical Engineering

by

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Abstract

The manufacturing industry is in crisis trying to find skilled workers to fill open positions. There is an apparent “skills gap” in that there are not enough trained workers in the job market and there is evidence that the gap is widening as not enough potential workers are entering the training pipeline. This project quantifies the skills gap and attempts to identify the factors that are keeping existing vocational training programs from keeping with workforce demands in the manufacturing industry. Potential solutions are discussed.

Table of Contents

- Abstract ii
- Introduction 1
 - Manufacturing Renaissance 1
 - Objective 1
 - Rationale 1
 - Manufacturing adds Economic Value..... 2
 - Manufacturing drives Innovation..... 3
 - Manufacturing Wages 3
- Approach..... 3
- Methods..... 4
 - Skills gap..... 4
 - Root Cause Investigation 4
 - Survey 4
 - Interviews..... 5
- Results..... 5
 - Skills Gap..... 5
 - Machine Tool Technology 7
 - Root Cause Investigation 7
 - Survey 7
 - Interviews..... 12
 - Leslie Parady..... 12
 - William Weir 13
 - Torbjorn Bergstrom 13
 - Alexander Segala 14
- Discussion 15
 - Skills Gap..... 15
 - Root Cause 15

Survey Shortcomings	17
Possible Solutions	17
Conclusions	19
Future Work	19
Acknowledgements	20
Works Cited	21
Appendix	23

Table of Figures

Figure 1: Comparison of Shop Floors; 1900 vs 2012 (Photo Credit: American Machinist and HaasCNC.com) 2

Figure 2 Enrollment on MTT Programs 6

Figure 3: Enrollment and Facility Sizes..... 7

Figure 4: Equipment Controller Types 8

Figure 5: Challenges facing enrollment..... 9

Figure 6: Sourcing methods for current equipment 10

Figure 7: Factors for sourcing new equipment 11

Figure 8: Midnight at the Glassworks, 1908, Lewis Hine 16

Figure 9: Promotional ad for the Premier of Metal & Flesh..... 18

Introduction

While the topic of job creation looms large, an industry that is responsible for 12.2% of the US GDP is desperately looking to fill already open positions (National Association of Manufacturers). According to a study by the Manufacturing Institute, upwards of 600,000 jobs are going unfilled simply because employers cannot find people with the right skills (Morrison, et al. 2011).

Manufacturing Renaissance

Over a 40 year period, the United States watched as 41 percent of its manufacturing jobs were lost. (Helper, Krueger and Wial 2012) In light of a changing global economy, there is the opportunity to bring manufacturing industry back to the US and spark a manufacturing renaissance. Rising cost of foreign labor and increases in transportation costs are quickly erasing the benefits once seen of moving off shore, making the option of ‘re-shoring’ more viable.

Objective

The objectives of this work are to investigate the existence or emergence of an apparent skills gap in the manufacturing workforce in the US; to investigate root causes of any skills gap; and to propose possible solutions and further work.

Rationale

The manufacturing industry has endured great change over the last century. Manufacturing facilities are no longer dark, soot filled factories with death and danger around every bend. The introduction of computer controls and process automation has increased the technical knowledge demanded of the daily operator. Now, 42% of manufacturing employees have at least an

Associate's Degree, which has increased by 6% in the past 8 years alone (Manufacturing Advancement Center 2012).

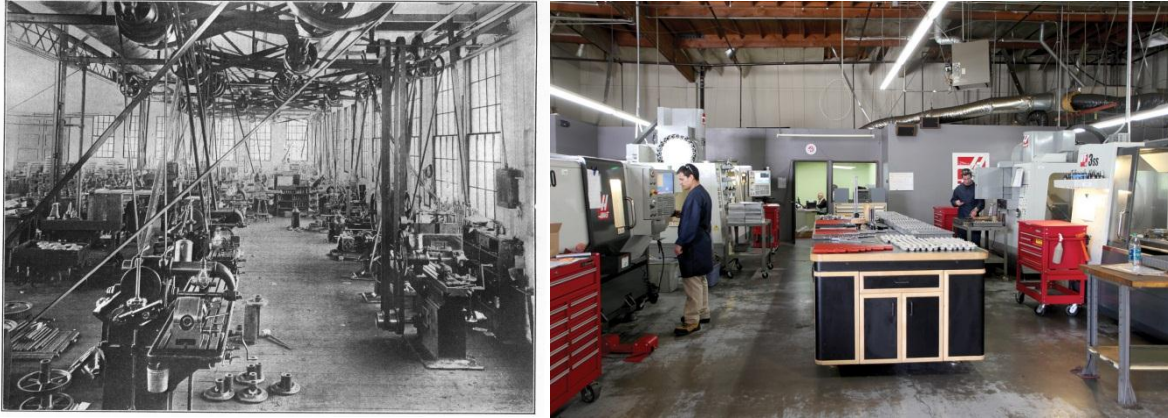


Figure 1: Comparison of Shop Floors; 1900 vs 2012 (Photo Credit: American Machinist and HaasCNC.com)

In a study by the Manufacturing Institute in 2012, the Manufacturing Industry was viewed as the most important to maintain a strong national economy in the US; however the public still has reservations of safety and job stability (Giffi and McNelly 2012). Only 56% of respondents strongly believe that jobs in US manufacturing are clean and safe, and only 43% agree or strongly agree that US manufacturing jobs are stable and provide job security relative to other industries (Giffi and McNelly 2012).

Manufacturing adds Economic Value

It is widely acknowledged manufacturing is vital to our economic security and standard of living. Virtually all manufactured products are no more than a few steps removed from some sort of precision machining operation. According to an article in Time Magazine, for every \$1 of manufacturing output in a community, there's another \$1.48 of wealth created (Rana Foroohar 2013).

Manufacturing drives Innovation

Manufacturing companies go above the average spending on R&D and continue to push the boundaries. Innovations that are brought on by this tend to spill over into other industries, driving product development in other industries (Morrison, et al. 2011). Professor Pisano from Harvard School of Business was asked if exporting manufacturing ultimately drains away American innovation, Pisano replied, *“Absolutely. That’s the heart of our argument. That’s what we feel is not well understood in a lot of discussions. Willy and I would characterize it as a naive view that innovation is just about R&D and separate from manufacturing. People in the United States and other advanced industrialized countries say that the future is in innovation, not manufacturing, as if manufacturing is not part of the innovation process. In many sectors that’s simply not true. The ability to develop very complex, sophisticated manufacturing processes is as much about innovation as dreaming up ideas.”* (Thompson 2011)

Manufacturing Wages

Jobs in manufacturing require employees to maintain a high skill level and employers compensate as such. In Massachusetts, the average annual wage is \$52,396 and the average annual manufacturing wage is \$65,333 (Parady 2012). Nationally, manufacturing jobs pay on average 25 percent more than other jobs (Bluestone, et al. 2008).

Approach

This work documents the existence and severity of the skills gap in the US through a combination of literature research and personal interviews. Causes of the skills gap are investigated through surveys of educators and personal interviews of industry professionals. Possible solutions are identified through personal interviews and literature research.

Methods

Skills gap

The existence of the skills gap was documented through a literature review and personal interviews.

Interviews were conducted with

- Dr. William Weir (Trident Machine Tools, Windsor CT)
- Leslie Parady (MassMEP, Worcester, MA)
- Torbjorn Bergstrom (Worcester Polytechnic Institute, Worcester, MA)

Root Cause Investigation

The root causes for the skills gap were investigated with personal interviews and survey of machine tool technology (MTT) faculty at several Massachusetts Vocational Technical High Schools were survey

Survey

In order to gather perspective from current educators, a survey was drafted for educators in MTT programs. Preliminary research on how to administer a useful survey was done by referencing *Questionnaire Design : How to Plan, Structure and Write Survey Material for Effective Market Research (2nd Edition)* by Ian Bruce. The survey was limited to ten questions to ensure quickness and improve response rate. Questions were asked with ranges or as rankings to facilitate analysis. To prevent unintentional queuing, ranking questions were presented in random order.

The survey was arranged so that it led off with qualifying questions. Factors deemed to be important were enrollment size, facility size, and breakdown of available equipment. These qualifiers were followed by questions addressing enrollment adversities and factors associated with capital equipment decisions. With hopes of soliciting additional opinions, a comment field was added to the end of the survey.

A list of known vocational teachers in MTT programs was compiled for this survey. The survey was distributed via email and administered using SurveyMonkey.com.

Interviews

Another method used for gathering information will be interviews. Interviews were set up with both a representative from industry and a former technical school student. The results of these interviews can be found in the next section.

Interviews were conducted with

- Alexander Segala (Phoenix Inc., Seekonk, MA)
- Leslie Parady (MassMEP, Worcester, MA)
- Torbjorn Bergstrom (Worcester Polytechnic Institute, Worcester, MA)

Results

Skills Gap

One topic that continued to present itself was the so-called ‘Skills Gap’. The skills gap is a term that is used to refer to the mismatch between the skills of available workers and the skills that are in demand. According to a survey by the Manufacturing Institute, 80% of respondents

indicated that machinists, operators and other skilled technical positions will be hit hardest by retirements in the upcoming years and that these jobs will be the hardest to fill (Morrison, et al. 2011). Locally, Massachusetts is projected to lose almost 1,500 machinists through 2016 to retirement and is only projected to graduate 345 students directly into the workforce over the same period. (Parady 2012)

The Massachusetts Department of Education publishes enrollment data year maintains and archive of the previous 10 years of enrollment in vocational programs. Due to a change in program designations in 2007, only the previous 6 years of data could be used reliably.

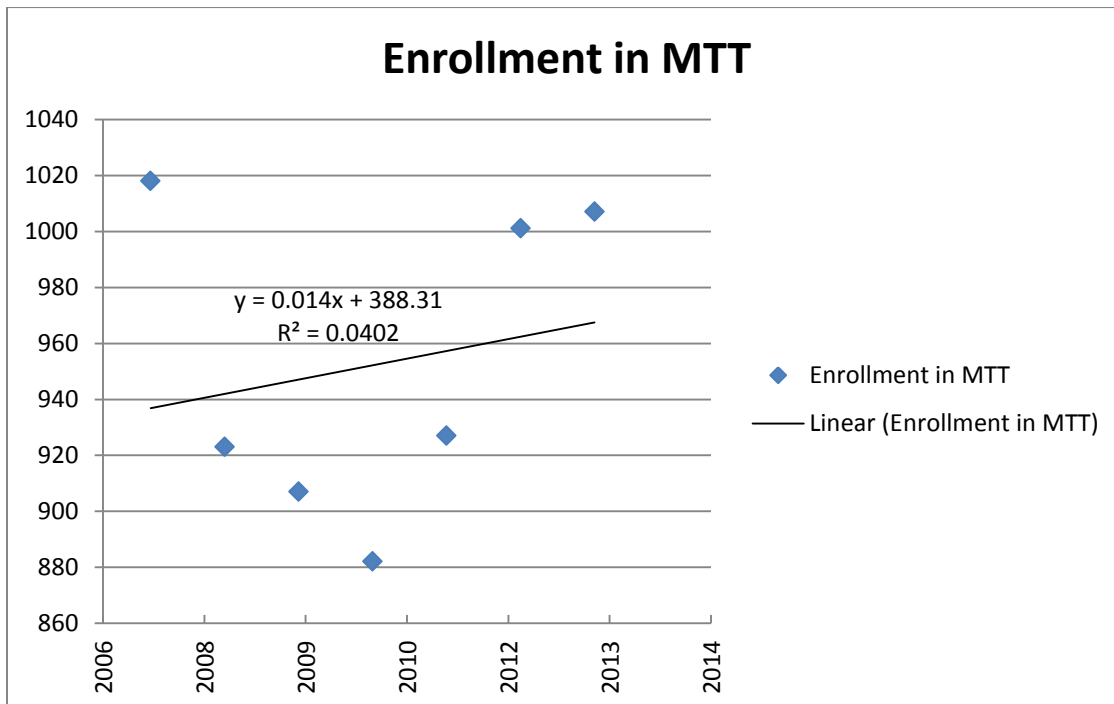


Figure 2: Enrollment on MTT Programs

In Figure 2, enrollment for all MTT programs in Massachusetts vocational schools is graphed as a function of time. When a trend line is fit the data, it shows a slope of near zero, showing that the growth rate of programs is stagnant. This is problematic for an industry that is trying to expand its workforce.

Machine Tool Technology

In order to facilitate students entering precision machining careers, vocational schools offer programs in Machine Tool Technology (MTT). The programs contain a 4-year curriculum that starts with the fundamentals of machining and culminates with students working with modern computer controlled machine tools.

Root Cause Investigation

Survey

Invitations were sent to educators from 16 of the states 30 schools with a MTT program. The survey drew 9 responses giving it a respectable response rate of 56%. Although it only provides a small sample size, the responses are convincing enough to draw conclusions from. Survey results are all posted in the Appendix section of the paper.

Qualifiers

First we wanted to qualify the responses to look for potential anomalies. Participants were asked to report their total program enrollment. Abnormally large or small programs may have driving factors that are different from that of the average program.

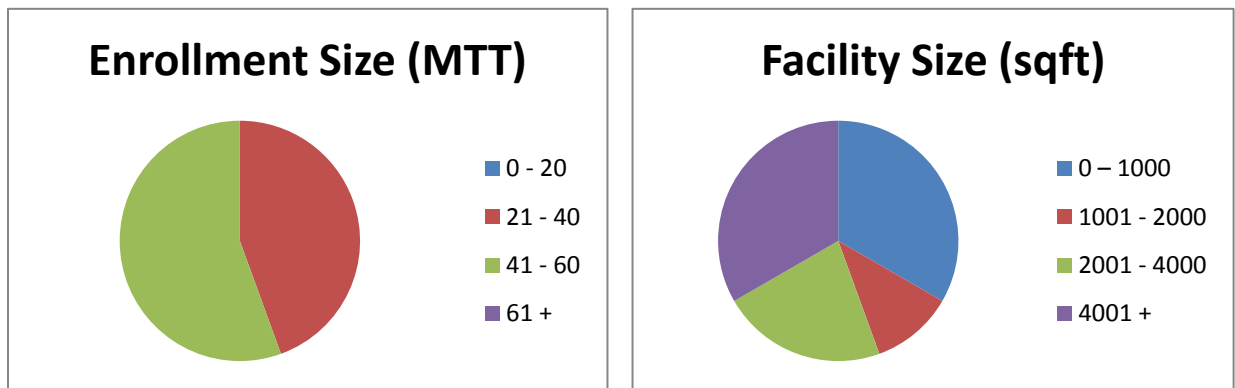


Figure 3: Enrollment and Facility Sizes

The results in Figure 3 showed us that our data collection came from average enrollment schools which contain varying facility sizes.

The quantity and types of machines available can be a bottleneck for an educational program.

Two questions were used to assess how many machines each program had with either manual or CNC controls.

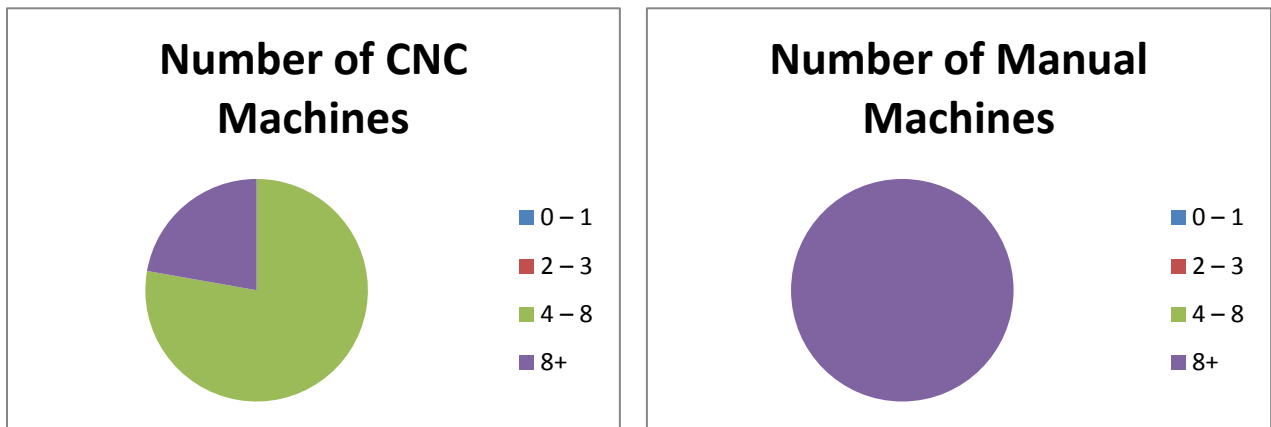


Figure 4: Equipment Controller Types

The results for this question are difficult to draw any firm conclusion from. The available selections were outside of the required range to provide a good cross-section. One of the respondents commented that their facility had just moved to a new building and currently housed over 50 pieces of equipment. Although not optimal, it does illustrate that the machines with more modern CNC controllers are typically less available. This could be due to several factors including both financial considerations and physical limitations.

Enrollment

While researching enrollment rates in MTT programs, it appeared that the rate of enrollment was stagnant. The future of the US manufacturing is depending greatly on the

availability of skilled labor. The industry is already experiencing a shortage and it's important to find out why there isn't more interest in entering the available programs.

A ranking question was created with 3 challenges which I believe affect their enrollment. Another selection labeled 'Other' was made available and responders were given the option to elaborate more on what these other influences were. In order to reduce the amount of influence on the results, the options were presented in random order.

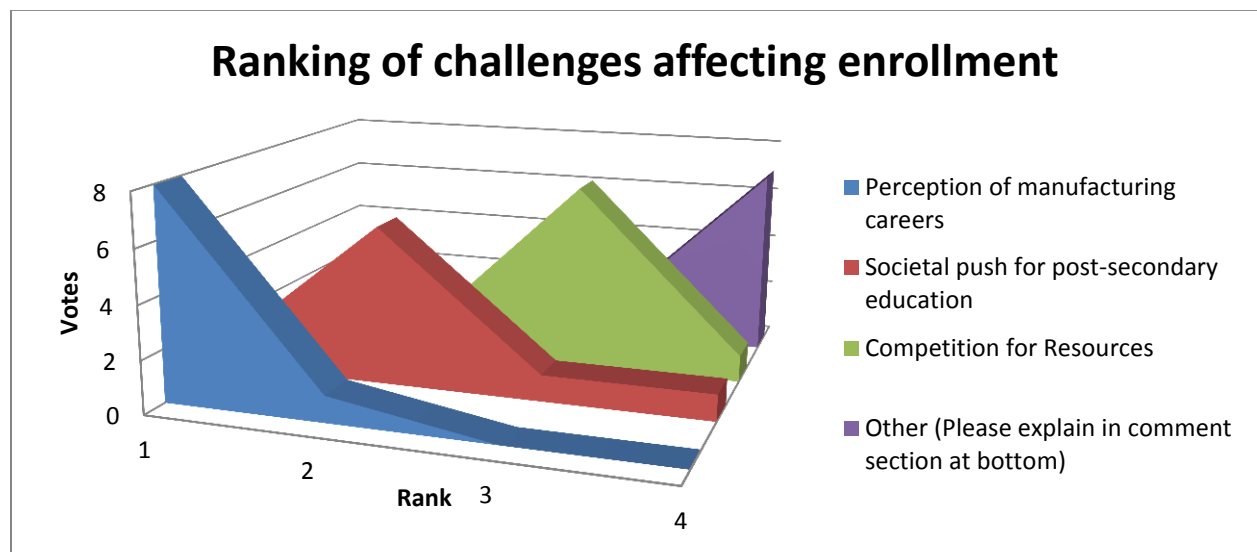


Figure 5: Challenges facing enrollment

The chart in Figure 5 shows each answer and how many votes it received for each rank. This method of visualizing the data best shows how uniform the participants' responses were. Eight of Nine responses ranked perception of manufacturing careers as the number one challenge affecting their enrollment. Receiving the most 2nd place votes was the societal push for post-secondary education. The 3rd place votes fell greatly to the competition for resources and other reasons received 7/9 last place votes. The final breakdown of these can be seen in the appendix. One participant elaborated on their reason for choosing societal push for post-secondary

education as their reason by stating, “*Society is pushing all students to further their education but all students are ready. Most students are ready for the world of work.*”

Equipment

If enrollments were to increase, equipment would be at a premium. Programs rely on hand-on user experience as a vital part of the training process, and if the students greatly outnumber the available equipment it could limit effectiveness. Questions were created to address factors involved in procurement of equipment.

The first thing we wanted to know was how the current equipment was acquired. Respondents were asked to rank how their current equipment was sourced and were given to option to check N/A on the options that did not apply.

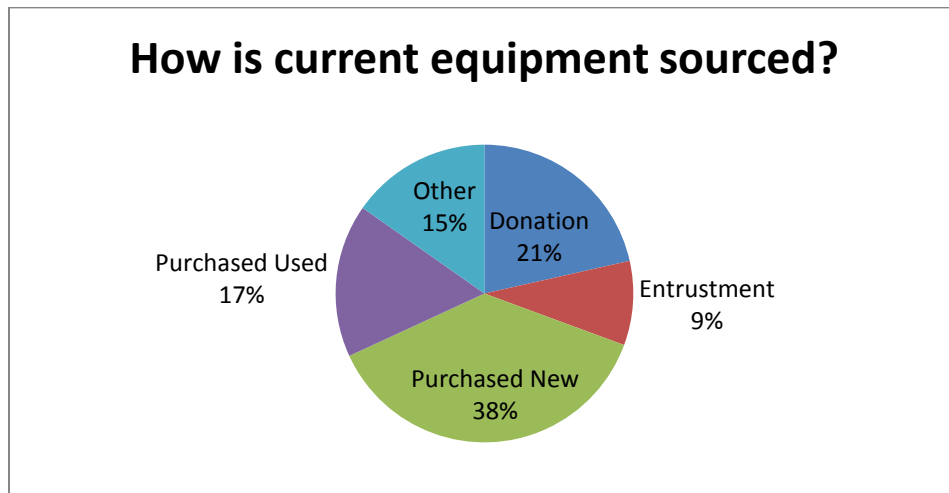


Figure 6: Sourcing methods for current equipment

Of the responses, the 78% of respondents chose purchased new as the main avenue for acquiring machines, and the other respondents credited new purchases as the 2nd most route. Donations were a clear contributor to the machine selections for school as the majority of responses chose that as the 2nd most common source of machines.

The next question asked to rank the importance of factors that go into the decision of acquiring equipment. A list of 8 options were provided with one listed as ‘other’. All responses voted ‘other’ as the least factor so it was dropped from the list of factors.

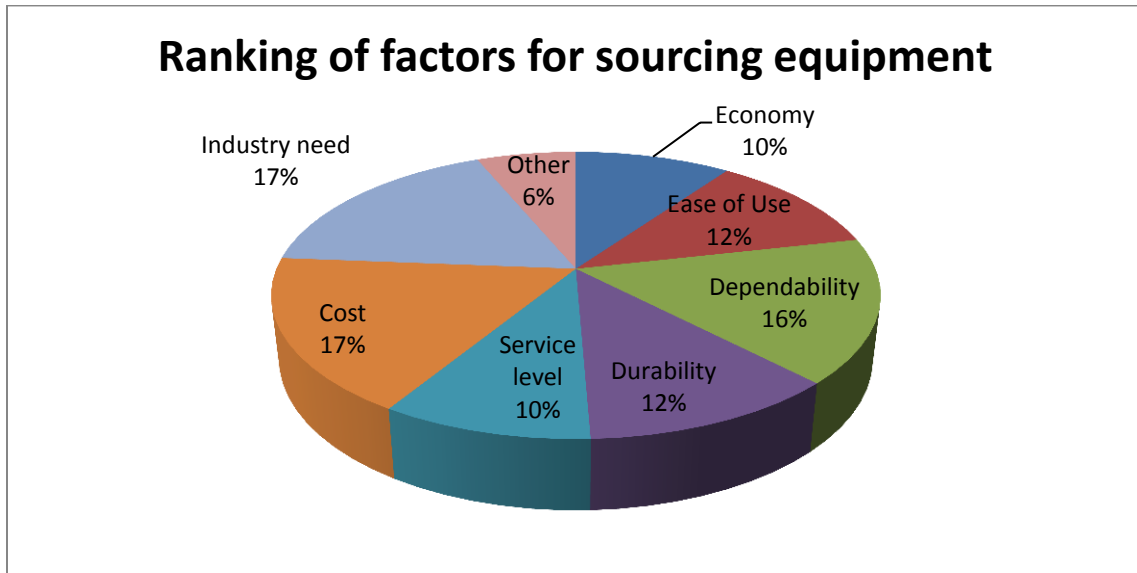


Figure 7: Factors for sourcing new equipment

Both cost and industry need provided the highest influence on decisions. Dependability ranked high receiving several 2nd and 3rd place votes. Machines must be dependable for programs because service outages can greatly alter the student to machine ratio, adversely affecting the student experience.

The last question attempted to learn what happened to equipment when it was deemed to no longer be useful. The majority of responses cited that they removed the machines as scrap, with one responder noting that they needed to gain approval by the city before removal.

Interviews

Leslie Parady

To gain insight on the needs of the marketplace, an interview was arranged with Leslie Parady, Project Manager from the Massachusetts Manufacturing Exchange Partnership (MassMEP). The MassMEP is an organization that *helps companies to grow and innovate as a Next Generation Manufacturer*. The organizations specialty in workforce strategies and intimate knowledge of regional manufacturing companies makes them a perfect candidate to provide useful information on industry needs.

The first topic of our interview was establishing the expectations of new employees by industry. She stressed that companies are looking for students with good work readiness skills and an enthusiasm to keep learning. Skills that are particularly important to employers are problem solving and the ability to think critically. These skills provide a solid foundation for the employers to build off of.

When asked why she thought vocational programs are struggling to fill the needs of industry she cited several reasons. The lack of enrollment numbers is a major concern. MTT is the most capital intensive shop in most school systems and also requires a large facility, and the school commitment to providing for the facility is a great influence on the perception of the program and ultimately enrollment. Another hurdle was the schools need to accommodate standardized testing. She remarked, *“[Standardized testing] has cut shop time to about 1000 hours over the course of 4 years. That is the equivalent of about 6 months of on the job training. No way near what industry would like to see.”*

Lastly she said that the system as a whole has struggled to engage industry. She said the framework of the curriculum is outdated and needs to be reworked to better suit the needs of industry today. Currently, students are required to spend a couple of years learning manual equipment before graduating to the use of CNC equipment, while industry has largely moved away from the use of manual equipment.

William Weir

Dr. Weir is the former Robotics laboratory Manager at WPI and currently working as a Sales Engineer at Trident Machine Tools, Windsor CT. Trident is the New England HFO (Haas Factory Outlet). Haas Automation, Oxnard, CA, is one of the largest unit volume machine tool manufacturer in the world shipping approximately 1500 machine tools per month up to 30% of them shipping to China where they compete on price with Chinese mad machine tools.

Dr. Weir has extensive contacts in the New England manufacturing industry. He has been frequently told by manufacturers that they would buy more machine tools if they could find qualified operators, and that it is a major impediment to expansion.

Torbjorn Bergstrom

Professor Torbjorn Bergstrom is the Operations manager of Manufacturing Laboratories at Worcester Polytechnic Institute, the chair of chapter 25 of the Society of Manufacturing Engineers, and a past president of the Haas Technical Education Center Council. He has traveled and spoken extensively in the area of manufacturing training and training facility operations.

Several conversations with professor Bergstrom have echoed the comments from Dr. Weir. When discussing the root cause and the apparent lack of enrolment in manufacturing

training programs professor Bergstrom has indicated that one main cause is likely to be the program instructors.

“Programs that are doing well have one thing in common. That is an exceptional instructor.” He went on to explain that programs that were doing poorly had “uninspired” instructors and “row after row” of dated equipment. Much of the equipment in these programs is in fact, older than the instructors.

Alexander Segala

An interview was scheduled with a recent graduate of a vocational school. Alexander Segala graduated through a MTT program in Massachusetts. Since graduation, Alex completed a Bachelors of Science in Mechanical Engineering at Worcester Polytechnic Institute and now works as a design engineer for a company that makes large scale machine tools. The main topics I wanted to address were the challenges to enrollment, and his thoughts on what could make the programs more effective moving forward.

When asked to why he himself chose the program, he cited an early mechanical aptitude and an enthusiasm for project work. As a son of a construction supervisor, his wish lists often consisted of tools instead of toys. His hobby of automotive customization allowed him an outlet to help hone his skills as a machinist as well as designer. At the age of 15 he purchased his first truck and spent several years redesigning and fabricating customized parts for it. Not only did this allow a practical application to the theories taught in school, but he also won awards for his work including ‘Best Engineered’ at the annual WPI Car Show. In his case, the excitement of innovation outweighed the negative connotations surrounding the industry. He did however acknowledge how this is a real problem for those who aren’t as sure in their ambitions.

Alex did not offer much input on how the program as a whole could be made better. He said that the program he completed was very forward thinking and was what he considered a leader in the field of vocational education. The insight he did offer was that most programs he was familiar with consist of a full 2 years of manual machine training, which he believed was more than necessary. Although manual experience helps breed and intimate knowledge of the machining process, most shops are moving to computer controlled processes requiring operators be more of a technician than a craftsman.

When asked about the overall impact his experiences have made on his pathway, he responded *“Manufacturing has had not only an effect on my career, but my life in general. I am most happy when building something. And I am now especially happy to be building some of the biggest machinery in the world, which will be used to manufacture some of the world’s biggest products.”*

Discussion

Skills Gap

Evidence from the personal interviews and literature review indicates that the skills gap exists and is clearly evident in Massachusetts.

Root Cause

After looking at the data, the perception of manufacturing careers is the main hurdle to advancing the manufacturing industry. If no progress is made, jobs will remain unfilled and companies will be unable to improve.

The question becomes then how do you change this perception? One factor for the persisting perception is the lingering imagery from the industrial revolution. These images of children working in deplorable conditions represent a difficult period of industrial growth and in no way represent the industry today. In order to overcome this, the industry needs to do a better job marketing and promoting images of current day work environments.



Figure 8: Midnight at the Glassworks, 1908, Lewis Hine

This stigma also helps drive another phenomenon affecting vocation program enrollment in a societal push for post-secondary education. Parents that have a negative view of the industry will unquestionable want better for their young. Professor Pisano from the Harvard School of Business said about his book, Producing Prosperity: Why America Needs a Manufacturing Renaissance, “*One of our key messages is to get students to appreciate that manufacturing involves a lot of knowledge work. There has almost been a whole generation of MBA students and managers who have been brought up on a false idea that manufacturing is kind of the brawn*

and not the brain, and that the country should focus on the brain.” (Thompson 2011)

Recently, the rise of social media has created a new platform on which this cause may be championed. Networks such as Facebook and Twitter have given individuals the ability to reach out and inspire millions with ease. Large companies in the manufacturing industry are picking up on this and allotting resources to help take full advantage of these new platforms. HAAS Automation, one of the largest machine tool builders in the world, has done a great job utilizing both Facebook and Twitter to engage with their customer base, sharing stories and photos that generate excitement.

Survey Shortcomings

The survey could be improved in the future in several ways. First, the ranges for questions regarding machine numbers could be adjusted to provide a better look. The ranges that were chosen proved to be too low as evidenced by all respondents choosing the largest answer (8+) in the question about manual machine tool numbers, represented in Figure 4. Second, since it was apparent that the perception of manufacturing careers is an area of need, a question could be created asking about the effectiveness of existing efforts for improvement. Lastly, future iterations would benefit from an increase the sample size in both number and geographical regions

Possible Solutions

A recent attempt to grab the attention of the nation has been made by the creators of the Edge Factor show, Jeremy Bout and Francois Driessen. Edge Factor is a company that is using their media prowess to make movies spotlighting inspirational stories which showcase modern manufacturing. Since their first movie was released online, they’ve made several videos that mix

cool subject matters along with inspirational story lines that aim to increase awareness to a younger demographic.



Figure 9: Promotional ad for the Premier of Metal & Flesh

Currently Edge Factor just finished their first full length feature called *Metal & Flesh* and are working on a new series called LaunchPoint. LaunchPoint is a 15 episode series that is intended to be a tool for vocational schools to help break the stigma and bolster enrollment.

Conclusions

- Perception of manufacturing needs to change if there is any hope to overcome the skills gap
- The societal push for post-secondary education is partially driven by the perception of industry
- Vocational education programs can help smooth students transition to work force by offering more real-world applications
- Programs utilizing new marketing techniques are critical to improving the status of manufacturing in the US

Future Work

It would be beneficial if another IQP could expand on these conclusions, particularly the effectiveness of marketing campaigns changing the perceptions of manufacturing careers. One avenue would be working together with Edge Factor the group could coordinate study-groups and gain tangible data on the effectiveness of their videos.

Acknowledgements

In addition to my advisors, I'd like to thank the people who took the time to respond to the educators' survey. My sincerest thanks to Leslie Parady and Alex Segala for providing interviews and input that was indispensable to the project. Also, I'd like to thank Ruth McKeogh for assisting in the process of attaining IRB exemption.

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Appendix

Contents

Application for IRB Exemption24

Educator Survey.....27

Industry Survey.....30

Educator Survey Results33

MTT Enrollment Numbers40

Flow Chart of a Precision Machining Business.....42

Application for IRB Exemption



WORCESTER POLYTECHNIC INSTITUTE
Institutional Review Board
Application for Exemption from IRB Review for
Survey or Interview Research Involving Minimal or No Risk

WPI IRB use only
IRB #
Date:

This application is specifically intended for projects in which students are expected to conduct interviews, surveys or focus groups. Use of this application is recommended for most student project research involving minimal risk. Proposed research meets the definition of "minimal risk" when the risks to research subjects are not greater than those ordinarily encountered in daily life.

Project Faculty Advisor(s):

Name:	<input type="text" value="Torbjorn Bergstrom"/>	Tel No:	<input type="text" value="5082083024"/>	E-Mail Address:	<input type="text" value="torbjorn@wpi.edu"/>
Department:	<input type="text" value="Mechanical Engineering"/>				

Name:	<input type="text" value="Jerome Schaufeld"/>	Tel No:	<input type="text" value="5088316114"/>	E-Mail Address:	<input type="text" value="jjs@wpi.edu"/>
Department:	<input type="text" value="Business"/>				

Project Faculty Instructor:

Name:	<input type="text"/>	Tel No:	<input type="text"/>	E-Mail Address:	<input type="text"/>
Department:	<input type="text"/>				

Student Investigator(s): *ALL student investigators must be listed.*

Name:	<input type="text" value="Adam Sears"/>	Tel No:	<input type="text" value="7742004085"/>	E-Mail Address:	<input type="text" value="asears@wpi.edu"/>
Name:	<input type="text"/>	Tel No:	<input type="text"/>	E-Mail Address:	<input type="text"/>
Name:	<input type="text"/>	Tel No:	<input type="text"/>	E-Mail Address:	<input type="text"/>
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Name:	<input type="text"/>	Tel No:	<input type="text"/>	E-Mail Address:	<input type="text"/>

Project Title:

Project Location and Time Frame:

On Campus, C13 & D13.

**WPI IRB Application for Exemption from IRB Review for
Survey or Interview Research Involving Minimal or No Risk**

Expected Research Subjects: (e.g. museum visitors under the age of 12)

Vocational School Teachers and Potential Employers

Project Mission Statement and Objectives

While the topic of job creation looms large, an industry that is responsible for 12.2% of the US GDP is desperately looking to fill already open positions. According to a study by the Manufacturing Institute, upwards of 600,000 jobs are going unfilled simply because employers cannot find people with the right skills. This project aims to identify the needs of these potential employers and compare them to what is currently offered by existing educational pathways. Data gathered will be analyzed and a plan will be proposed to improve the relationship between education and industry.

Brief Methods Listing: (e.g. “Survey of public to ascertain knowledge and opinions about climate change” or “Interviews of professionals working on climate change regarding effective city climate change program”)

One survey to vocational teachers to gain knowledge about existing educational programs and facilities. Another survey for potential employers in manufacturing to establish needs.

Appendix 1: Attach the draft methodology chapter or statement of research methods.

Appendix 2: Attach a draft of surveys and/or a list of questions to be used for interviews or focus groups. If sample questions are included in Appendix 1, Methodology Chapter, indicate page numbers here.

1. Is the proposed research sponsored or supported by a US federal agency or by US government funding? If so, identify sources. No Yes
2. Is the proposed research funded by a corporation or foundation? If so, identify sources. No Yes
3. Does the proposed research involve vulnerable research subjects? (e.g. children, prisoners, students, persons with mental or physical disabilities, pregnant women) No Yes
4. Does the research involve human subjects in ways other than as participants in interviews, focus groups, or surveys? (e.g. observation of public behavior, use of archived data or experimental procedures) If yes, explain. No Yes
5. Will the researchers collect information that can be used to identify the subjects? No Yes
6. Could the disclosure of a human subject’s identity and responses place the subject at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability or reputation? No Yes
7. Will the researchers disclose the identity or the individual responses of any human subjects? (e.g. by quoting an individual, whether or not identified by name or title) No Yes

**WPI IRB Application for Exemption from IRB Review for
Survey or Interview Research Involving Minimal or No Risk**

IF you answered yes to question 6 or 7, answer these questions:

A. What is the potential risk to human subjects?

If a quote is critical of the subjects organization, it could create animosity between the subject and his coworkers and/or superiors.

B. How will you eliminate or reduce said risk to an acceptable level?

I will use no quotes that are purposely divisive and any quotes that are used will be reviewed by my advisors well in advance. I will respect any subjects requests for anonymity.

Please Print Form Before Signing Below

By signing below, all participants in this research project are agreeing to abide by the following instructions:

1. You agree to inform subjects orally or in writing that:
 - Participation in the research is voluntary.
 - Participants may end their participation at any time.
 - Participants need not answer every question in an interview or survey.
2. If your research is **anonymous**, you also inform subjects that you are not collecting names or any identifying information from them.
3. If your research is **confidential**, you inform subjects that no identifying information will be disclosed with individual responses.
4. If your research is **NOT** completely anonymous and confidential, you must obtain each subject's permission to publicly disclose his or her identity and/or responses. All requests for anonymity and confidentiality must be honored. The subject must be offered the opportunity to pre-approve the publication of any quoted material

Signature of Faculty Advisor



Date

3/19/13

Print Full Name and Title

TORBJORN BERGSTROM Ops. MANAGER MANUFACTURING LABS

*Please return a signed hard or electronic copy of this application to the WPI IRB c/o Ruth McKeogh,
2nd floor Project Center or irb@wpi.edu.*

If you have any questions, please call (508) 831-6699.

Educator Survey

1. What is your current enrollment (MTT)?

- What is your current enrollment (MTT)? 0 - 20
- 21 - 40
- 41 - 60
- 61 +

2. What is the size of your facility in square feet?

- What is the size of your facility in square feet? 0 – 1000
- 1001 - 2000
- 2001 - 4000
- 4001 +

3. How many CNC machine tools does your facility have?

- How many CNC machine tools does your facility have? 0 – 1
- 2 – 3
- 4 – 8
- 8+

4. How many manual machine tools does your facility have?

- How many manual machine tools does your facility have? 0 – 1
- 2 – 3
- 4 – 8
- 8+

5. Rank these challenges based on how they affect your enrollment.

- Perception of manufacturing careers
- Societal push for post-secondary education
- Competition for Resources
- Other (Please explain in comment section at bottom)

**6. Please rank how your current equipment was sourced?
(If an option doesn't apply, check N/A)**

- N/A Other (Please explain in the comment section at bottom)
- N/A Purchased New
- N/A Entrustment
- N/A Donation
- N/A Purchased Used

7. When acquiring equipment, rank these factors in order of their importance.

- Economy
- Ease of Use
- Dependability
- Durability
- Service level
- Cost
- Industry need (regional or national)
- Other

8. Does your facility have the resources to add equipment if it were beneficial to your program?

- Does your facility have the resources to add equipment if it were beneficial to your program? Yes
- No
- Maybe

**9. How do you handle disposing of machines that are no longer useful?
Select all that apply.**

- How do you handle disposing of machines that are no longer useful? Select all that apply. Donations
- Removed for Scrap
- Private Sale
- Other (please specify)

10. Please feel free to add any comments or elaborate on previous answers.

Please feel free to add any comments or elaborate on previous answers.

Done

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Industry Survey

1. How many people does your company employ?

- How many people does your company employ? 0 - 20
- 21 - 50
- 51 - 150
- 151 +

2. How many machinists and operators does your company employ?

- How many machinists and operators does your company employ? 0 - 2
- 3 - 6
- 7 - 15
- 16 +

3. How many CNC machine tools does your facility have?

- How many CNC machine tools does your facility have? 0 – 1
- 2 – 3
- 4 – 8
- 8+

4. How many manual machine tools does your facility have?

- How many manual machine tools does your facility have? 0 – 1
- 2 – 3
- 4 – 8
- 8+

5. When hiring machine operators, please rate these skills in order of importance

- Manual Machining Experience
- General work habits (Dependable, On time, etc)
- Knowledge of Lean Manufacturing
- Problem Solving Skills
- Blueprint/GD&T
- Measurement & Inspection
- CNC Machining Experience

6. When acquiring equipment, weight these factors in order of their importance.

- Productivity
- Availability of Skilled Operators
- Required floor space
- Durability
- Service level
- Dependability
- Saving time/labor
- Economy

7. Are there any restrictions on buying used equipment?

- Are there any restrictions on buying used equipment? No
- Yes (Please explain)

8. If good used machines were available, would it influence your decision to buy or upgrade more often?

- If good used machines were available, would it influence your decision to buy or upgrade more often?
- No

Comments

9. When purchasing used equipment, weight these factors in the decision process.

Hours

Price

Work History

10. How do you dispose of older machinery? (Choose all that apply)

- How do you dispose of older machinery? (Choose all that apply) Reseller
- Removed as scrap
- Private sale
- Donation to education facility
- Other (please specify)

Done

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Educator Survey Results



Response Summary

Total Started Survey: 9
Total Finished Survey: 9 (100%)

PAGE: 1

1. What is your current enrollment (MTT)?		Create Chart	Download
		Response Percent	Response Count
0 - 20		0.0%	0
21 - 40		44.4%	4
41 - 60		55.6%	5
61 +		0.0%	0
		answered question	9
		skipped question	0

2. What is the size of your facility in square feet?		Create Chart	Download
		Response Percent	Response Count
0 - 1000		33.3%	3
1001 - 2000		11.1%	1
2001 - 4000		22.2%	2
4001 +		33.3%	3
		answered question	9
		skipped question	0

3. How many CNC machine tools does your facility have?			
		Create Chart	Download
		Response Percent	Response Count
0 – 1		0.0%	0
2 – 3		0.0%	0
4 – 8		77.8%	7
8+		22.2%	2
answered question			9
skipped question			0

4. How many manual machine tools does your facility have?			
		Create Chart	Download
		Response Percent	Response Count
0 – 1		0.0%	0
2 – 3		0.0%	0
4 – 8		0.0%	0
8+		100.0%	8
answered question			8
skipped question			1

5. Rank these challenges based on how they affect your enrollment.

[Create Chart](#) [Download](#)

	1	2	3	4	Rating Average	Rating Count
Perception of manufacturing careers	88.9% (8)	11.1% (1)	0.0% (0)	0.0% (0)	1.11	9
Societal push for post-secondary education	11.1% (1)	66.7% (6)	11.1% (1)	11.1% (1)	2.22	9
Competition for Resources	0.0% (0)	11.1% (1)	77.8% (7)	11.1% (1)	3.00	9
Other (Please explain in comment section at bottom)	0.0% (0)	11.1% (1)	11.1% (1)	77.8% (7)	3.67	9
answered question						9
skipped question						0

6. Please rank how your current equipment was sourced? (If an option doesn't apply, check N/A)

[Create Chart](#) [Download](#)

	1	2	3	4	5	N/A	Rating Average	Rating Count
Donation	11.1% (1)	55.6% (5)	22.2% (2)	0.0% (0)	0.0% (0)	11.1% (1)	2.13	9
Entrustment	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	22.2% (2)	77.8% (7)	5.00	9
Purchased New	77.8% (7)	22.2% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	1.22	9
Purchased Used	0.0% (0)	11.1% (1)	33.3% (3)	0.0% (0)	0.0% (0)	55.6% (5)	2.75	9
Other (Please explain in the comment section at bottom)	11.1% (1)	11.1% (1)	11.1% (1)	33.3% (3)	0.0% (0)	33.3% (3)	3.00	9
answered question								9
skipped question								0




7. When acquiring equipment, rank these factors in order of their importance.

[Create Chart](#) [Download](#)

	1	2	3	4	5	6	7	8	Rating Average	Rating Count
Economy	11.1% (1)	0.0% (0)	0.0% (0)	33.3% (3)	0.0% (0)	22.2% (2)	33.3% (3)	0.0% (0)	5.11	9
Ease of Use	11.1% (1)	22.2% (2)	0.0% (0)	0.0% (0)	33.3% (3)	22.2% (2)	11.1% (1)	0.0% (0)	4.33	9
Dependability	0.0% (0)	22.2% (2)	55.6% (5)	11.1% (1)	11.1% (1)	0.0% (0)	0.0% (0)	0.0% (0)	3.11	9
Durability	0.0% (0)	11.1% (1)	11.1% (1)	44.4% (4)	0.0% (0)	33.3% (3)	0.0% (0)	0.0% (0)	4.33	9
Service level	0.0% (0)	0.0% (0)	11.1% (1)	11.1% (1)	44.4% (4)	0.0% (0)	33.3% (3)	0.0% (0)	5.33	9
Cost	55.6% (5)	11.1% (1)	0.0% (0)	0.0% (0)	0.0% (0)	22.2% (2)	11.1% (1)	0.0% (0)	2.89	9
Industry need (regional or national)	22.2% (2)	33.3% (3)	22.2% (2)	0.0% (0)	11.1% (1)	0.0% (0)	11.1% (1)	0.0% (0)	2.89	9
Other	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	100.0% (9)	8.00	9
answered question									9	
skipped question									0	

8. Does your facility have the resources to add equipment if it were beneficial to your program?

[Create Chart](#) [Download](#)

		Response Percent	Response Count
Yes		33.3%	3
No		22.2%	2
Maybe		44.4%	4

[Hide Responses](#)

[Responses \(4\)](#)
[Text Analysis](#)
[My Categories \(0\)](#)

Showing 4 text responses No responses selected

we would have to rotate existing do to space
4/21/2013 10:04 PM [View Responses](#)





state budgets are being cut to the point of programs ending just when they are needed the most
4/20/2013 8:37 PM [View Responses](#)

We are currently wating for a new piece of CNC equipment now our floor space is getting tight.
4/19/2013 8:39 AM [View Responses](#)

We would need to remove existing equipment to replace with new equipment.
4/17/2013 4:03 PM [View Responses](#)

answered question	9
skipped question	0

9. How do you handle disposing of machines that are no longer useful? Select all that apply. [Create Chart](#) [Download](#)

		Response Percent	Response Count
Donation		22.2%	2
Removed for Scrap		77.8%	7
Private Sale		44.4%	4
Other (please specify) Hide Responses		11.1%	1

[Responses \(1\)](#)
[Text Analysis](#)
[My Categories \(0\)](#)

Showing 1 text responses No responses selected

The city needs to approve of removal
 4/17/2013 4:03 PM [View Responses](#)

answered question	9
skipped question	0

10. Please feel free to add any comments or elaborate on previous answers.

[Download](#)

Response
Count

[Hide Responses](#) 4

[Responses \(4\)](#) [Text Analysis](#) [My Categories \(0\)](#)

Showing 4 text responses

No responses selected

We had just moved into a new building and have new equipment as well, we currently have over 50 pieces of equipment

4/21/2013 10:04 PM [View Responses](#)

#5 Society is pushing all students to further their education but all students are ready. Most students are ready for the world of work. #6 All manual machines that we use have been at our school since I started, the four CNC machines that I have currently were purchased by a grant in 2000.

4/17/2013 4:03 PM [View Responses](#)

HELP

4/16/2013 5:29 PM [View Responses](#)

Standardization of equipment to be able to do full class instruction is absolutely essential when student to teacher ratio is high.

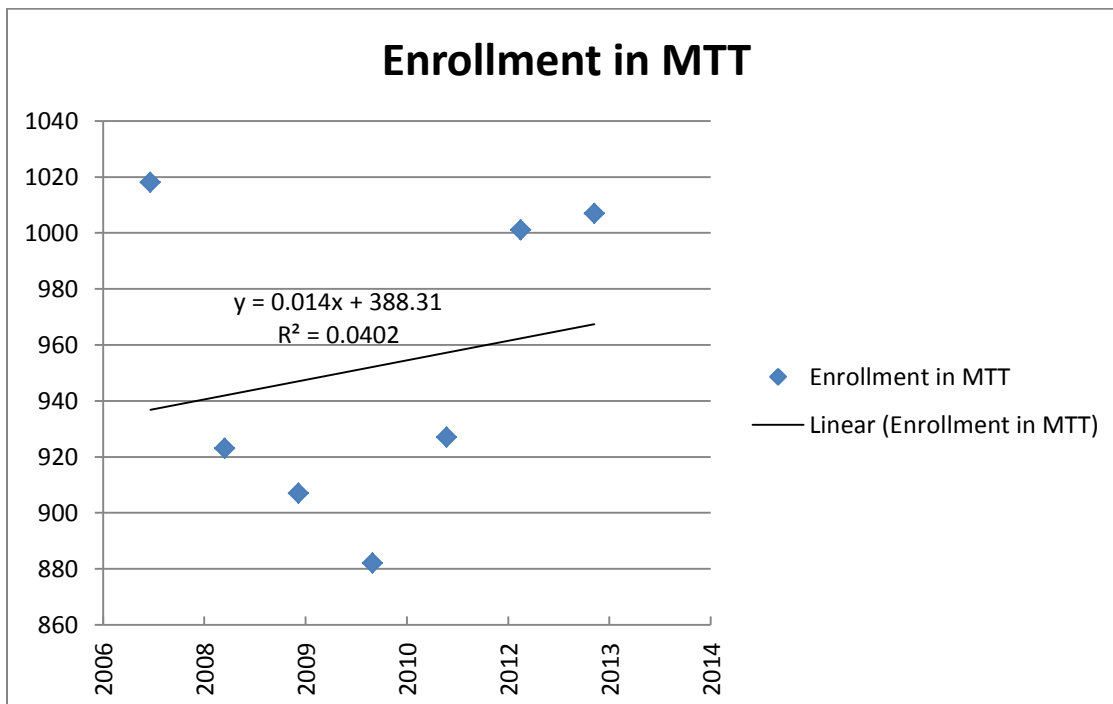
4/15/2013 5:33 PM [View Responses](#)

answered question 4

skipped question 5

MTT Enrollment Numbers

School Year	Program Code	Program Title	Total	GR_09	GR_10	GR_11	GR_12	GR_S P
2007	480501	Machine Tool Technology	1018	13	396	329	280	0
2008	480501	Machine Tool Technology	923	7	299	329	287	1
2009	480501	Machine Tool Technology	907	9	321	280	297	0
2010	480501	Machine Tool Technology	882	13	337	270	262	0
2011	480501	Machine Tool Technology	927	9	335	324	259	0
2012	480501	Machine Tool Technology	1001	21	358	319	303	0
2013	480501	Machine Tool Technology	1007	16	373	320	297	1



School Year	District Code	District Name	County	Program Type	Program Code	Program Title	District Total
2012-2013	0061	Chicopee	Hampden	C74	480501	Machine Tool Technology	20
2012-2013	0107	Gloucester	Essex	C74	480501	Machine Tool Technology	20
2012-2013	0137	Holyoke	Hampden	C74	480501	Machine Tool Technology	25
2012-2013	0153	Leominster	Worcester	C74	480501	Machine Tool Technology	29
2012-2013	0236	Pittsfield	Berkshire	C74	480501	Machine Tool Technology	26
2012-2013	0274	Somerville	Middlesex	C74	480501	Machine Tool Technology	25
2012-2013	0281	Springfield	Hampden	C74	480501	Machine Tool Technology	44
2012-2013	0325	Westfield	Hampden	C74	480501	Machine Tool Technology	39
2012-2013	0348	Worcester	Worcester	C74	480501	Machine Tool Technology	10
2012-2013	0406	Northampton-Smith Vocational Agricultural	Hampshire	C74	480501	Machine Tool Technology	26
2012-2013	0650	Dighton-Rehoboth	Bristol	C74	480501	Machine Tool Technology	22
2012-2013	0770	Tantasqua	Worcester	C74	480501	Machine Tool Technology	37
2012-2013	0801	Assabet Valley Regional Vocational Technical	Middlesex	C74	480501	Machine Tool Technology	34
2012-2013	0805	Blackstone Valley Regional Vocational Technical	Worcester	C74	480501	Machine Tool Technology	54
2012-2013	0810	Bristol-Plymouth Regional Vocational Technical	Bristol	C74	480501	Machine Tool Technology	49
2012-2013	0818	Franklin County Regional Vocational Technical	Franklin	C74	480501	Machine Tool Technology	30
2012-2013	0821	Greater Fall River Regional Vocational Technical	Bristol	C74	480501	Machine Tool Technology	72
2012-2013	0825	Greater New Bedford Regional Vocational Technical	Bristol	C74	480501	Machine Tool Technology	39
2012-2013	0828	Greater Lowell Regional Vocational Technical	Middlesex	C74	480501	Machine Tool Technology	63
2012-2013	0832	Montachusett Regional Vocational Technical	Worcester	C74	480501	Machine Tool Technology	45
2012-2013	0851	Northern Berkshire Regional Vocational Technical	Berkshire	C74	480501	Machine Tool Technology	44
2012-2013	0852	Nashoba Valley Regional Vocational Technical	Middlesex	C74	480501	Machine Tool Technology	17
2012-	0854	North Shore Regional	Essex	C74	480501	Machine Tool	27

2013		Vocational Technical				Technology	
2012-2013	0855	Old Colony Regional Vocational Technical	Bristol	C74	480501	Machine Tool Technology	41
2012-2013	0860	Pathfinder Regional Vocational Technical	Hampden	C74	480501	Machine Tool Technology	42
2012-2013	0871	Shawsheen Valley Regional Vocational Technical	Middlesex	C74	480501	Machine Tool Technology	33
2012-2013	0872	Southeastern Regional Vocational Technical	Bristol	C74	480501	Machine Tool Technology	31
2012-2013	0873	South Shore Regional Vocational Technical	Plymouth	C74	480501	Machine Tool Technology	11
2012-2013	0876	Southern Worcester County Regional Vocational Technical	Worcester	C74	480501	Machine Tool Technology	27
2012-2013	0885	Whittier Regional Vocational Technical	Essex	C74	480501	Machine Tool Technology	25
						Average number of Students	33.6

Flow Chart of a Precision Machining Business

