

# Mind the Chasm

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*Why There is no Workforce of Tomorrow*

*AN INTERACTIVE QUALIFYING PROJECT SUBMITTED TO THE FACULTY OF*

*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 "Skills Gap" refers to the current condition in the manufacturing industry where there are more positions available than there are people to fill those positions. This project studies the root cause of the "Skills Gap" through literature review, interview and survey. The literature reviews revealed three potential causes: specialization of manufacturer's needs in employees, a societal push away from skilled labor positions and a public stigma against manufacturing. These three possible causes are further analyzed using surveys and interviews. It is shown that the societal push away from skilled labor and the public stigma against manufacturing spring from the same poor public opinion of manufacturing/skilled labor. Possible solutions to the "Skills Gap" are discussed.

**Contents**

Abstract .....2

Introduction .....4

    Objective.....4

    Rationale.....4

    State of the Art.....5

    Approach .....8

Methods.....9

Results..... 12

    Literature Review ..... 12

    Surveys and Polls ..... 17

    Interview ..... 34

Discussion..... 36

Conclusion..... 42

Future Work..... 43

Acknowledgements..... 44

Appendix..... 45

    Bibliography ..... 45

    Project Proposal..... 47

## **Introduction**

### **Objective**

The goal of this project is to determine the primary causes of the lack of available skilled personnel to fill the available jobs in the US manufacturing industry – a situation known as the “Skills Gap” - and propose potential solutions to those causes.

### **Rationale**

The manufacturing industry is facing a crisis. Sales are in a definite upward trend. Products that were being manufactured overseas for US companies are coming back to the US for their manufacture. New technologies make the manufacture of traditional parts faster and less expensive, and previously hard to make parts practical - sometimes even easy – to make. However, there is an overwhelming lack of people to fill the jobs to make the parts to get the sales.

Manufacturing is an important economy sector to the United States. The US manufacturing industry creates almost 50% of total US exports and accounts for over 10% of the US economy. In fact, the US manufacturing industry by itself would be the world’s tenth largest economy. It also has the largest multiplier effect of any economy sector at \$1.34, meaning that every dollar spent on obtaining manufactured goods creates \$1.34 in sales in other economy sectors [1].

Though large and trying to expand, the US manufacturing industry’s growth has stagnated partially due to a lack of personnel available to fill the available jobs. The Manufacturing Institute reports that 5% of skilled production positions - approximately 600,000 jobs or 0.2% of the US population - go unfilled simply due to a lack of personnel to fill the positions [1]. Recent studies also suggest that, without intervention, the “Skills Gap” will not work itself out but will continue to worsen for the foreseeable future.

Reversing the “Skills Gap” may be one of the biggest issues that US society has before itself. Doing so would directly allow potentially millions of families to put food on the table [2]. The secondary economic growth would then create an additional several

hundred thousand jobs. What other initiative has the potential to significantly affect so many people?

Reversing the “Skills Gap” would not only grow the economy and provide potentially millions of jobs; it would also strengthen the US economy and increase international respect for the US. Manufacturing tends to be one of the least affected economic sectors during recessions [2], meaning that growth in the manufacturing sector tends to stay when facing economic challenges. With the size of the manufacturing industry, this hardiness would also make recessions have a lighter impact on the entire US economy. The US is also known internationally for its manufacturing. It, in fact, grew to be the largest world economy through manufacturing and other technical industries. To remain the world economic leader and overall world leader that the US is, the US manufacturing industry and all the technical US industries must continue to grow.

### **State of the Art**

The “Skills Gap” is a major issue in manufacturing and, as such, has been significantly studied and written about recently. One recent study was the Interactive Qualifying Project by Adam Sears *Mind the Gap: Training the Manufacturing Workforce of Tomorrow* [3]. In his report, Sears concludes that the general public has an incorrect perception of the environment in factories and of the condition of the manufacturing industry; and that this perception must be corrected to overcome the “Skills Gap”.

Probably the most significant of recent reports on the “Skills Gap” is The Manufacturing Institute’s *2011 Skills Gap Report* [1]. This is the organization’s third installment in their “Skills Gap” study series, with the original in 2001 and the first update in 2005 . Some of their conclusions include:

- The positions that most impact performance tend to be the ones that are hardest to fill.
- Many companies rely on old methods for the recruitment and training of personnel.
- The difficulty in recruiting personnel, especially in the skilled production and production support areas, is independent of the unemployment.

- The increasing rate at which manufacturing methods advance is making it more difficult for personnel to keep their skills up to date.
- The portion of the manufacturing workforce most affected by the "Skills Gap" is skilled production.
- The ""Skills Gap"" will likely get worse for the foreseeable future.

Another study often referenced and challenged when discussing the "Skills Gap" is the Boston Consulting Group's *Made in America, Again: Why Manufacturing Will Return to the US* [4]. This study was actually not done to determine the severity of the "Skills Gap" but rather the practicality and likelihood of US manufacturers "Reshoring" – bringing jobs that had been sent overseas back to the US. The conclusion of the study with regards to the "Skills Gap" is that the "Skills Gap" is much smaller than others have made it out to be. This conclusion has been challenged by Hemphill, Lillevik and Perry, [5] among others.

A 2012 study by Deloitte and The Manufacturing Institute on the public's perception of the manufacturing industry titled *Leadership Wanted U.S. Public Opinions on Manufacturing* [6] clearly shows that Americans value manufacturing and feel the success of the industry is highly important to the overall strength of the US (Study respondents ranked manufacturing as the most important to maintain a strong national economy in the US.). It also shows that Americans are in favor of the expansion of manufacturing facilities over other commercial facilities (Study respondents also chose a manufacturing facility over all other commercial facilities for a new commercial facility that would produce 1000 jobs in their communities.). However, the study also shows that Americans also believe that the manufacturing industry is declining and that jobs in the manufacturing industry do not offer good opportunities. Some of the major conclusions from this study are:

- The American public values strength in the manufacturing industry
- Policies that offer stronger support of the manufacturing industry are supported by the general US public.
- The manufacturing sector is seen as fragile and unstable
- The US public wants manufacturing jobs in their neighborhood, but do not want a manufacturing job for themselves.

- The American public doubts the capability of the public school system to provide the necessary career guidance and training for a job in the manufacturing industry.

## **Approach**

The existence of a "Skills Gap" in the manufacturing industry will be assumed. Previous studies have already confirmed this. The severity of the "Skills Gap" will be determined by literature review. Trends and themes as to potential causes for the "Skills Gap" discovered during the literature review will be used to guide the creation of surveys and interviews to analyze those potential causes. The surveys will be sent to industry professionals, educators and students. Interviews will be conducted with industry representatives. The root cause of the "Skills Gap" will be identified and possible solutions to will be suggested.



## Methods

To establish the severity of the "Skills Gap", existing studies were examined. The data that was sought included: how many positions were unfilled due to a lack of workers, how much this influenced companies profitability and business strategy, and how the "Skills Gap" will change in severity in the coming years.

Root causes were initially studied by reviewing existing studies. Trends in the attitudes of respondents and researchers were used to guide the writing of surveys which were distributed to instructors, administrators, students and graduates of vocational schools with manufacturing programs, to human resources personnel in the manufacturing industry and to students at Worcester Polytechnic Institute who are lab instructors for the school's manufacturing classes. Interviews were conducted with consultants in the manufacturing industry.

The literature review was initially conducted on the Worcester Polytechnic Institute Summon system using the search terms "Skills Gap", "Manufacturing Skills", "manufacturing training" and "manufacturing jobs statistics" The literature review was then conducted using Google and similar search terms.

To ensure that the surveys are well constructed, the instructions set forth in *Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research* (2nd Edition) [7] were followed. Surveys were conducted online through the survey site SurveyMonkey. They were limited to ten questions out of respect for respondent's time and to encourage high response rate. The surveys began with qualifier questions to ensure that the respondent is qualified to complete the survey. To allow quantitative analysis and increase accuracy, when possible, questions were asked with a range and/or a ranking system. A free response section was appended to the end of the survey to allow participants to provide whatever additional information they may wish to contribute.

The survey for current students of vocational schools had the following questions:

- What type of program are you currently enrolled in at your school?
- What year are you?

- About how many students does your school have enrolled in manufacturing - related programs?
- About how many CNC machine tools does your school have?
- Does your school have more than enough money to meet its students' needs, less than enough money, or about enough money?
- How much of your training has been hands-on?
- Does your school offer training on a variety of CNC machine tool makes and models?
- Please rank these in order of why you think people would avoid enrolling in manufacturing programs?
- What was it that caused you to want to go into manufacturing? Was there anything that complicated this decision?
- What is it about your favorite instructors that makes them your favorite?

The survey for graduates of vocational schools will have the following questions:

- Are you a graduate of a vocational school?
- About how many students did your school have enrolled in manufacturing - related programs?
- About how many manual machine tools did your school have?
- About how many CNC machine tools did your school have?
- Did your school have more than enough money to meet its students' needs, less than enough money, or about enough money?
- How much of your in-school training was hands-on?
- Did your school offer training on a variety of CNC machine tool makes and models?
- What was it that attracted you to any employers you have worked for since graduating?
- What do you wish you had learned while you were in school that you didn't?
- What was it that caused you to want to go into manufacturing? Was there anything that complicated this decision?

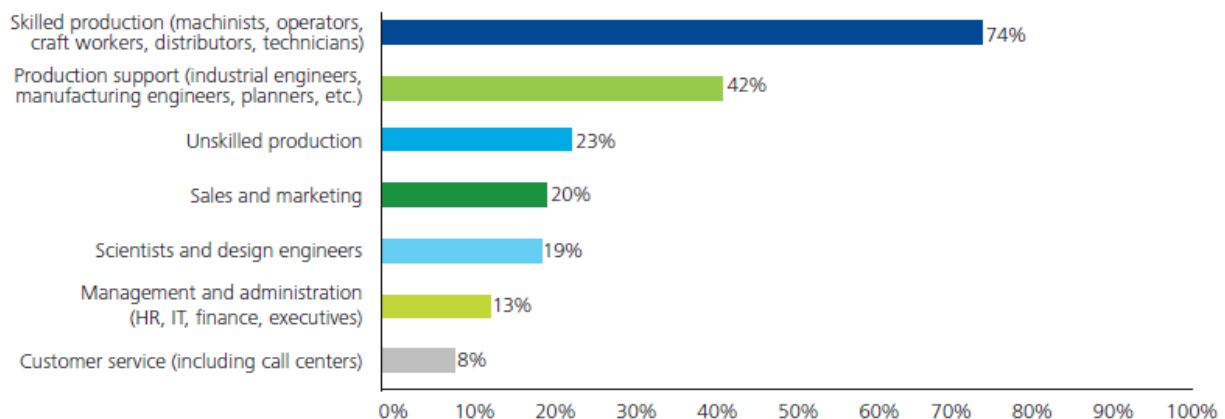
The survey for vocational school instructors and administrators will have the following questions:

- Are you either an instructor or an administrator at a vocational school?
- About how many students does your school have enrolled in manufacturing - related programs?
- About how many manual machine tools does your school have?
- About how many CNC machine tools did your school have?
- About how large is your facility?
- What is your school currently doing to recruit students who are currently in a comprehensive school?
- Please rank these in order of biggest factor on your school's enrollment?
- Does your school allow students to work on personal projects using the school's machines?
- How much use do your school's machine tools see?
- What is the most common complaint you hear from graduates about their education at your school?

## Results

### Literature Review

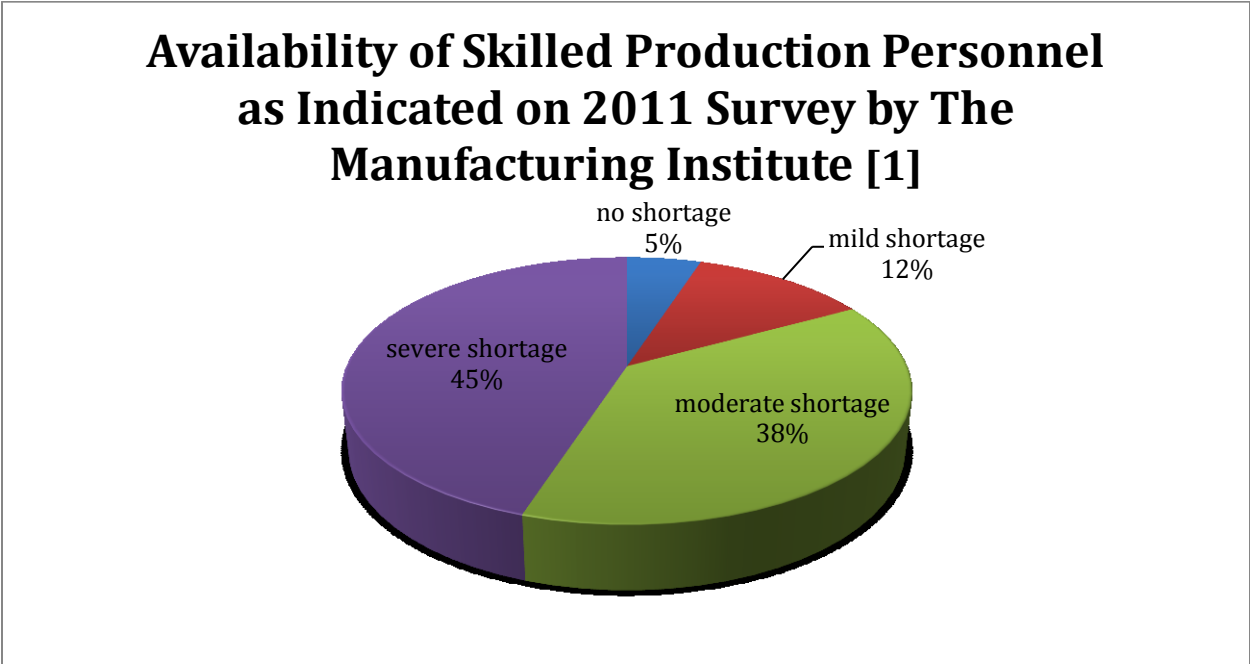
The first question to answer with the literature is how severe the "Skills Gap" is. On a survey by The Manufacturing Institute from July and August of 2013 respondents reported a median of 5% of positions go unfilled do to a lack of qualified personnel. [1] On the same survey, respondents indicated that the skilled production segment (machinists, operators, craft workers and similar) was by far the most affected employee segment followed by production support (Industrial and Manufacturing Engineers, planners and similar positions). It can be seen how much more severely these employee segments have been impacted by the responses to one of the questions from the previously mentioned survey. When asked "What employee segments have had a significant negative impact on ability to expand or improve productivity?" the third most common response was unskilled production with 23% of respondents indicating that this was an issue. In contrast, production support was ranked 2<sup>nd</sup> with 42% of respondents indicating this was an issue – nearly double that for the unskilled productions segment. Furthermore, skilled production was ranked as the employee segment most limiting increases in productivity with 74% of respondents indicating that this was an issue. This is nearly double that for production support and well over triple that for unskilled production. The responses to this question can be seen in the Figure 1 below.



Note: This is a multiple selection question, percentages may not add to 100%. Base used is 1123.

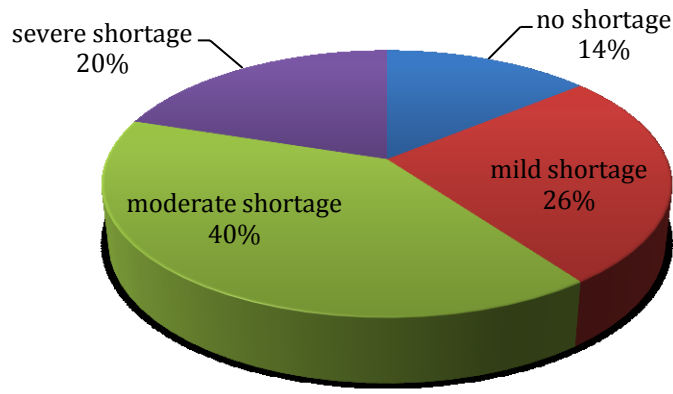
**Figure 1: Employee Segments that have had a Significant Negative Impact on Ability to Expand or Productivity [1]**

When asked on the same survey to assess the availability of qualified personnel in the skilled production and production support segments only 5% of respondents indicated that there was no shortage for skilled production personnel and 14% for production support personnel. However 45% of respondents indicated a severe shortage of skilled production personnel and 20% of respondents indicated that there is a severe shortage in production support personnel [1]. This can be seen in Figure 2 and Figure 3



**Figure 2: Availability of Skilled Production Personnel**

### Availability of Production Support Personnel as Indicated on 2011 Survey by The Manufacturing Institute [1]



**Figure 3: Availability of Production Support Personnel**

However, this is not the only existing study. The Boston Consulting Group's *Made in America, Again: Why Manufacturing Will Return to the US* [4] reports smaller figures for the size of the "Skills Gap" compared to other studies. Though criticized for making the magnitude of the issue appear smaller than it actually is, the report will serve well as a lower bound for the possible size of the "Skills Gap". The Boston Consulting Group reports that only 10% of the largest manufacturing centers are experiencing severe skills gaps in the segment that they refer to as "Highly-skilled manufacturing labor", a segment which aligns closely with what The Manufacturing Institute refers to as "Production support personnel". The Manufacturing Institute also reported that the impact is felt less by larger companies. This means that a similar survey of the US manufacturing industry as a whole would likely report a larger percentage of manufacturing centers experiencing a severe lack of "Highly-skilled manufacturing labor".

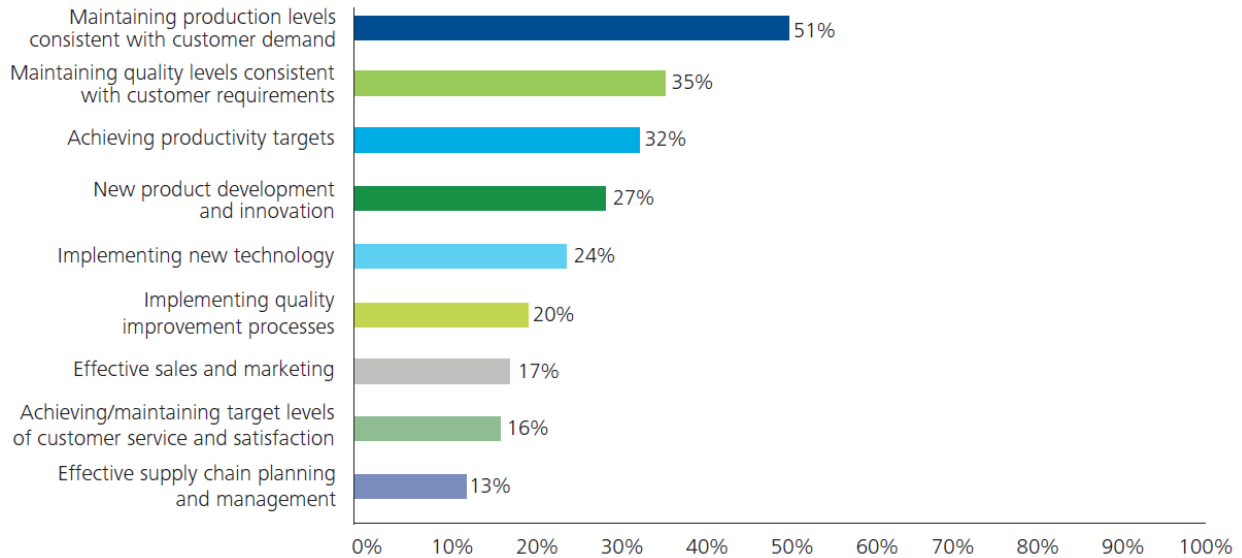
A third study by McKinsey & Company has a more moderate view than either of the two previously cited studies. They report that 43% of US manufacturing companies had positions open for more than six months that they could not fill [8].

The exact numbers aside, the "Skills Gap" is a very severe issue. Taking the average of the values from The Manufacturing Institute and The Boston Consulting Group gives

15% of companies are experiencing a severe shortage in what is not even their most impacted segment. This problem is large enough that it threatens the state of manufacturing.

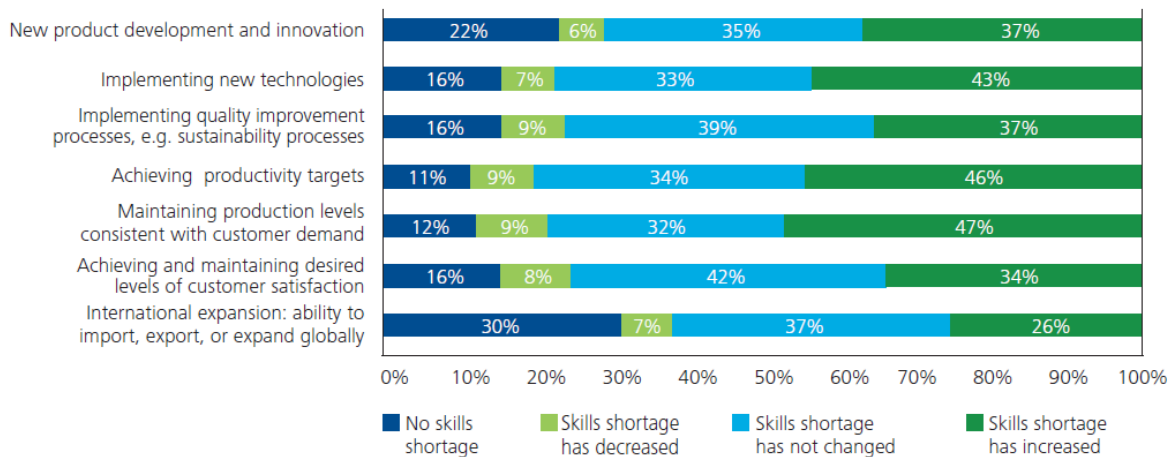
Most studies agree that the "Skills Gap" issue will continue to worsen over time. Since the turn of the century, the US has had declining trade school enrollment and fewer people pursuing journeyman jobs [9]. The consequences of this are still to come as personnel currently in this sector retire. With a lack of trained younger personnel to replace them and an expected lack of new talent to fill the positions currently held by the younger personnel, the "Skills Gap" can be expected to worsen at a faster rate than it currently is. The Manufacturing Institute estimates that the "Skills gap" will likely almost double between 2010 and 2020 with the possibility of quadrupling in severity in the decade after.

If this is such a large issue, what are the effects that this lack of skilled production and production support personnel have? Most studies agree that the "Skills Gap" is dominantly affecting manufacturers in two ways. The first is in achieving/maintaining production levels and targets and achieving/maintaining output consistent with customer demand. The second is in achieving/maintaining/improving quality level goals and maintaining quality consistent with customer demand. The Manufacturing Institute reports that over half of manufacturers report difficulties with the first effect due to the "Skills Gap" [1]. Excerpts from the results of their 2011 survey can be found in Figure 4 and Figure 5 .



This is a multiple selection question, percentages may not add to 100%. Base used is 1123.

**Figure 4: Responses to what operational areas have respondent's companies experienced the most difficulty due to employee shortages or skill deficiencies on a 2011 survey by The Manufacturing Institute [1]**



**Figure 5: Responses to how skills shortages have impacted each of the listed areas over the past 5 years on a 2011 survey by The Manufacturing Institute [1]**

Knowing the size of the "Skills Gap" and the areas impacted by the "Skills Gap" allows for the identification of themes that warrant investigation for their contribution to causing the "Skills Gap". The trends in the following bullet point list were discovered among the existing studies, among editorial pieces on the "Skills Gap" by columnists and among

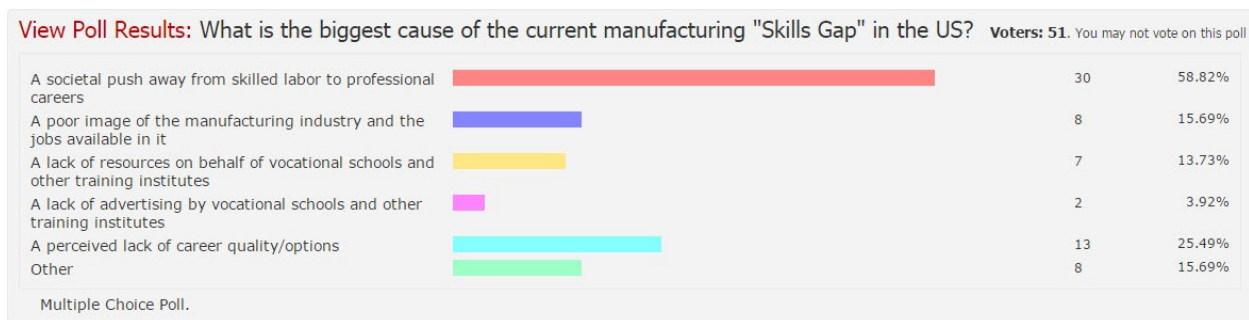


anecdotal descriptions of the "Skills Gap" as possible reasons for the "Skills Gap". These trends will be used to guide the direction of individual research into the root cause of the "Skills Gap".

- Society is moving away from skilled labor positions and valuing professional careers.
- Manufacturing has gotten and continues to get more advanced and, therefore, requires more advanced, specialized and harder-to-find training for its workers than it has in the past.
- There is a public stigma against the manufacturing industry. People perceive that it offers poor working conditions, low pay, minimal job security and other unattractive features.

## Surveys and Polls

A poll was created on the popular machining forum CNCzone.com to ask visitors of the forum what they believe is the biggest cause of the manufacturing "Skills Gap" in the US. The results can be seen in Figure 6. Respondents overwhelmingly decried a societal change away from skilled labor to professional careers as the dominant cause. Results were recorded 5/1/2014 and the poll can be found at <http://www.cnczone.com/forums/polls/216822-skills-gap.html>.

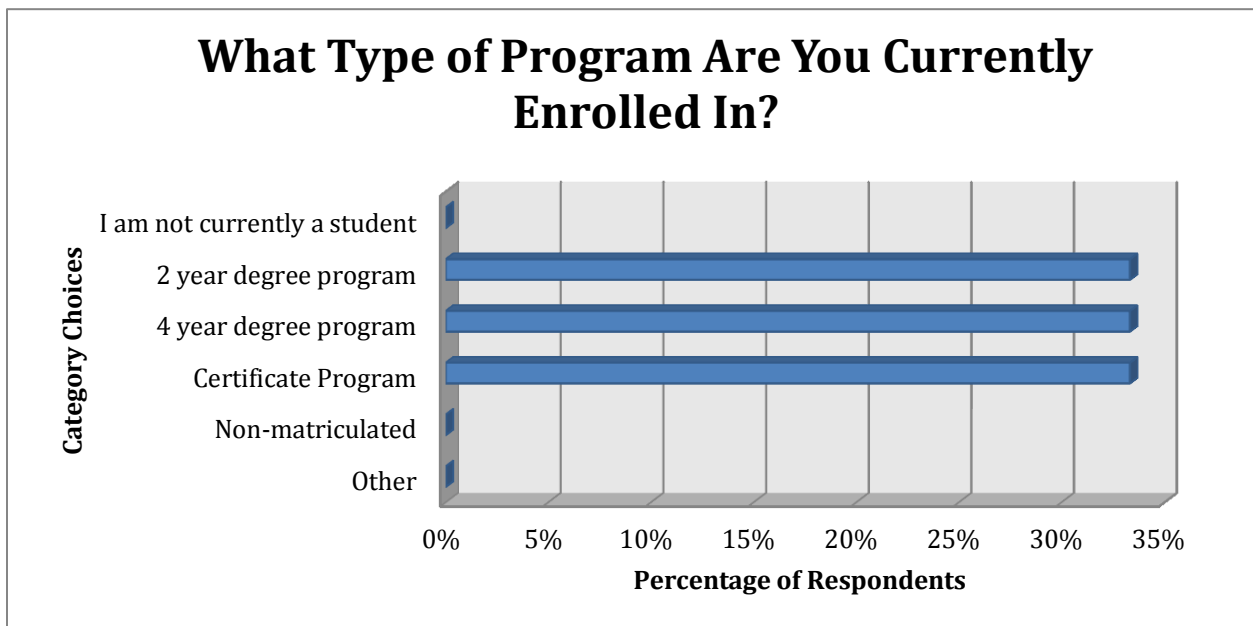


**Figure 6: Results of a poll posted on CNCzone.com, a common forum for CNC machining.**

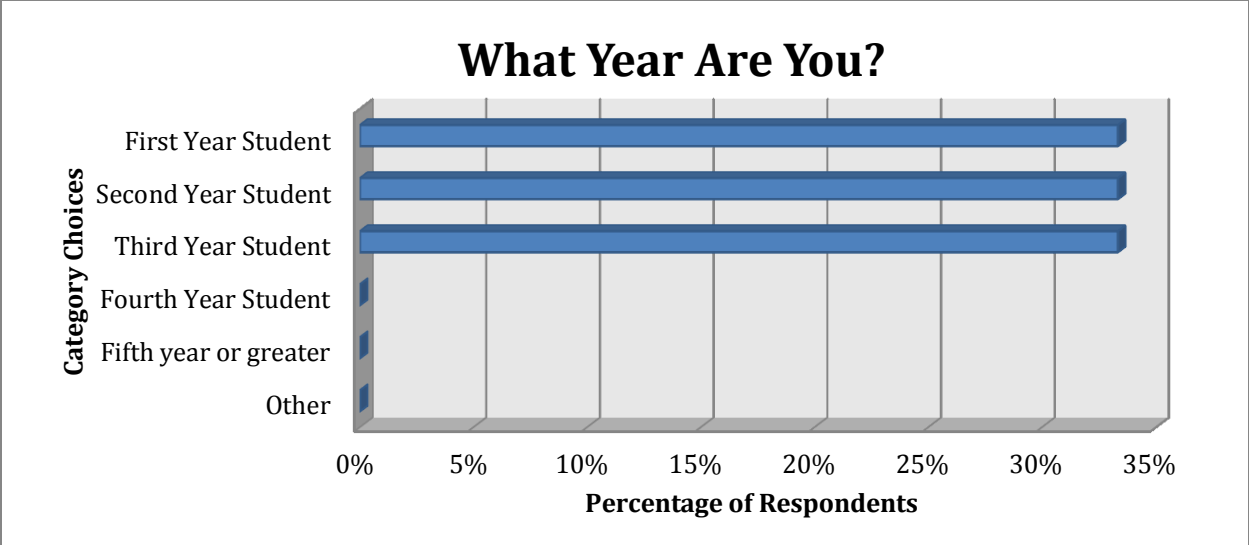
A survey was sent to current students of vocational school programs in manufacturing to determine what they believe about the "Skills Gap". Their opinion is important because they will be the ones filling the jobs left open by the "Skills Gap". The

goal of the survey was to determine how comprehensive the student’s education were and what the driving factors were behind the student’s choices to pursue a degree in manufacturing. The survey consisted of two multiple choice questions, 5 single choice questions, 1 ranking question and 2 free response questions for a total of ten questions. There were three respondents.

The first two questions were multiple choice questions and were used to confirm that the respondent was a vocational school student. The questions and the responses can be seen in Figure 7 and Figure 8, below. The question text has been used as the figure title.

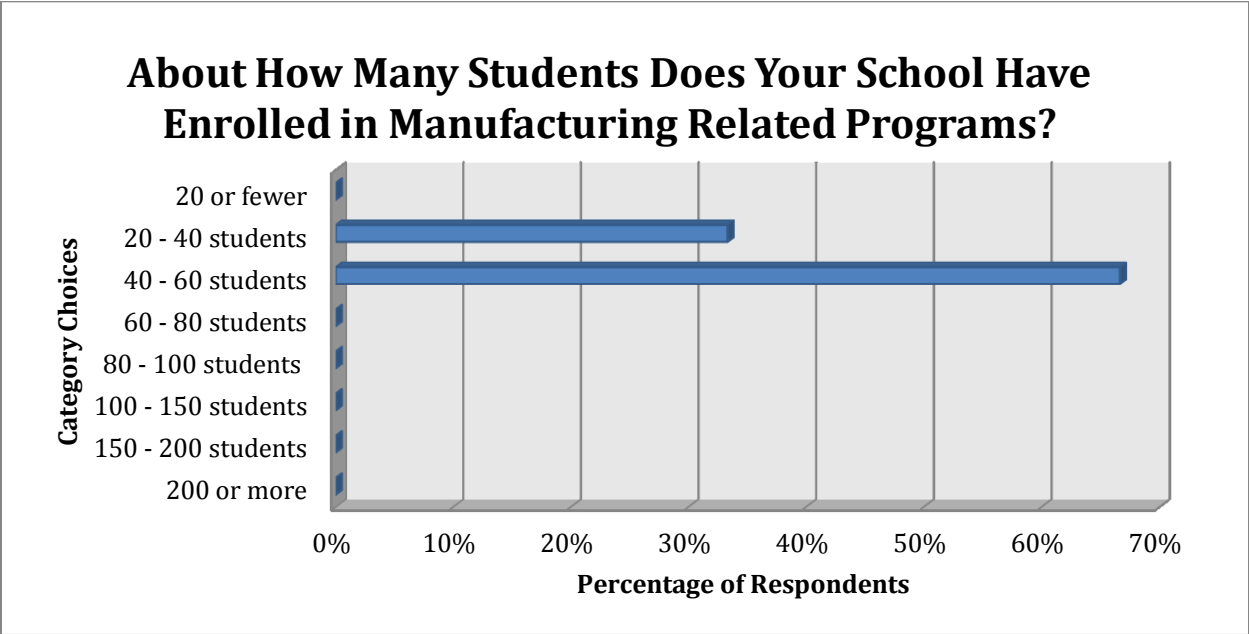


**Figure 7: Question 1 of the Vocational School Student Survey**



**Figure 8: Question 2 of the Vocational School Student Survey**

Questions 3 through 7 of the survey were intended to determine the capacity of the student’s school and the comprehensiveness of the student’s education. They were all single choice questions that asked respondents to rank how their experience compared to what might be seen and expected from a typical vocational school. The questions and responses can be seen in Figure 9 through Figure 13.



**Figure 9: Question 3 of the Vocational School Student Survey**

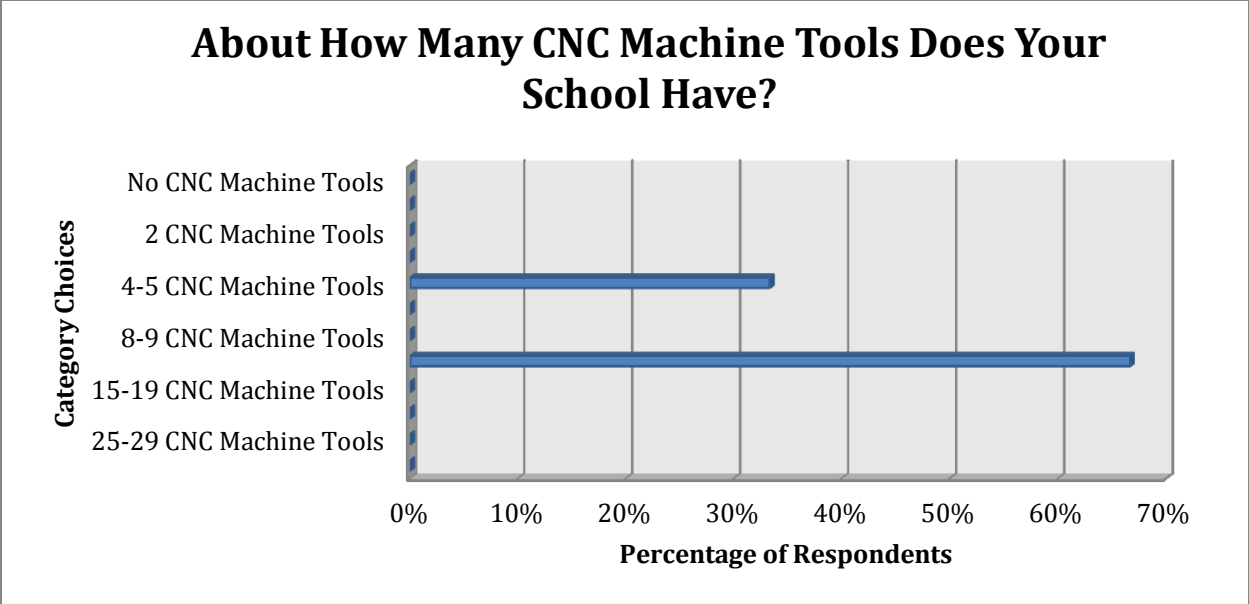


Figure 10: Question 4 of the Vocational School Student Survey

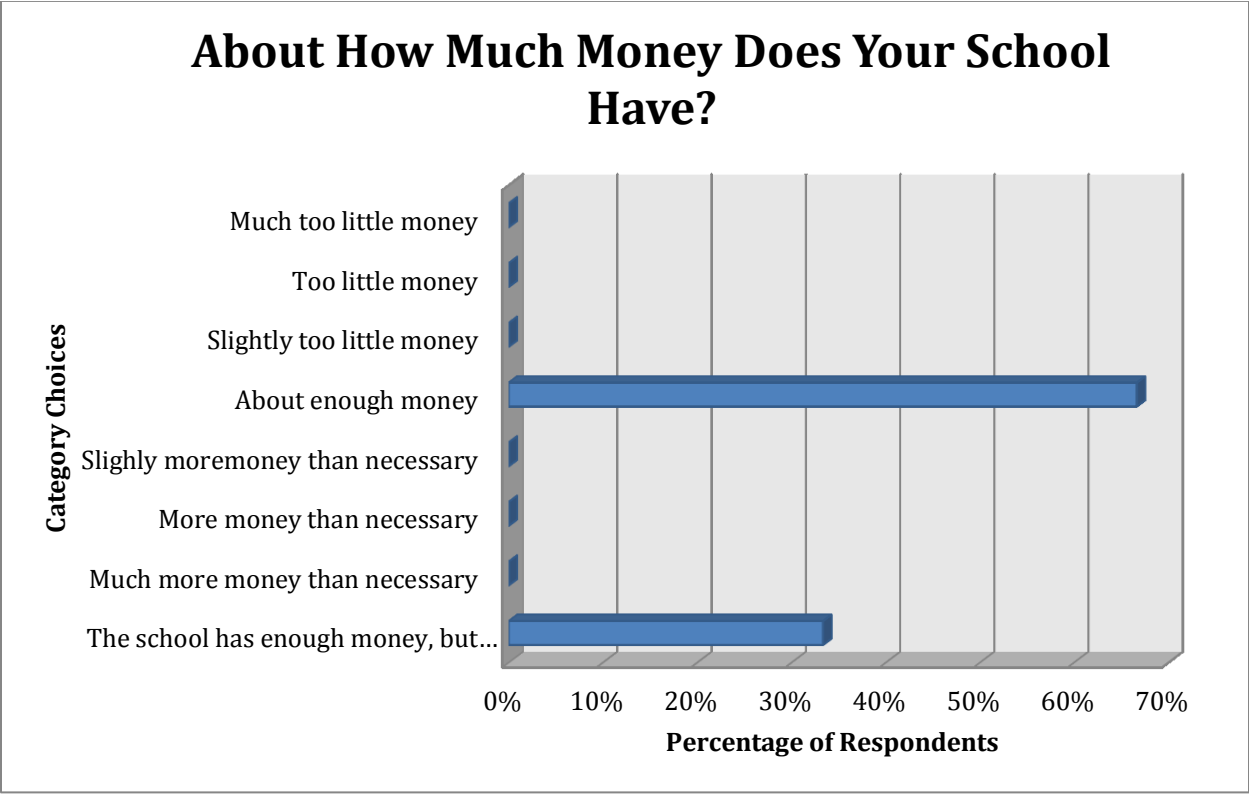


Figure 11: Question 5 of the Vocational School Student Survey

## How Much of Your Training Has Been Hands On?

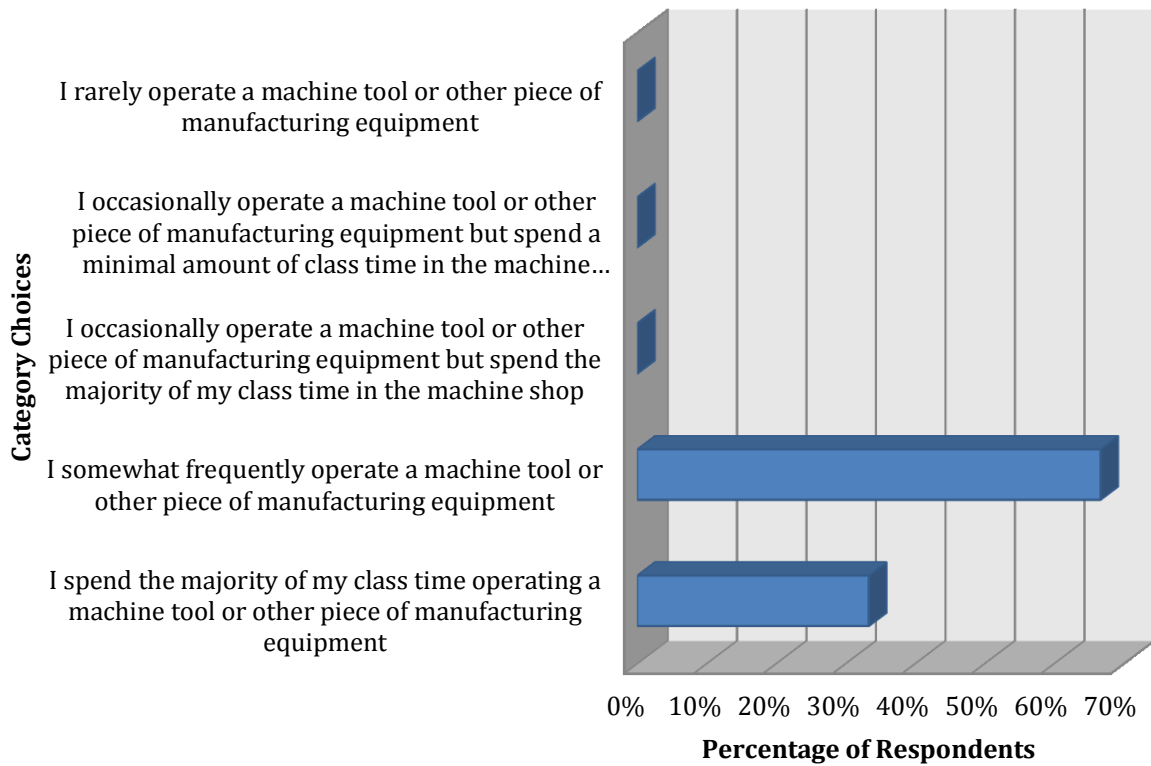
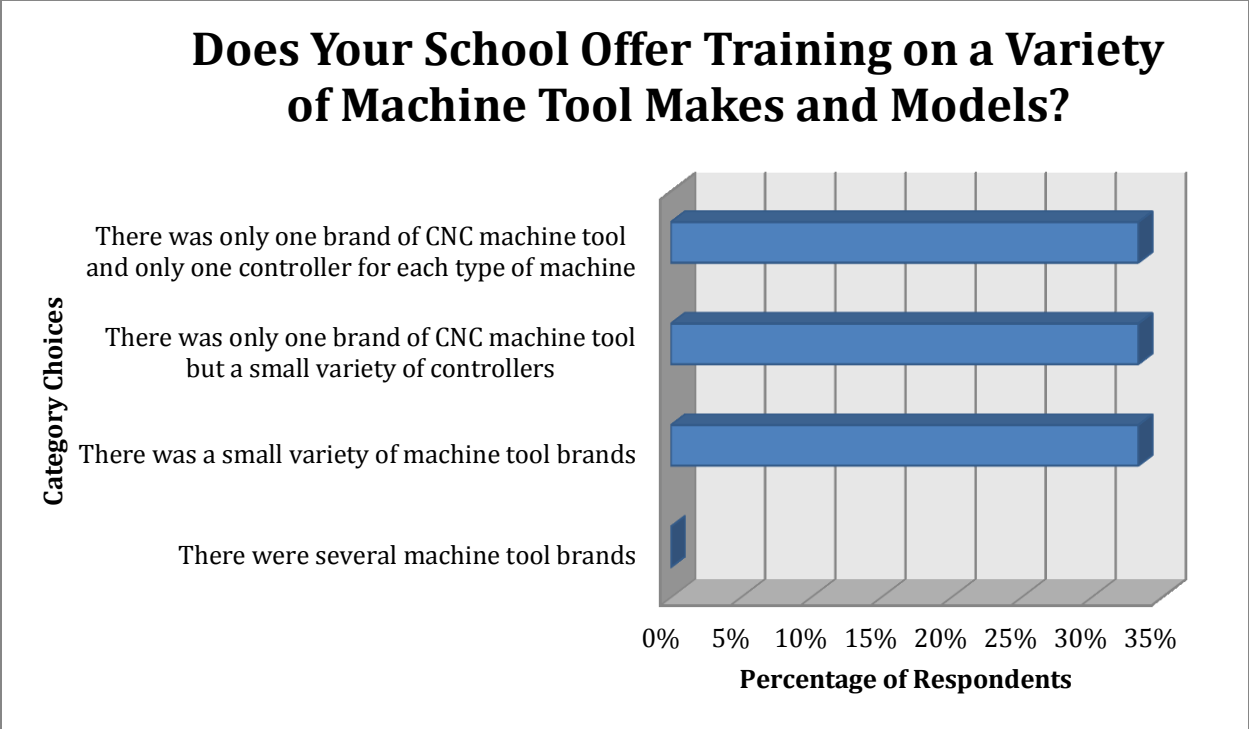
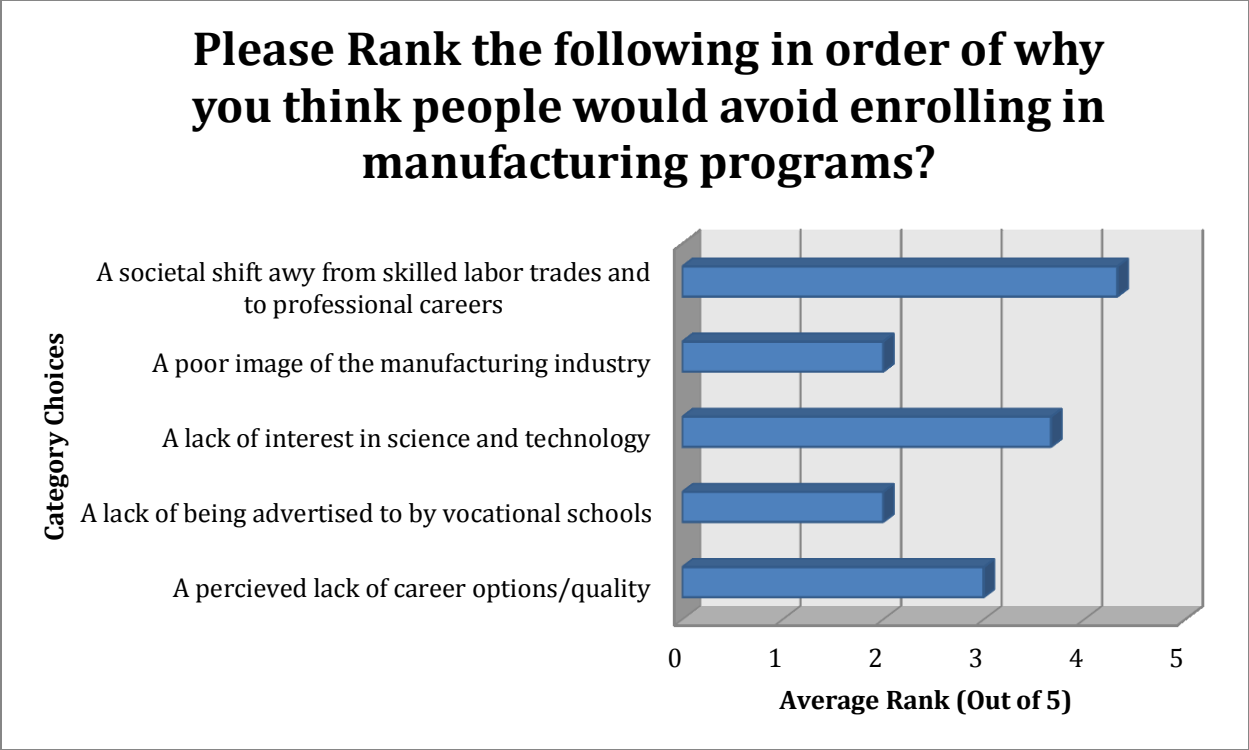


Figure 12: Question 6 of the Vocational School Student Survey



**Figure 13: Question 7 of the Vocational School Student Survey**

Questions 8 and 9 were designed to determine why the student had chosen to pursue a career in manufacturing and what might have deterred from that decision. This is especially important because the lack of motivation for people to join the manufacturing industry is what is being attempted to be fixed. Question 8 was a free response question that asked students to rank the reasons that someone might avoid a career in manufacturing. Question 9 was a free response question that asked respondents to explain why they had chosen to go into manufacturing and anything that deterred from that decision. The questions and responses can be seen in Figure 14 and Table 1.



**Figure 14: Question 8 of the Vocational School Student Survey**

**Table 1: Question 9 of the Vocational School Student Survey**

Question	“What was it that caused you to want to go into manufacturing? Was there anything that complicated this decision?”
Answers	“My grandfather was a machinist, so I was guided into it my sophomore year of high school. I've considered switching trades due to bad employment experiences, but each time I've left the trade, I've always wished I was back in front of a machine.”
	“I've always enjoyed making stuff. Manufacturing seemed like that.”

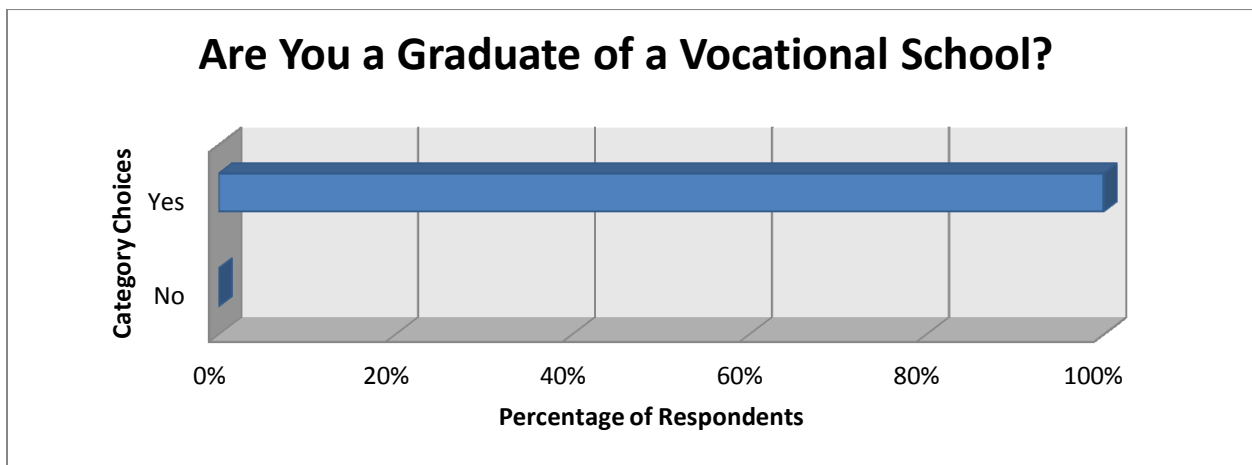
The last question was a free response question that asked respondents to explain how their favorite instructors earned that status. This provides insight into both how well the students are being taught as it reveals the techniques and methods that endear students to an instructor and a practice. It also provides insight into what to do to encourage students to stay in and enter manufacturing training programs. This is done by showing the education techniques in use that convince students that manufacturing is a

viable and rewarding career path that will provide them with challenges to solve and profitable work to do. The results and text of the question can be seen in Table 2.

**Table 2: Question 10 of the Vocational School Student Survey**

Question	“What is it about your favorite instructors that make them your favorite?”
Answers	“They are understanding of today’s job market, and can help tailor the lessons to what you hope to get out of the class, and what your future goals are.”
	“their enthusiasm and love for helping students get better.”

A second survey was distributed to graduates of vocational school programs in manufacturing. This would allow for the gathering of opinions of personnel currently working in the manufacturing industry as to why they were working in the manufacturing industry and how well they were prepared for their current jobs. This is important because at the heart of fixing the "Skills Gap" is the matter of convincing more people to go into manufacturing and to get the skills needed for a successful career in that field. The survey consisted of one multiple choice question, 6 single choice questions and 3 free response questions. The first question was the multiple choice question and was used to confirm that respondents were graduates of a vocational school. The question and responses can be seen in Figure 15. There were seven respondents.



**Figure 15: Question 1 of the Vocational School Graduate Survey**



Questions 2 through 7 of the survey are similar to several of the questions from the current vocational school student survey. They were also intended to determine the capacity of the graduate’s school and the comprehensiveness of the graduate’s education. They were all single choice questions that asked respondents to rank how their experience compared to what might be seen and expected from a typical vocational school. The questions and responses can be seen in Figure 16 through Figure 21.

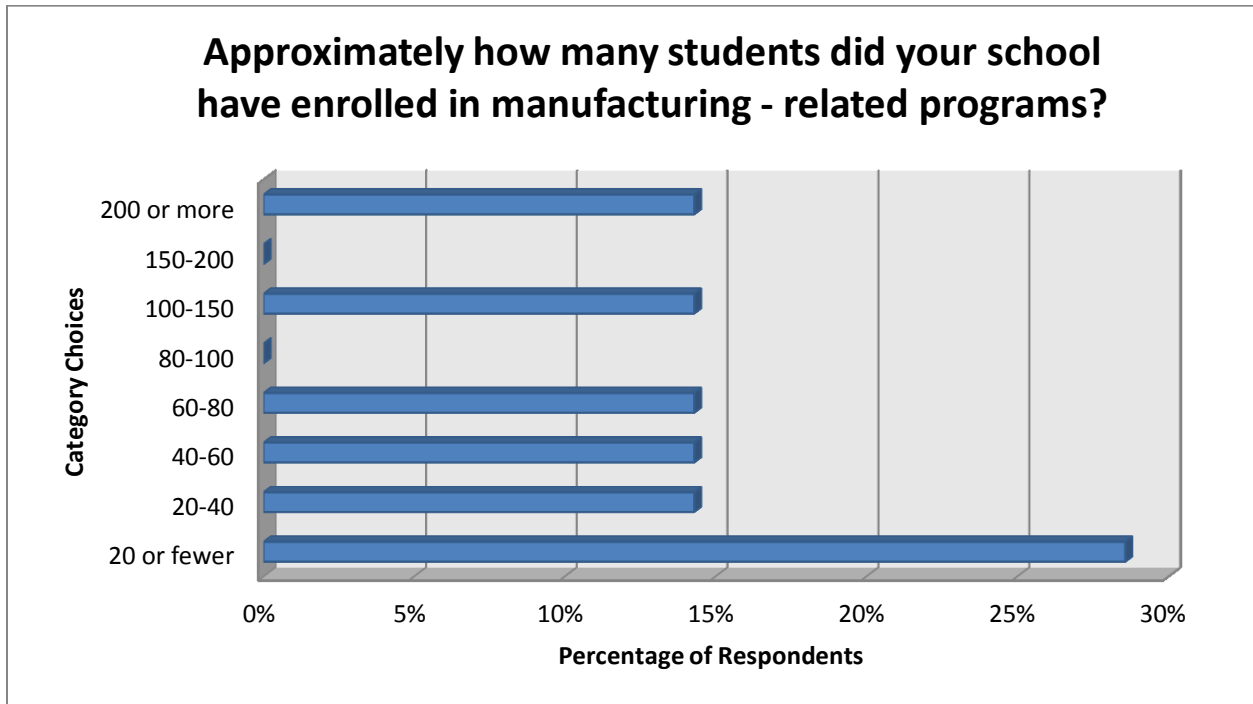


Figure 16: Question 2 of the Vocational School Graduate Survey

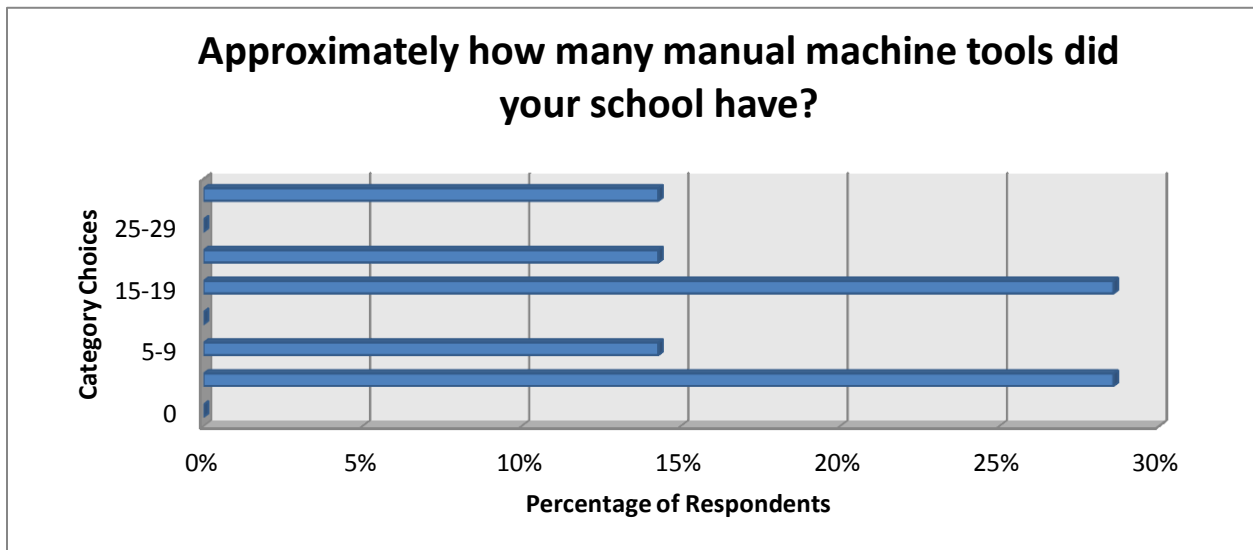
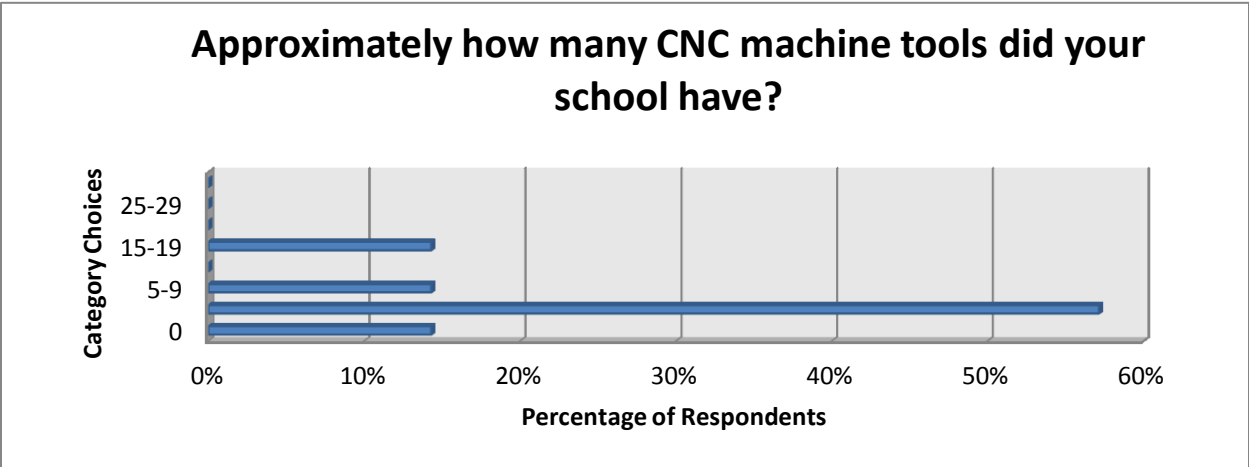
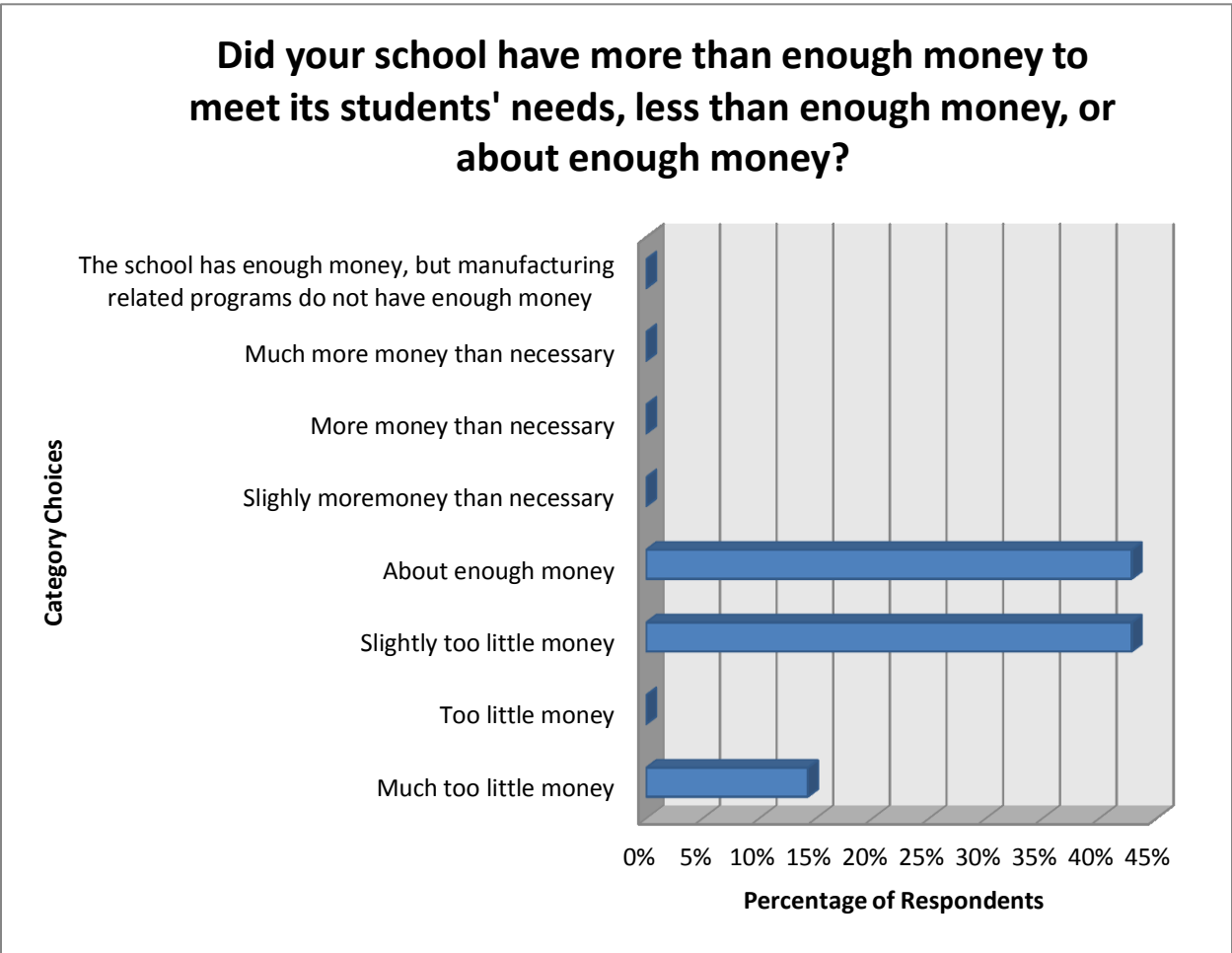


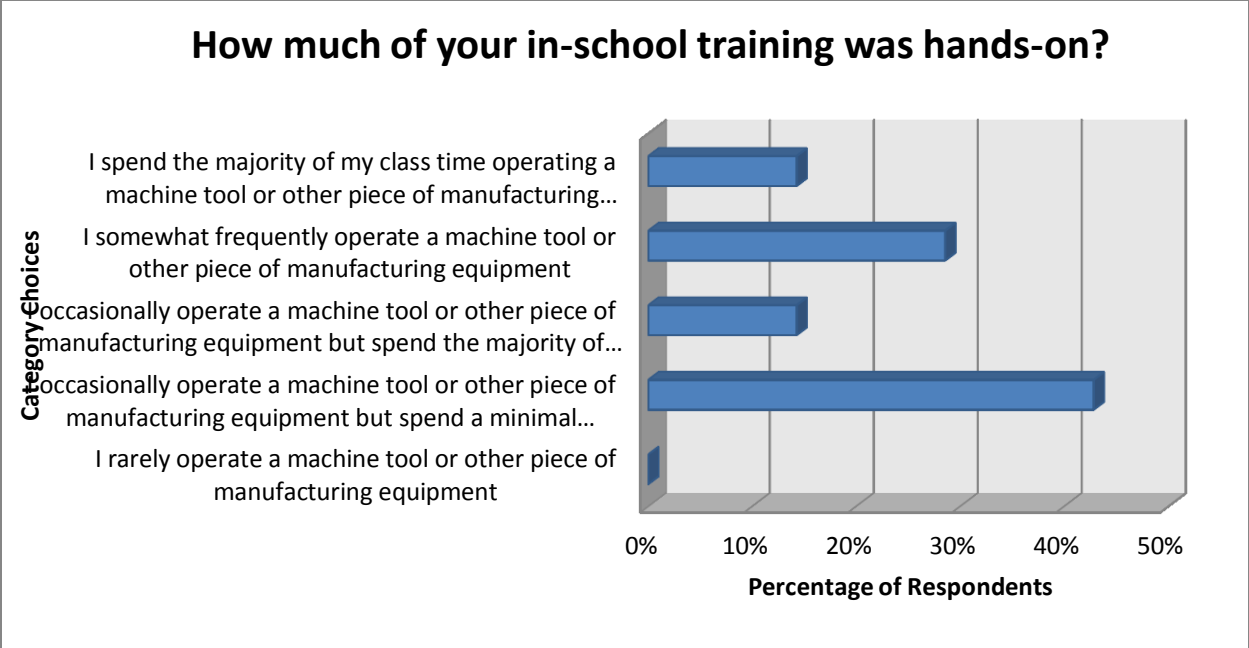
Figure 17: Question 3 of the Vocational School Graduate Survey



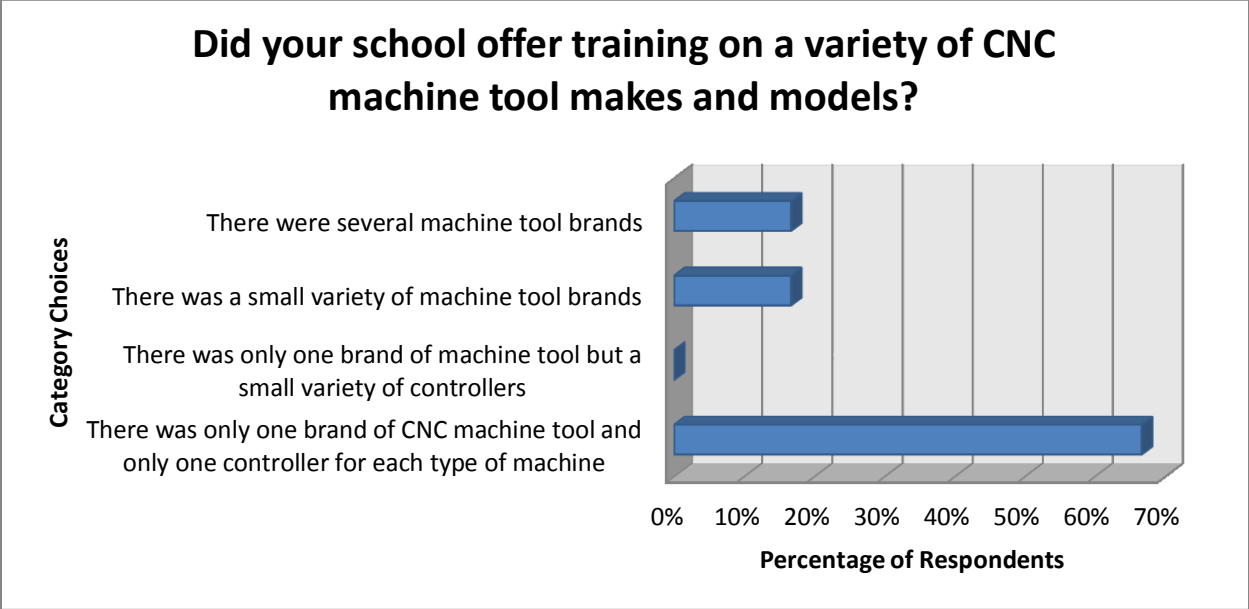
**Figure 18: Question 4 of the Vocational School Graduate Survey**



**Figure 19: Question 5 of the Vocational School Graduate Survey**



**Figure 20: Question 6 of the Vocational School Graduate Survey**



**Figure 21: Question 7 of the Vocational School Graduate Survey**

Question 8 of the survey was intended to determine what had drawn graduates to their specific job, thereby explicitly showing what attracts people to manufacturing jobs. Question 9 was intended to probe further into how well prepared the graduates were upon leaving school to see whether they had the needed skills or not. Question 10 directly asks the respondents about their decision to go into manufacturing and any deterrents that they

encountered to that decision. The question text and results can be seen in **Table 3** and Table 4.

**Table 3: Question 8 of the Vocational School Graduate Survey**

Question	“What was it that attracted you to any employers you have worked for since graduating?”
Answers	“Just happy to have a job.”
	“Their need for a mechanic.”
	“The opportunity it offered to frequently work on new challenges.”
	“Early 90's soft job market: anywhere I could find a job. Mid 00's booming Alberta economy: wage offer.”
	“Work environment (clean, organized, etc.) Type of work (production, Automotive, custom machine building, heavy industry, etc.) Paid Time Off Wage.”

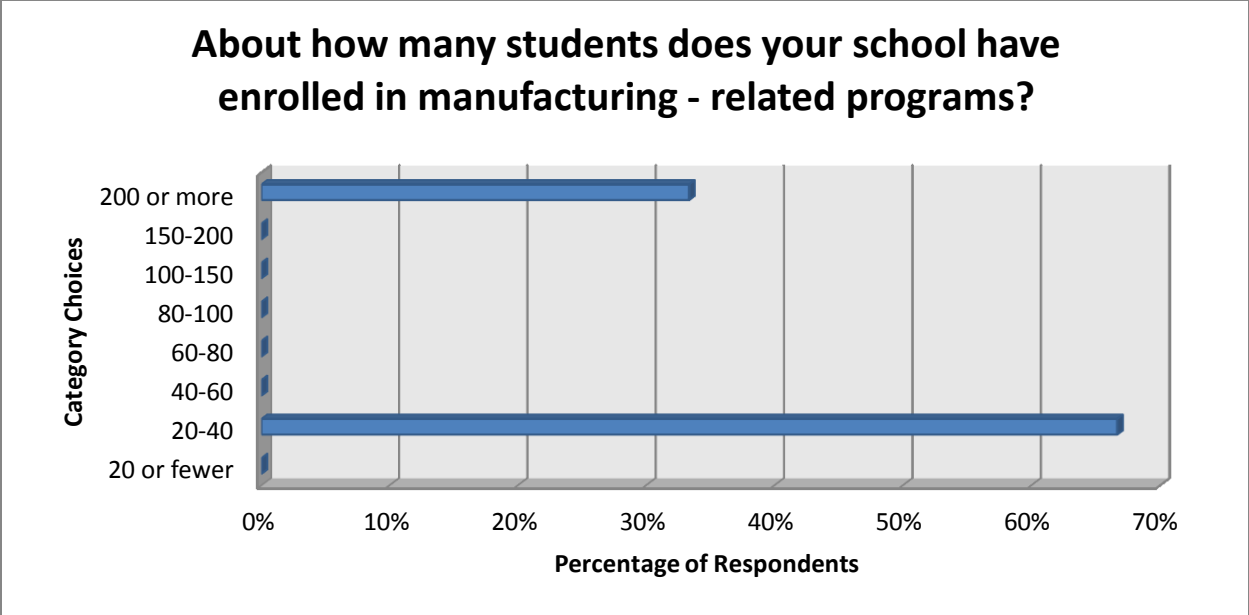
**Table 4: Question 9 of the Vocational School Graduate Survey**

Question	“What do you wish you had learned while you were in school that you didn't?”
Answers	“More advanced CNC programming.”
	“A different trade than this, because it's a dead industry”
	“I wish I had focused on building my technical skills via schooling.”
	“The school program was very good.”
	“More CAM, Metallurgy, Speed and Feeds”

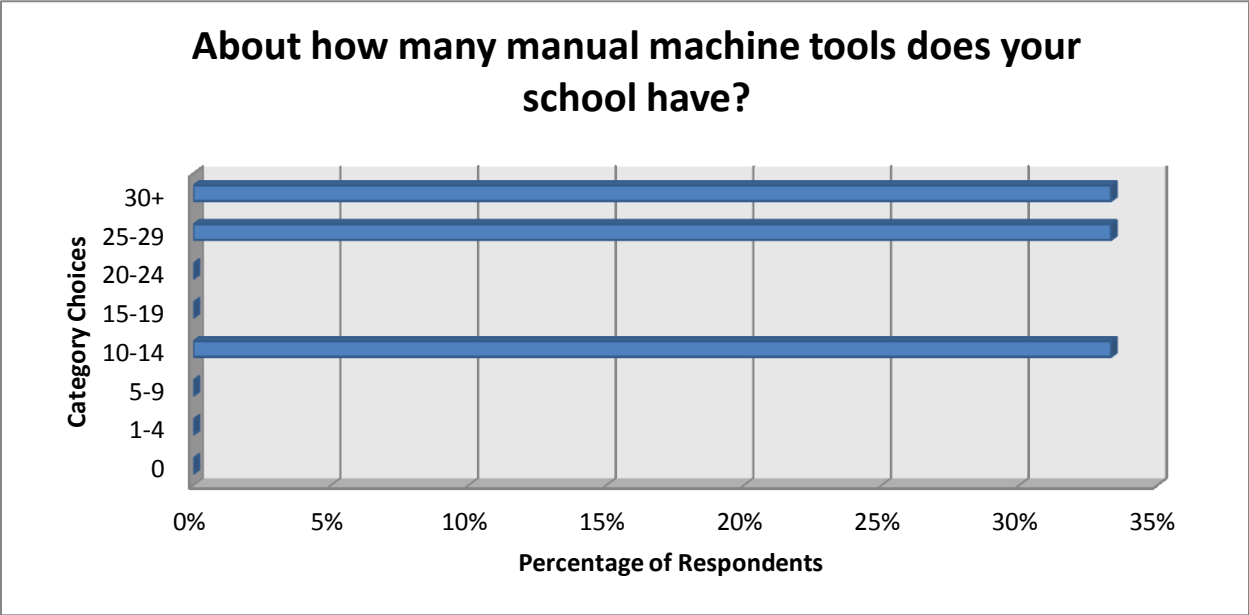
**Table 5: Question 10 of the Vocational School Graduate Survey**

Question	“What was it that caused you to want to go into manufacturing? Was there anything that complicated this decision?”
Answers	“I enjoyed the precision aspect of machining.”
	“It's what my grandfather did.”
	“Incidental reasons. That is where the job was.”
	“I just enjoy taking bits of raw material and turning them into something useful.”
	“Personal interest in making things. Complicated by lack of awareness of the profession due to lack of introduction in high school.”
	“It was the only two year course that caught my eye. Promise of good wages.”

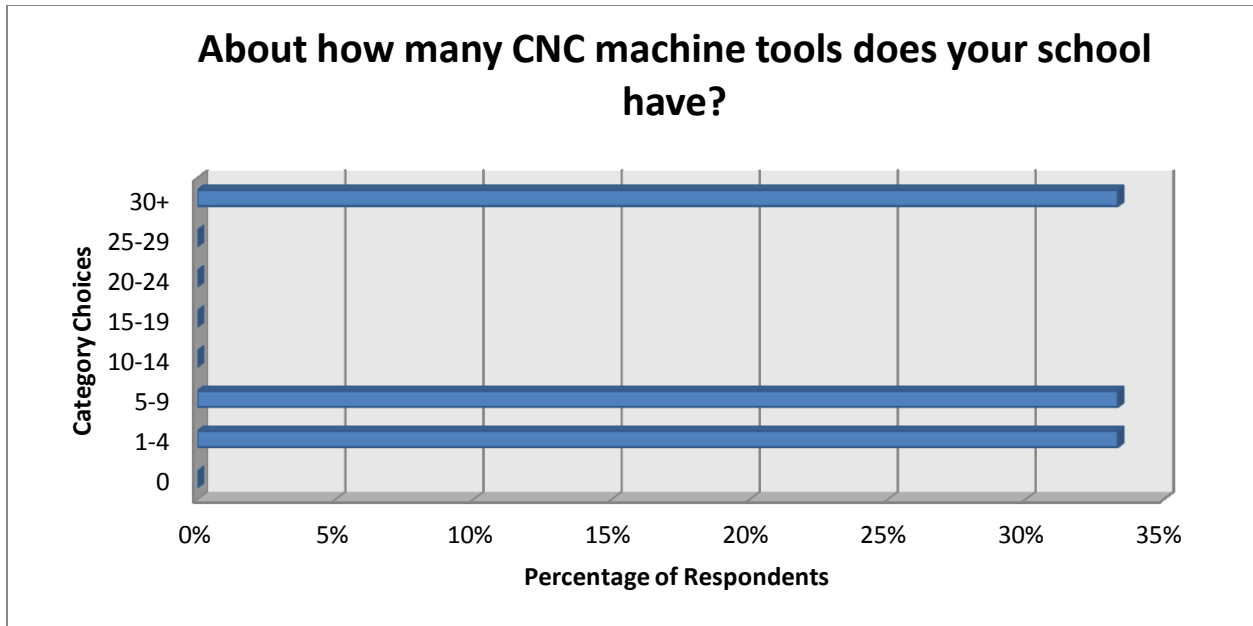
A third survey was made and distributed to instructors and administrators of vocational schools. The point of this survey was to see if the schools had the resources they needed to effectively educate their students, what the schools were doing to recruit students and how effective the school’s recruitment efforts were. The survey consisted of 7 single choice questions, 1 ranking question and 2 free response questions. The first question was a single choice question that confirmed that the respondents were either instructors or administrators at vocational schools. All respondents who proceeded to complete the rest of the survey answered in the affirmative. Questions 2 through 5 asked about the capabilities of their facility to determine the school’s capacity and the potential comprehensiveness of the program. The questions and responses can be seen in Figure 22 and Figure 25. There were five respondents.



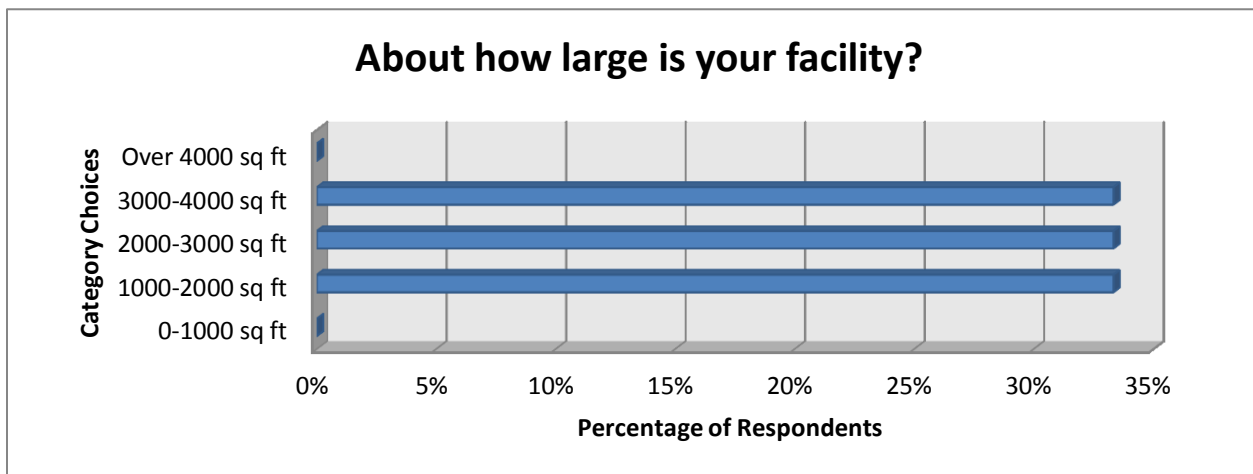
**Figure 22: Question 2 of the Vocational School Administrator and Instructor Survey**



**Figure 23: Question 3 of the Vocational School Administrator and Instructor Survey**



**Figure 24: Question 4 of the Vocational School Administrator and Instructor Survey**

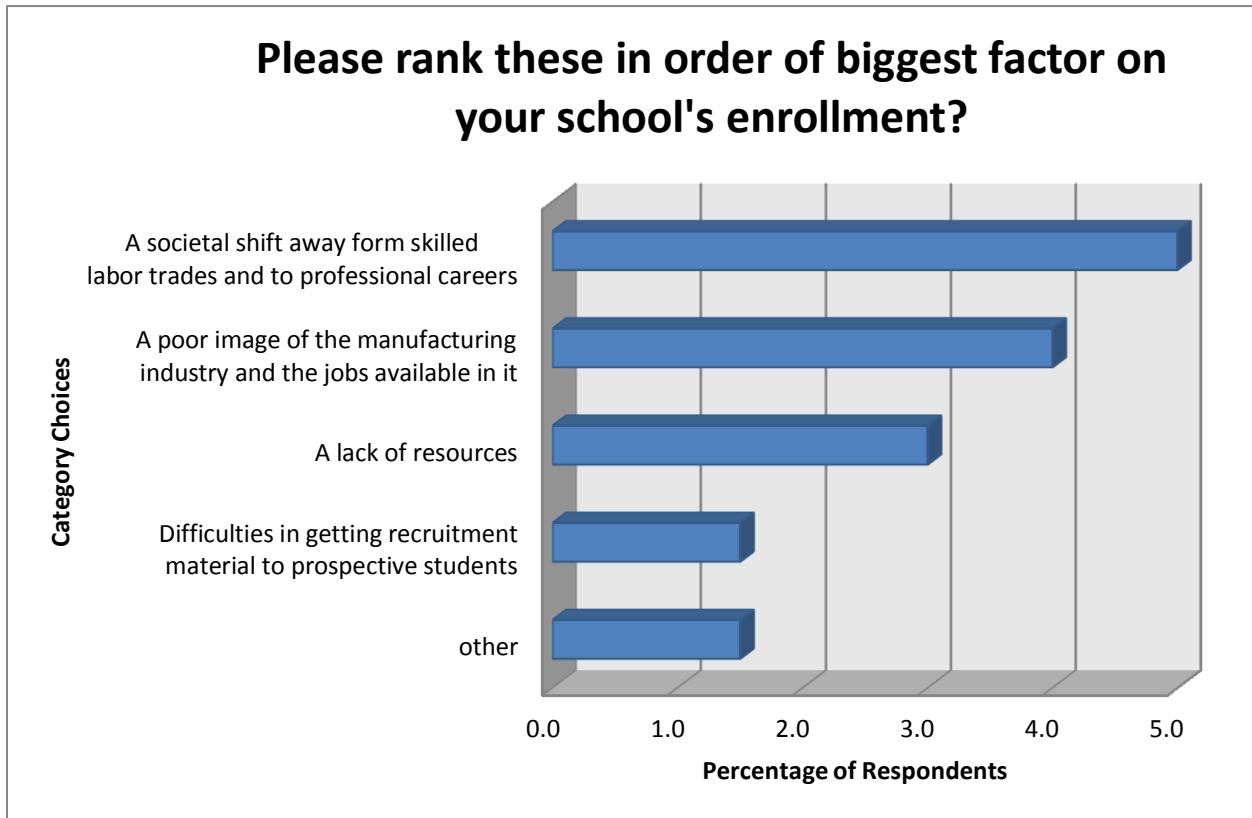


**Figure 25: Question 5 of the Vocational School Administrator and Instructor Survey**

Questions 6 and 7 were intended to determine the techniques being used to recruit new students, the success that the schools were having at this and what challenges the schools were facing when recruiting students. Question 6 was a free response question and the responses can be seen in Table 6 and Figure 26.

**Table 6: Question 6 of the Vocational School Administrator and Instructor Survey**

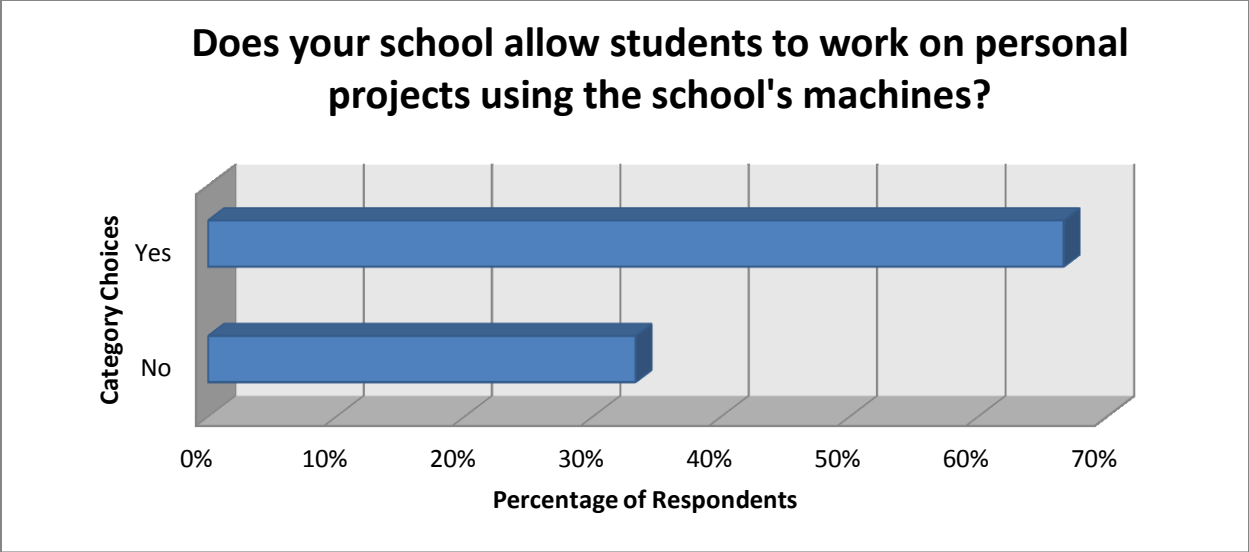
Question	“What is your school currently doing to recruit students who are currently in a comprehensive school?”
Answers	“Open House 8th Grade Tours”
	“Not much effort is being placed on recruiting.”



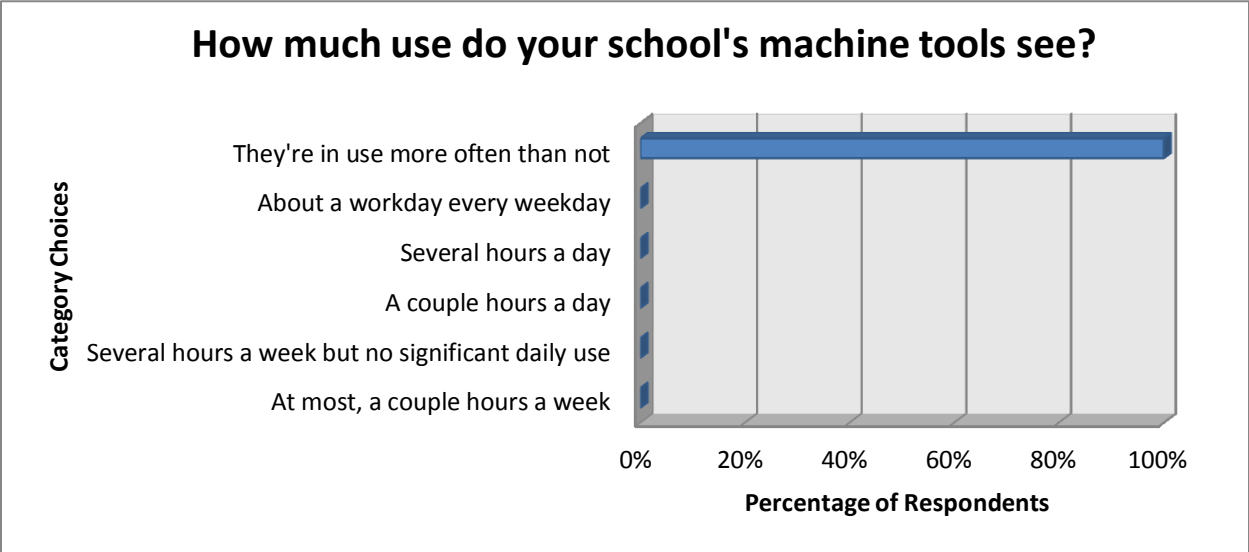
**Figure 26: Question 7 of the Vocational School Administrator and Instructor Survey**

Questions 8 and 9 were intended to determine how thorough an education the school’s students received but more so to see how much the school encouraged development of the skills taught in class by seeing how accessible the school’s machines are and how much the school’s machines are used. Allowing students to use machines for personal projects enables the students to hone and significantly grow their skillset. High machine utilization means that there are students actually using the machines and learning. The responses to these questions can be seen in Figure 27 and Figure 28.





**Figure 27: Question 8 of the Vocational School Administrator and Instructor Survey**



**Figure 28: Question 9 of the Vocational School Administrator and Instructor Survey**

The last question asked about common complaints that are received from the students. This was to determine what could be done better. The question and responses can be seen in Table 7.

**Table 7: Question 10 of the Vocational School Administrator and Instructor Survey**

Question	“What is the most common complaint you hear from graduates about their education at your school?”
Answers	“No Complaints”
	“Not enough time in lab setting - too much GenEd.”

## **Interview**

An interview was conducted with Leslie Parady of the Massachusetts Manufacturing Extension Partnership (MassMEP) to provide a view of what manufacturers are expecting out of their current workforce, their potential future workforce and what manufacturers are doing to provide the training needed by their personnel. MassMEP is an organization devoted to making small and midsize Massachusetts manufacturers competitive and highly profitable through implementing improved operations strategies, workforce training and development programs and innovative growth solutions. This provides MassMEP with an intimate look at the struggles that the manufacturing industry is facing and the causes of those issues.

One of the issues that Parady mentioned the manufacturing industry is having is that the skill sets that are possessed by the available personnel are often not the same as that needed by the manufacturers. According to Parady, as the manufacturing workload shifts away from OEM suppliers to small and midsize manufacturers, training people has become more difficult. This is because the smaller companies don't have the resources needed to get the needed training for their personnel or to take the personnel off the shop floor to receive the training. This leaves manufacturers searching for people to hire who already have the needed skills and eliminates the consideration of people who would make good employees but need a little training before they would be good. Also, as manufacturing has grown more advanced, the needed skills have grown more specialized making it harder for individuals to be highly versed in a wide array of manufacturing technologies. This combination of needing employees to already have the needed skillset

and the needed skillset being less common makes it extremely difficult for employers to find potential employees who would be immediately ready to do the needed work.

One common trend that repeatedly emerged during the interview was manufacturing having a poor public image that deters people from joining the industry themselves and encouraging other people to join the industry. She said that people tend to think of sweatshops and similar dangerous, dirty, hot and messy working conditions when they think of manufacturing. They also tend to think that US manufacturing is a dyeing industry and that if you go into manufacturing in the US it's only a matter of time before your job gets shipped to China. The described environment is generally not an environment someone would be looking to join by choice.

It is also not an environment that one would generally encourage someone to join. This becomes an issue with guidance counselors and parents. Parents, tending to want good things for their children would do what they can to prevent their teens and young adults from pursuing careers in industries with what they perceive as dangerous and poor working conditions and low job security. Similarly, middle and high school guidance counselors tend to advise against going into the manufacturing industry for similar reasons.

## Discussion

The previous research revealed three possible causes for the current "Skills Gap":

- Society is moving away from skilled labor positions and valuing professional careers
- Manufacturing has gotten and continues to get more advanced and, therefore, requires more advanced, specialized and harder-to-find training than it has in the past.
- There is a public stigma against the manufacturing industry. People perceive that it offers poor working conditions, low pay, minimal job security and other unattractive features.

Each of these will be analyzed for their possible contribution as the root cause of the "Skills Gap".

It is true that manufacturing has gotten more advanced and requires a more specialized skillset. This is an issue that has impacted manufacturers and made it harder for manufacturers to find personnel with the needed skills. This can be seen from the fact that in both the report by The Manufacturing Institute [1] and the report by Sears [3], respondents ranked this as the third most significant cause of being unable to find the needed personnel. This opinion was also blatantly expressed by Parady in her interview.

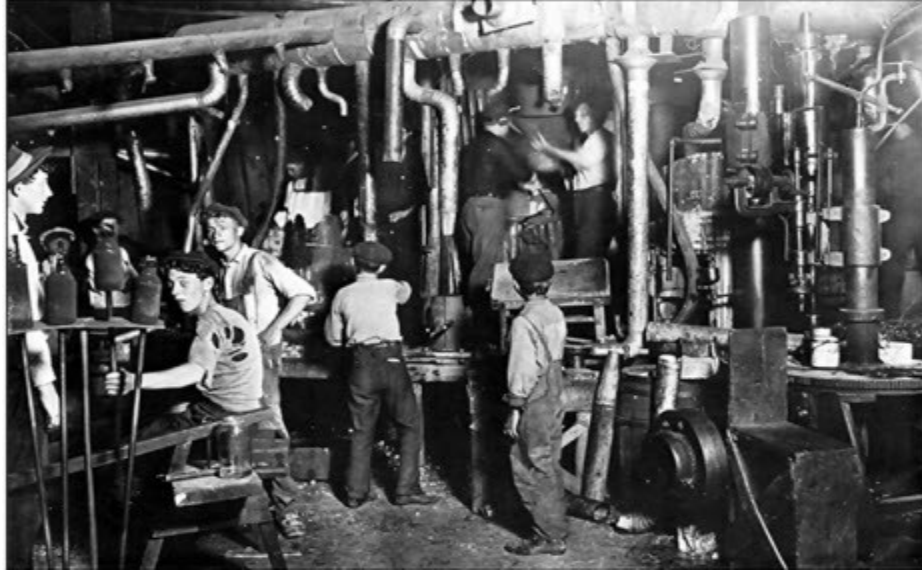
However, this does not appear to be the root cause. In both of the two reports mentioned in the previous paragraph, the advanced nature of manufacturing work was ranked third, significantly behind the same two categories: a societal shift towards post-secondary education and a public stigma against manufacturing. This pattern of manufacturing's advanced nature being ranked significantly behind a public stigma against manufacturing which was itself ranked significantly behind a societal push for post-secondary was also repeated elsewhere in the data. For instance, in the seventh question of the vocational school administrator survey the public stigma against manufacturing was ranked as one third more instrumental to causing the lack of personnel as having the resources to train people. A societal push for post-secondary education was ranked as two thirds more instrumental.

There are also techniques already in place to ease this burden. One such technique is used by the MassMEP where they coordinate training sessions across multiple manufacturers. This allows the different companies to share the load of getting training material for their employees.

The resources also appear to already be in place to administer this training. When asked about funding, students indicated that they generally believe that their schools have the funding to teach what needs to be taught. Students and instructors also indicated that there tends to be a similar number of students and machine tools in their schools. Students also replied that they received training on a variety of equipment.

A public stigma against the manufacturing industry was consistently ranked a close second to a societal push for post-secondary education as the cause for the "Skills Gap" by respondents to the surveys for the reports by The Manufacturing Institute [1], Sears [3] and on the surveys for this project. This means that the general public thinks that manufacturing and the work that goes on in the industry is "uncool". Unfortunately, manufacturing is seen as uncool because of a false perception of the manufacturing industry. It is not true that manufacturing suffers from poor working conditions, low pay or minimal job security.

Manufacturing does not offer low wages. In fact, manufacturing employers pay their employees, on average, nearly 10% more than the average for all employers in the economy [2]. It also offers good job security. Manufacturing is one of the least responsive market segments to market downturns [1] and many employers are actively looking to add employees.



**Figure 29: Old Sweatshop Working Conditions [10]**

As was suggested by Parady, the poor working conditions that are generally associated with manufacturing are often due to images from child sweat shops, like what is shown in Figure 29. This is not the case with modern factories. The modern factory is a clean, well-lit vanguard of safety like what is pictured in Figure 30. Robots and CNC machine tools automate dirty work, heavy lifting is done with machinery and some factories even run their employees through stretching routines each day for injury prevention.



**Figure 30: Modern Factory Conditions [11]**

This leaves a societal push for post-secondary education as the likely candidate with it consistently being ranked as the biggest factor in preventing people from joining the manufacturing industry and being repeatedly brought up throughout almost every referenced article as an obstacle to manufacturing growth. But what does it mean that society is pushing for post-secondary education over skilled labor? It means that “Professional careers” are considered more valuable than employment in skilled labor positions. In other words, work is being looked down on and labeled as “uncool”. Therefore, this is really the same issue as manufacturing suffering from an undeserved stigma.

If the data is re-examined considering a societal push for post-secondary education and the public stigma against manufacturing to be the same thing, this new issue would consistently be ranked as several times more detrimental to manufacturing than its closest rival, the specialized skill sets required. From the poll posted on CNCZone.com, 52 out of 70 responses would indicate that this new issue is the fundamental cause of the "Skills Gap". Unfortunately, it cannot be easily determined how this new combined issue would compare to the other issues on ranking questions as were used in the surveys for this project. However, due to the fact that this new issue is the combination of the what was ranked as the most significant and second most significant on every question for this project that asked respondents to directly compare the possible causes, it can be safely assumed that this combined issue would be dominantly ranked as the most significant cause of the "Skills Gap".

This is the primary cause of the "Skills Gap". That manufacturing, and skilled labor jobs in general, are considered undesirable because as a society we look down on work and look for easy, cushy jobs. This is the same opinion as expressed by Mike Rowe, host of “Dirty Jobs” in a 2008 TEDTalk [9] where he said “We’ve declared war, on work, as a society, all of us. It’s a civil war. It’s a cold war really.” He goes on to say that one of the places this war is waged is on TV and suggests creating a PR campaign for work to counteract this “war”. This is also the same opinion as held by Titan Gilroy, CEO of Titan Engineering and host of MAVTV’s “Titan – American Built”, who has been quoted as saying “I believe that the hardest thing in manufacturing is changing people’s opinions; changing people’s minds.” [12]

What causes this stigma against manufacturing? As already discussed, images of sweat shops from the 1800's and from China still cloud people's minds when they think about manufacturing. This is a major contributing factor. It is also the author's belief that a major factor in this is what people were taught was cool by TV. Skilled laborers are pictured as laughable in movies and TV shows. To use Mike Rowe's example, "If there's a plumber, he's 300lbs and has a butt crack [9]." Furthermore, the TV that the new generation of manufacturing employees is being taught by, such as the Disney Channel, consistently elevates and glamorizes careers such as being a singer or movie star. This is quite the opposite of any form of skilled labor.

To reverse the "Skills Gap" manufacturing will need to be made cool in the public opinion. The most effective medium for this will most likely also be television. One example of this is MAVTV's "Titan – American Built". The show follows the exploits of Titan Gilroy as he operates his job shop, Titan Engineering, and produces "The world's most intricate parts, completing impossible projects that no other team would dare attempt. [13]" on a quest to "Restore the United States of America as the Undisputed Champions of Manufacturing. [13]"



**Figure 31: Promotional Banner for Titan – American Built**

Also attempting to make manufacturing cool through the use of TV is Edge Factor. Edge Factor is a series of short films aimed at showing how lives and the economy are changed through manufacturing. Edge Factor has also launched a second series called "LaunchPoint" that follows the career paths of real people in advanced manufacturing.





**Figure 32: Edge Factor Promotional Banner**

## **Conclusion**

- It is harder to find qualified personnel to fill specific jobs because the needed skillset for particular jobs has become more specialized. This however is not the primary cause of the "Skills Gap".
- Manufacturing suffers from an undeserved stigma and is popularly considered "uncool". This is the primary cause of the "Skills Gap".
- To cure the "Skills Gap" manufacturing will need to be made cool again.

## **Future Work**

The effectiveness of shows such as “Titan – American Built” and “Edge Factor” at increasing the public opinion of manufacturing should be evaluated. Additional methods for increasing the public opinion of manufacturing should also be explored.

## **Acknowledgements**

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## **Project Proposal**

The manufacturing industry is facing a crisis. Sales are in a definite upward trend. Products that were being shipped overseas are coming back to the US for their manufacture. New technologies make the manufacture of traditional parts faster and less expensive, and previously hard to make parts practical - sometimes even easy. However, there is an overwhelming lack of people to fill the jobs to make the parts to get the sales.

The goal of this project will be to investigate the root causes of this issue and what is already being done about this issue by both the companies looking to hire more skilled workers and by schools trying to train skilled workers. The effects of these efforts will be examined; new techniques and modifications to existing efforts will be proposed and analyzed.

Many individuals have identified this issue and done their own research on it. Most important, as this project will be building off of it, is the IQP *Mind the Gap – Training the Manufacturing Workforce of Tomorrow* (Sears, Adam) which focused on the effects of technical schools.

To achieve its goal, this project will start by gathering data about what is currently being done by both the manufacturing industry and technical schools, what affects these efforts are having and what is limiting these efforts through interview and/or survey. Using insights gained from that data the public opinion about working in the manufacturing industry through survey. Surveys will be designed and the gathered data analyzed in accordance with the principles set forth in *Questionnaire Design : How to Plan, Structure and Write Survey Material for Effective Market Research* (Bruce, Ian) or similar. The data gathering phase will be focused on A-term 2013, allowing B-term 2013 and C-term 2014 for data analysis and write-up.