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Identifying the Need for Trained Machinists in the Greater Tri-Cities Area  
A Survey of Employers to Evaluate the Future of Machining

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A thesis  
presented to  
the faculty of the Department of Engineering  
East Tennessee State University

In partial fulfillment  
of the requirements for the degree  
Master of Science in Technology, Engineering Technology concentration

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by  
Bradley Stufflestreet  
December 2020

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Keywords: machinist, machining, employment, skill gap

## ABSTRACT

Identifying the Need for Trained Machinists in the Greater Tri-Cities Area

A Survey of Employers to Evaluate the Future of Machining

by

Bradley Stufflestreet

Machinists are skilled tradespeople responsible for running a variety of machine tools to produce precision components for end-users or use in other manufacturing. This project identifies the current and future change in the number of machinists in the Tri-Cities area, especially the five-county service area of Northeast State Community College. Using an industry survey, the need for machinists is identified and evaluated to understand local employers' needs. The results indicate industry needs more machinist to keep up with demand, as 6 out of 14 companies have open positions and, 8 reported difficulty filling openings. Furthermore, most companies are growing or stable overall, but have an average 15% of their machinists eligible to retire. The survey results show a need for more students to enroll in programs, such as the Machine Tool degree, or even for regional policy changes to encourage more young people to pursue machining.

## DEDICATION

This thesis is dedicated to those who have helped me get to this point in my life. To Devoid Wright for hiring a young kid with no experience and investing in me, and all my mentors at Wright Tool. To my deans, leaders, and colleagues at Northeast State, who continue to let me teach the next generation all the things I have been so fortunate to learn.

To my parents and my brother Mike, for all your support and helping me along the way. To my “Papa”, who I dearly miss, who taught me more about life and being a man than he ever realized.

To my church family, who keep me grounded and never let me go a week without laughter. Finally, to my Lord and Savior Jesus Christ, who gives my life meaning and purpose. Thank you for the gifts of an able mind and the hands I can work with.

-Brad

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## CHAPTER 1. INTRODUCTION

### *Background*

The career of a machinist gives someone the opportunity to create, by utilizing machines to machine precision parts to make manufacturing possible. While this career is rewarding for those who pursue it, the current skills gap is creating an unfilled need for machinist. Local employers are starting to struggle to find enough employees to fill all their open positions and are worried about being able to fill future openings, a common concern for manufacturers across the nation. (National Association of Manufacturers, 2020) There has also been an increase in programs and media that are promoting technical trades and describe the current skills gap between the jobs that will be available versus the skilled workers available. (Giffi, et al., 2015)

From a more personal level, for the past 9 years, I have worked as an instructor in the Machine Tool Technology department at Northeast State Community College (NSCC). I started as an adjunct instructor and moved into the full-time position eight years ago. During that time, I have worked with numerous local companies to help them find new employees to fill their need for machinists. During my tenure, I have noticed an upward trend in the number of companies that contact the school, and myself, looking for machining students to employ. From this, I am personally motivated to define the opportunities and market for the students who enroll in this program. What kind of job market will be available to graduates as they start seeking employment, and will this region's needs continue to grow?

The job of machinist is often misunderstood or poorly defined for people unfamiliar with the career. People often visit the facilities on campus, whether other college employees, current or future students from different majors, parents, or other visitors who don't understand the career. Many times, the questions focus on what students will be learning as part of the

program. Quite a few of these questions seem to be from people who do not differentiate a machinist from a mechanic or a maintenance technician. To further exacerbate this problem, many companies use the job title of machinist to describe a variety of responsibilities.

### *Problem Statement*

There has been a noticeable increase in companies contacting the school for help to find new employees, indicating there is a strong need for new machinists in this area. However, the Bureau of Labor Statistics information for Machinist and Tool and Die Makers (these two job titles are listed together), the job outlook is only 1% expected growth from 2016 to 2026. (Bureau of Labor Statistics, 2020) This still leaves the question, is there more potential growth in our immediate area than predicted by the Bureau of Labor Statistics, or is another phenomenon is occurring? Are only the few companies that are in need of new employees reaching out to the college, while the rest are as stagnant as that 1% growth would indicate? Much as a police officer who only arrests criminals may begin to think there is an abundance of crime.

Any attempts to research an answer to this question, generally show one of two results. Either the information is geographically broad covering the nation or entire state, or the information covers a multitude of job titles all grouped into one data set. Many of these sources fall into both categories and only represent a need for technical trades in the nation as a whole. This general information still leaves doesn't explain the need for machinists in the Tri-Cities and surrounding area. While some of these reports show positive trends for the future, the broad data set just can't be applied to the small geographic area that NSCC students are seeking employment in.



### *What is a Machinist?*

Many people are unclear what the job title of machinist really means. People commonly confuse this job for a mechanic or industrial maintenance technician. Webster's dictionary (Merriam-Webster, n.d.) gives three definitions for a machinist:

1. *A worker who fabricates, assembles, or repairs machinery*
2. *A craftsman skilled in the use of machine tools*
3. *One who operates a machine*

While these definitions give an idea of what a machinist is, the definitions are still vague. The second definition seems to most closely match the job title as it appears in our region. The Bureau of Labor Statistics gives a more thorough definition that can be summarized as: a machinist is someone who uses machine tools, such as lathes, mills, drills, grinders, and other precision machines, to produce precision parts, primarily from various metals. They are responsible for reading engineering drawings, determining necessary operations and processes, machine operations, and inspection of the part during and after production to ensure quality. Additionally, many modern machinists use both traditional manually operated machine tools as well as CNC (Computer Numerically Controlled) machines to produce parts with high precision. Components produced include everything from simple fasteners to complete industrial assemblies, automotive components, aerospace items, medical and surgical implements and implants, and an unending list of other precision components used throughout the manufacturing industry.

### *Proposed Objective*

While there could be many questions to ask local companies about the machinist they employ and the work they do, this project will focus more specifically on the workforce of

machinists and the need for new entrants to this career field. In the design of the survey and analysis of the results, the primary questions to answer are:

- Are local companies that employ machinists growing as a business?
- Do these local businesses need more machinists?
- If companies need machinists, are they successful in finding good employees?
- Are there a significant number of machinists in our area that can retire?

The goal is to create, distribute, and analyze responses to a survey sent to area companies that identify machining as a primary business function, as well as companies that employ large numbers of machinist in support roles, such as Eastman Chemical Co. and some of our other large manufacturing companies in the area. The survey would go to companies across the five-county service area of Northeast State Community College; Sullivan, Washington, Johnson, Carter, and Unicoi counties to focus on those companies who would be most likely to hire community college graduates with an Associate's Degree of Applied Science with a concentration in Machine Tool.

## CHAPTER 2. RESEARCH LITERATURE REVIEW

In the process of researching data relevant to the state of the machining industry, most of the available data is rather broad. Either sources, such as the Department of Labor, give numbers and statistics for the nation or possibly broken down by state, or the data is not specific to a single job, as is the case with the Manufacturing Institute's publications. The inspiration for this study also severely limits the number of outside resources available to gather data from.

### *Deloitte and the Manufacturing Institute*

Since 2001, Deloitte and The Manufacturing Institute have published multiple reports on the skills gap and how it affects manufacturing in America. These reports, specifically the 2015 report, were the inspiration for this project as they show a significant need for new employees to enter the manufacturing sector. Throughout these reports, the authors detail the increasing need for skilled workers to fill open positions in the manufacturing industry. The primary focus being how retiring workers and a growing economy are leaving open positions that are unable to be filled. This phenomenon is defined as the "skills gap."

From their 2015 report entitled "The Skills Gap in U.S. Manufacturing 2015 and Beyond," the authors predicted that approximately 2 million manufacturing jobs would go unfilled by 2025. An updated report was published 3 years later titled, "2018 Deloitte and The Manufacturing Institute Skills Gap and Future of Work Study" and expands that number to 2.4 million unfilled jobs by 2028. Part of this growth is detailed as a result of the rapidly growing economy in America since the new presidential administration took office in 2017.

Unfortunately, all the reports from The Manufacturing Institute are focused on the United States as a whole and do not disaggregate the data to any specific region. Furthermore, they only separate the data into two subcategories; skilled production workers and engineering related

professions. Of these two categories, the job of machinist would fall into the skilled production worker category.

The updated 2018 report opens with the following statement:

*The United States is experiencing near-historic low unemployment amid an extended period of economic expansion. The skill shortage that Deloitte and The Manufacturing Institute have been tracking for the past 17 years continues to swell, threatening to impede the current growth in the US manufacturing industry.*

Based on this statement and other facts from the report, the authors fear that the shortage of qualified workers will be so significant as to slow the growth of manufacturing in America. The 2018 report goes on to describe a shift in perspective that has occurred since the 2015 publication was written. Previously the surveyed executives ranked “retirement of baby boomers” (Giffi, et al., 2015) as the most significant challenge they faced. Three years later, however, the new number one concern was a “shifting skill set due to the introduction of new advanced technology and automation.” (Giffi, et al., 2018) The retirement of senior employees fell to third place, behind the “negative perception of students/their parents toward the manufacturing industry.” The authors list two specific examples of the type of technologies that are creating challenges for new employees, the need to program CNC machines, and the ability to interact with CAD/CAM software. Both tasks are almost exclusively machinist related skills used for more automated manufacturing processes.

*National Association of Manufacturers*

Each quarter the National Association of Manufacturers surveys American manufacturing companies to determine the outlook for the Manufacturing over the next calendar year.

Respondents are asked about their expectations for the next year for their company. Specifically, the expected change in their sales, production levels, prices, materials cost, number of employees, capital investment plans, employee wages, and other details of their business. The survey goes further to ask about expected challenges, before asking categorical questions about company size and specific market. At the end of each quarter, the survey responses are published as the NAM Manufacturer's Outlook Survey.

As of the first quarter of 2020, "attracting and retaining qualified workers" was listed as the biggest challenge facing the largest percentage of companies. The ability to grow their workforce had been the main concern for companies for the previous two and a half years of the report. This challenge was only unseated after the beginning of the COVID-19 pandemic early in the second quarter of 2020 but remained a major concern. During the previous 10 quarters, as many as 70% of responding companies listed finding skilled workers as their biggest challenge.

The first NAM Manufacturer's Outlook Survey was published on March 18, 2020, with the actual survey being filled out during the last 2 weeks of February. From this report, 75.6% of the respondents were optimistic about their own company's outlook. Company's expected growth in full time employment of 1.1% over the next 12 months and capital investment growth of 1.9 percent. These figures reflected a stabilizing economy after trade concerns in 2019 and a positive outlook for 2020.

After the COVID -19 outbreak in America becoming a life altering pandemic in March of 2020, the next quarterly report was published May 28, with companies completing the survey between May 4 and May 15. This report showed the impact of the pandemic, as respondent's positive outlook for their own company's fell to under 34%, the lowest since the first quarter of 2009. The expected change in full time employment for the next 12 months is an average

decrease of 2.2% and a decrease in capital investments of 2.5 percent. Furthermore, the report goes on to say manufacturer's production fell 18.5% between February and April of 2020.

Even after the rise of the COVID pandemic, over 50% of the companies still listed finding qualified employees as a major concern. No information is available yet as to how the pandemic will affect retirement rates of senior employees and if this will cause additional concerns. As the pandemic continues to affect the economy, the total impact is still undetermined.

#### *Bureau of Labor Statistics*

The United States Bureau of Labor Statistics (BLS) provides data for evaluating the labor force in America. Their focus is to provide factual data concerning employment, without bias or opinion. The United States employed 383,470 machinists earning an average of \$46,120 annually as of May 2019. This data showed a decrease of 880 jobs from the previous year, but an increase in average salary of \$870 a year.

According to the BLS, there were 9,460 machinists employed in the state of Tennessee, earning a mean salary of \$44,410 each year. In comparison, BLS data from May 2018 showed only 7,690 machinists in the state of Tennessee. Therefore, there was an increase of 23% in machinist for the state overall. Based on the May 2019 data, an average of 3.15 out of every 1,000 workers in the state, were working as machinists. In comparison, the highest employment of machinists per 1,000 is in Indiana at 6.39 and the lowest is Hawaii with 0.44. Of the states neighboring northeast Tennessee, Virginia has 1.99 machinists per 1,000 employed persons, and North Carolina has 2.67. Each of these numbers covers the entire state regardless of distribution in the state.

The location quotient defines how reflective an area’s economy is of the nation as a whole. A labor quotient of less than 1.0 would indicate a region has less of a specific job than the national average, while a quotient of greater than 1.0 would indicate the area has more than the average. For the state of Tennessee, the labor quotient is 1.2 for machinist. This value indicates that Tennessee has a higher than average concentration of machinists when compared to the United States as a whole.

*Table 1 – Bureau of Labor Statistics* Local Information taken from the Bureau of Labor Statistics interactive map on their website.

Area	Total employees listed as machinists	Machinist per 1,000 workers for this area	Location Quotient	Average Salary (yearly)
Johnson City	130	1.69	0.65	\$36,580
Kingsport- Bristol (TN & VA)	310	2.67	1.02	\$48,210
East Tennessee – Non-metropolitan area	440	3.38	1.26	\$39,820

Within the interactive maps on the BLS website, data is available for smaller regions of the country. Table 1 shows the data from this interactive map for the regions that best match up with the area of focus for the survey. The boundaries of each specific region are unclear from the map, and some areas cross state lines, as shown in the table. While this data doesn’t match the counties exactly, it gives a more local perspective.

## *The Skills Gap*

American Machinist. American Machinist, a national journal focusing on the machining trade, describes the issues faces manufacturers in a June 2016 article. “One of the greatest challenges that manufacturers must address now is to convince a new generation of workers to make the same career choice they made a generation ago.” (Weber, 2016) This article goes on to address the knowledge gap that college graduates and experienced workers face, as 90% of employees feel they must update their knowledge and learn new professional skills to stay current in their industry.

The major theme of this article is a focus on new and diverse training to help current and future employees find the skills they need to satisfy the demands of modern manufacturing. The author lists three technique; make training mobile, make training easy to digest, and teach skills that can’t be found elsewhere. Using these three approaches, the article describes benefits that will help to narrow the skills gap and make workers more effective in their positions.

Presidential Executive Order. A recent Executive Order, signed by President Trump on June 15, 2017, also reinforces the need for more trained employees to enter the manufacturing sector. The executive order, “Presidential Executive Order Expanding Apprenticeships in America,” focuses on creating more opportunities for training, especially Department of Labor recognized apprenticeship programs. In this order, the President cites there are 350,000 manufacturing jobs currently available and insists “Federal programs must do a better job of matching unemployed American workers with open jobs.” (The White House, 2017) Apprenticeships are described as a method for addressing this issue, and a way for American workers to become more qualified for the available manufacturing jobs. Defined as paid



opportunity to get relative work experience, apprenticeships help individuals develop the skill employers will value.

The Middle Skills Gap. The middle skills gap is a phenomenon described by David Cantor in an analysis from The 74 Million. (Cantor, 2018) In this article, Cantor discusses the large percentage of jobs available in America that require some level of education between a high school diploma and a 4-year college degree. The article focuses specifically on jobs where a 4-year apprenticeship is common for new hires to gain the necessary skills to be successful. The concept that a four-year degree is not the only path for a high school graduate to take and be successful is emphasized.

Furthermore, it is commonly overlooked how recently a four-year college degree became normal. As recently as the 1970's, before computers became commonplace, just 20 percent of jobs in America required more education or training than a high school diploma. In the modern workforce, 60% of jobs require education or training beyond high school.

### CHAPTER 3. RESEARCH METHODOLOGY

A survey was created with the goal determining the employer's current and future needs for machinist. The primary focus of the survey is the current state of the company's business, their current needs for new employees, and the timeline for hiring new individuals.

Unfortunately, the manufacturing sector in general is somewhat unpredictable, so questions that would ask the companies to predict the future of their companies were avoided. Instead, an accurate measure of the current status of the industry, in comparison to past national studies, should give an indication of future trends.

The companies were identified using the First Tennessee Development Districts' published "Directory of Manufacturers." (First Tennessee Development District, 2016) This directory includes NAICS<sup>1</sup> codes to identify those companies that define machining as a primary business. Furthermore, the directory would also allow very small companies to be excluded, since companies with less than 5 employees may not be a good indication of the overall industry. Also included are the primary contacts for each company so the survey could be sent directly to the correct person at each business. Company websites and personnel contacts established at NSCC will round out the research to contact identified companies.

By analyzing this information, it would be possible to assess the overall state of machining and machining positions in the region. This information will be very valuable for companies to plan and manage their expectations of the challenges of hiring future workers. These results would also help to boost educational programs if the results showed a major need for new employees in the future. Furthermore, local companies may be interested in the results to influence how they hire or pay their employees.

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<sup>1</sup> NAICS stands for North American Industry Classification System and is used by federal agencies to classify businesses as they collect, analyze, and publish industry data. (United State Census, n.d.)

## *The Survey*

The survey consists of a total of 12 questions targeted towards different areas of the company and their needs. The initial questions work to define the company, how many employees they have, and the wages those employees are paid. Next, the survey works to define the needs of the company, specifically their need for employees and how they are going about finding those future employees. The last section of the survey hopes to determine the future needs of the company based on how the company is growing and the number of current employees who are able to retire. A complete copy of the survey, as sent to employers is included in Appendix C.

Defining the Company. The initial questions asked the company about their machining applications, and whether they are primarily focused on creating machine products or if their company encompasses other manufacturing as well. For some of the companies surveyed, the main focus of the company is to create machine products to be sold to a third-party, this would be representative of what are commonly referred to as “job-shops.” Generally, these companies take orders from other manufacturing companies, or even independent customers, and produce machine parts based on the specifications they are given. There are also companies that were surveyed whose primary function is manufacturing other products, and machining is simply a support role for their company. They employ machinists in their maintenance department to create or repair components of the machines they use in their other manufacturing. Also surveyed were companies that fall somewhere in between, that make machine products as part of their manufacturing but not as the whole focus of the company. Identifying this difference is important, as it changes the type of machinists that are practical for the company to hire. Companies who produce machine products and sell them to third parties as a major component

of their business, are more likely to need lower skill operators as opposed to the maintenance machinists that are commonly required at a company making repair parts to support their other manufacturing operations.

The survey asked companies to choose one of the following choices:

*Machined products are our primary business and are sold to a third party.*

*Machined products are a portion of our business and are sold to third parties.*

*Machined parts are a portion of our business, used to produce a final part or assembly that is then sold to a third party.*

*Machined products are produced to support other business functions, such as repair parts, and are not routinely sold to a third party.*

The next portion of the survey asked the company to divide up their machinists into the three skill levels: unskilled or untrained machinist, entry-level or apprentice machinists, and high skill level or journeymen machinist. Each of these different levels would require a different education level, whether formal training or on-the-job experience, and would show different challenges for each company. The unskilled or untrained machinist category would include those individuals who run production machines and are not generally responsible for major adjustments or significant process control. Generally, these employees could also be considered operators or machine technicians, but because of the broad definition for machinist they may also be included in this category at most companies. Without asking the companies to identify how many of their machinists are at this level, the data can be difficult to interpret since the company may have a large number of untrained operators with the job title machinist skewing the numbers for their high skilled machining positions.

The second level, entry-level or apprentice machinists, are those employees who are on track to become high skilled or journeymen machinist but just haven't reached that level yet. Many of these employees are to be in some form of training whether it be a formalized apprenticeship program or an informal education on the job. Both the employee and the company's goal for this person should be to move them up at some time in the future to a higher skill position with more demands and responsibilities. Typically, these are the employees who will be hired after some training such as an Associate's degree in machining or a technical certificate in machining.

The third and final group, the high skill level or journeymen machinist encompasses those individuals who set up and maintain processes, without the need for frequent supervision. These individuals can make significant adjustments and repairs without assistance and in many cases are going to have a journeyman's card after completing a Department of Labor apprenticeship. In general, these individuals need to have significant work experience, beyond an initial training program such as an Associate's degree or technical certificate. The Department of Labor estimates 4 years for an employee to finish an apprenticeship as a machinist (Apprenticeship.gov, n.d.). These positions would be the most difficult to fill for most companies due to the required experience. Most companies promote these individuals from within so that their on-the-job experience is consistent with the operations of that specific company. Unfortunately, these are also the individuals who are most likely to retire and leave the company with a huge void in knowledge and experience.

In order to identify how the companies' experience levels are spread out, the next question on the survey asked them to identify how many of each of these three levels they currently employ. This data was used as a baseline for the next two questions, the first of which

is to ask what the average hourly wages for each of these three levels of machinists. Any company whose wages are identified as outliers from the sample data would skew the results of the other questions in the survey. A company with significantly lower wages may be unable to attract employees regardless of the availability of those employees. Conversely, a company paying substantially higher wages would be less likely to experience a shortage of applicants since they would generally be able to encourage employees to leave other companies in order to seek higher wages.

The Company's Needs. Once the company and their employees are defined, the next questions worked to determine the current needs of the company. To start this question, the survey asks if they have any open positions. If "yes" they will be asked how many openings in each of the three skill levels. Used in conjunction with the data from the previous question of how many of each skill level the company employs, this could give a percentage of how many employees the company is currently seeking to fill necessary roles. Extrapolating from this and the number of employees from the previous questions, it is possible to identify the vital few versus the trivial many for companies, as multiple openings at a very small company may be more significant than a large number of openings at a very large company. Furthermore, the distribution of these openings can show a company that is facing long term challenges in hiring.

Following these questions, the survey moves towards identifying how much trouble employers are having finding qualified applicants by asking: "How long (in weeks) does it take your company to fill an entry level position for a machinist?". Long hiring times would point towards a shortage of available candidates for each company to hire, especially if the times are significant for all companies. To better quantify this information a follow-up question asks each company to rate their difficulty in finding qualified candidates on a five-point Likert style scale.

Since the timeline for hiring could be significantly impacted by a company's hiring practices, this hopes to eliminate that variable from the responses.

*How would you describe your company's recent success in finding machinist to fill your open positions?*

Available answers employers picked from:

*We are usually successful in finding a qualified candidate quickly*

*We are able to find a qualified candidate, but not always as quickly as we would like.*

*Qualified candidates are difficult to find, and jobs stay unfilled for long periods of time.*

*We are unable to find qualified candidates and our business suffers as a result.*

*We are unable to find any qualified candidates and have to hire and train someone to fill open positions.*

To follow up on these questions, the next two questions focus on what challenges companies are seeing with individuals they interview or try to hire. These questions asked companies to identify what specific challenges they are seeing with the machinist applicants. While a company may have many applicants, they may not be good candidates for the position available. The responses to this question include issues such as poor technical or job-related skills, failing pre-employment testing, poor soft skills, or refusal to work at the offered compensation level. Responses such as refusal to work for the compensation level offered could point to a company issue, while many companies reporting poor job specific skills could show a lack of qualified candidates available for hire.

The next question looks to identify what methods a company uses to recruit potential applicants, specifically what medium they used to advertise open positions such as: newspaper classified ads, online postings, staffing agencies, or just word-of-mouth to recruit potential employees. Also, with younger generations' dependence on technology, older advertising methods may no longer be successful in recruiting employees to these companies. If there is a correlation between high success in finding new employees and the advertising methods used, this could indicate that the challenge for some employers is just the way they are seeking their applicants as opposed to a shortage of potential employees.

In order to identify the need for education prior to employment, the next question asked, "How important does your company feel that an Associate's Degree or technical certificate in machining is for an entry level position?" This question uses a five-point Likert rating to determine whether companies feel an Associate's degree or a technical certificate are a necessity for applicants. As a technical certificate or Associate's degree are the primary means of training available in this area, this would show if companies want potential employees trained prior to applying for a position. The Associate's degree is available from Northeast State Community College, while technical certificates in machining are available from the Tennessee Center for Applied Technology, with the nearest campus being in Elizabethton.

Future Needs. After reviewing the report from Deloitte and the Manufacturing Institute about the widening skills gap, the next question asked companies

*"Looking towards your future hiring needs, what percentage of your workforce (specifically machinist) are currently eligible to retire?"*

If a significant percentage of the workforce is able to retire, this would indicate the future need for these positions could grow very rapidly if the current individuals in these



positions choose to retire. From the other research reviewed, this is major concern for industry employers. (National Association of Manufacturers, 2020)

The final question of the survey asks the company to describe the current state of the company as a whole. Specifically, whether a business is currently growing, shrinking, or generally stable at this point. Not only will this question give insight into the current state of companies that employ machinist but may also indicate if the success of the company and their ability to hire new employees is related. Obviously, a company showing significant growth is more likely to be hiring new employees compared to a company that is stable or declining. Once again this will help identify root causes of potential variables that could skew the data from the other questions.

The overarching goal for this survey is to find out as much data relative to the company's current status as possible. Especially in their machining department and their need for machinists at any skill level.

### *The Participants*

The 2016 Directory of manufacturers published by the First Tennessee Development District in Johnson City (First Tennessee Development District, 2016) was used to identify companies for the survey. The initial list of companies was defined by the following criteria;

- More than five employees, as listed in the directory
- A part of the five counties served by Northeast State Community College; Sullivan, Washington, Unicoi, Johnson, and Carter.
- Business related to, or directly involving machining, especially any company identified by the NAICS code 332710 as a machine shop.

While many of the companies on the list utilized the code for being a machine shop, others are primarily focused on producing other products and machining supports this manufacturing. Knowing very small businesses could generate less consistent data, they were eliminated from the survey pool. Some of the very small machine shops, may not have any turnover for many years, especially when the employees are family as well. Once the companies were identified, the survey was sent to the company by email, either through a known contact or to the human resources department. In a few cases, phone calls were made to identify the best person, or to follow-up with companies that did not respond to the initial email.

#### *Data Analysis Process*

After gathering all the data from individual companies, the data were compiled and presented in order to draw reasonable conclusions. In order to protect the company's identities, the individual data were separated from the company and kept anonymous in all the analyses. Included in the attached appendix is a list of the responding companies as well as the original survey results. The companies were made aware that they would be listed but not tied to their own data in the email asking them to complete the survey, in the hopes that anonymity would encourage honesty in completing the survey.

All calculations, such as standard deviation, were made using the data analysis package in Microsoft Excel.

#### *Conducting the Survey*

Once the survey had been created, the entire survey was submitted to ETSU's Institutional Review Board (IRB) to ensure the questions asked were appropriate. The IRB agreed that the study questions were not related to human testing and that no oversight on their

part was required. After receiving this approval, the survey was sent to companies through email first, then phone calls were made to follow-up with companies that did not respond.

## CHAPTER 4. SURVEY DATA ANALYSIS

The survey was sent to thirty companies within the five-county service area of Northeast State Community College. ETSU's RedCap Software was utilized to distribute and collect responses for the survey. A total of 14 responses were received with a response rate of 47%. Unfortunately, during the process of collecting the data from the survey, the American economy faced an unprecedented challenge, as the COVID-19 pandemic forced the nation into quarantine. Eleven responses were received during January, February, and the first weeks of March, before having to postpone the rest of the research until after the first wave of the pandemic subsided. The remaining 3 responses were collected in July and August. The pandemic changed the American economy drastically and suddenly at every level. While most of the manufacturing companies were considered essential and continued working, the pandemic still affected them, especially their supply chains. Due to the pandemic, it became very hard to get in touch with the companies who had not completed the survey. Many of the companies were just too overwhelmed with adapting to the changes mandated due to COVID-19, and completing the survey was not their priority.

*Table 2 Number of Machinists at Each Company* - The chart above shows the number of machinists working at each of the responding companies. The mean of the data set is 23.

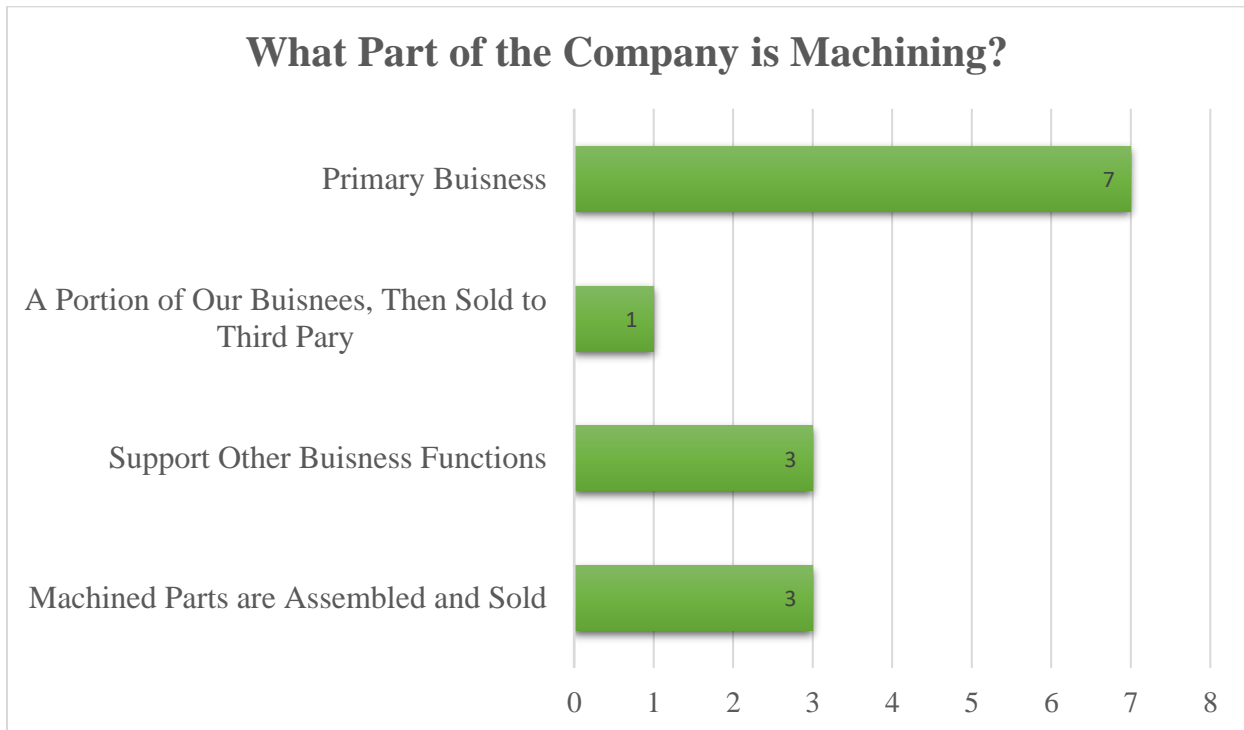
Number of Machinist at Each Company	
Less than 5	3
5-10	5
11-30	3
Greater than 30	3

The companies that responded to the survey covered a wide cross section of employers, with total employee counts as low as 6 to as high as almost seven thousand employees. Each of these companies represents a unique part of the market, with some being primarily “job shops” that take in outside work, to companies focused on machining products they then sell directly to individual end users. Some of the shops, however, are only doing maintenance work to support a larger operation, while others are a link in the manufacturing chain of complex systems. Figure 1 shows the distribution of the respondent’s answer to “Which of the following best describes the machined products produced at your company?”

### *Current Machinist*

Companies were asked to divide their machinists into three skill categories, then list how many of each category they employed, as well as an average wage. The division of worker’s skills varied significantly from company to company. In order to reasonably compare companies of various sizes, the raw data was converted to percentages of the total number of machinists working at each company. A median value of 7.5 was calculated for the data set, with an average number of machinists reported was 23, however, the data is significantly skewed with a standard variation of 37. This is due to one company reporting 140 machinists and another with 55 raising the average significantly. Table 2 shows the distribution of reported numbers of machinists at each company. The lowest reported numbers were 3 machinists at one company and another company with 4. Eight of the companies reported less than 10 total machinists at any skill level.

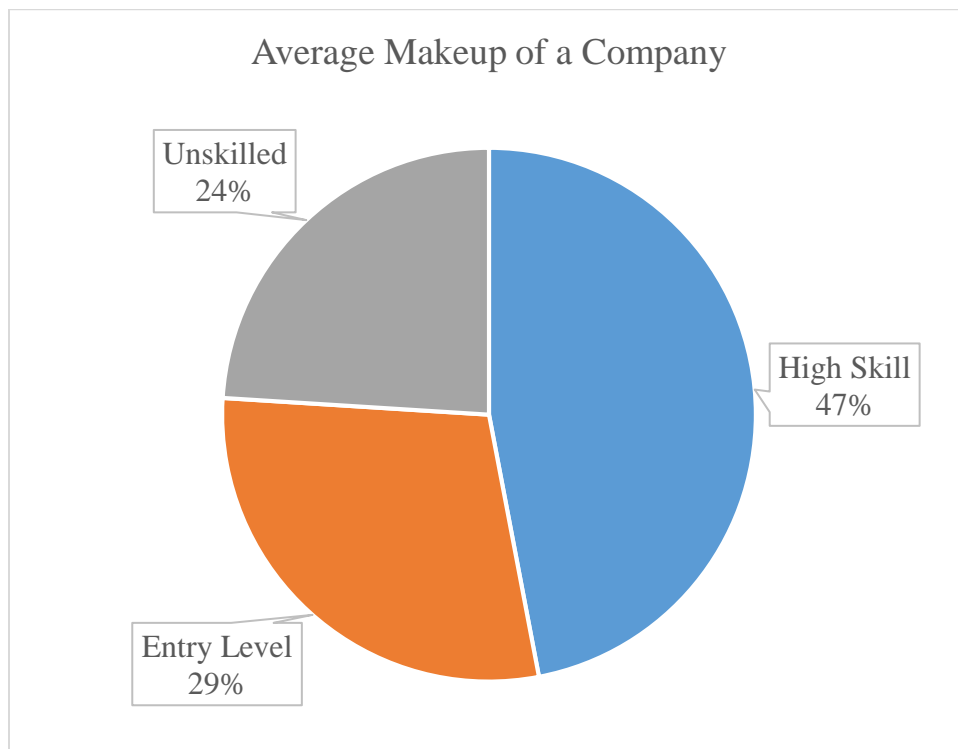
*Figure 1 – What Part of the Company is Machining?* – Companies were asked to describe what part of their business was directly related to machining. Of the responding 14 companies, half considered machined products to be their primary business, while only one company said that machined products were a portion of their business and sold to a third party. Three companies reported their machining was in support of other business functions, such as an in-house maintenance shop. The remaining three companies produced machined parts that were then assembled and sold to a reseller or directly to the end user.



Multiple companies reported having zero unskilled workers, implying all their machinists are actively engaged in a training program. On average companies responded that 23.7% of their machinists would be considered unskilled with no training program in place to advance their skillset. Figure 2 shows the distribution of workers in a company, based on the mean workers at each level for all the companies that responded to the survey. The average wage for this skill level was \$14 per hour based on the ten companies that reported a wage for this level. The highest hourly pay was \$22 and the lowest \$10 per hour, with a standard deviation of 3.5 for the data set. One company declined to provide wage data, while the other missing numbers were from the companies that listed zero unskilled workers in their response.

Only two companies in the survey reported having zero entry level workers, or machinists who are receiving some form of training, whether informal on the job training or a formal training program such as an apprenticeship. On average 29% of the workforce of these companies was described as entry level, with some companies reporting almost 70% of their machinists at this level. Eleven of the fourteen companies reported the hourly wage for these employees, with an average of \$15.94 and a standard deviation of 3.7. The highest pay was \$24, while the lowest was \$11 per hour.

*Figure 2 Average Makeup of a Company* – This graph shows the average distribution of a company based on the divisions used in the survey. Calculations were made by averaging the percentage of the workforce described as each level at each company.



In evaluating the high skill positions, companies reported their workforce as being comprised of 47% high skill machinists. These are machinists who are well versed in all aspects of their job and require minimal or no assistance to produce parts and carry out their tasks during the workday. Many of these machinists may have also completed an apprenticeship program and

be recognized as journeymen in the trade. In this data set, two companies reported that all their machinists fell into this category. Thirteen of the fourteen respondents included wages for this level, with an average of \$22.78 an hour, and a standard deviation of 4.0. The highest paid employees in this category made \$30 an hour, while the lowest wage was \$18.

*Figure 3 – Distribution of Wages* The figure below describes the distribution of wages for each of the three categories. The box represents the middle 50% of wage data for each position or 25% above and 25% below the mean. A horizontal line through each box represents the median of that data set. The tails above and below the boxes indicate the remaining 25% of the data for both the maximum and minimum. A single point above the entry level data is a statistical outlier at \$24.00 an hour.

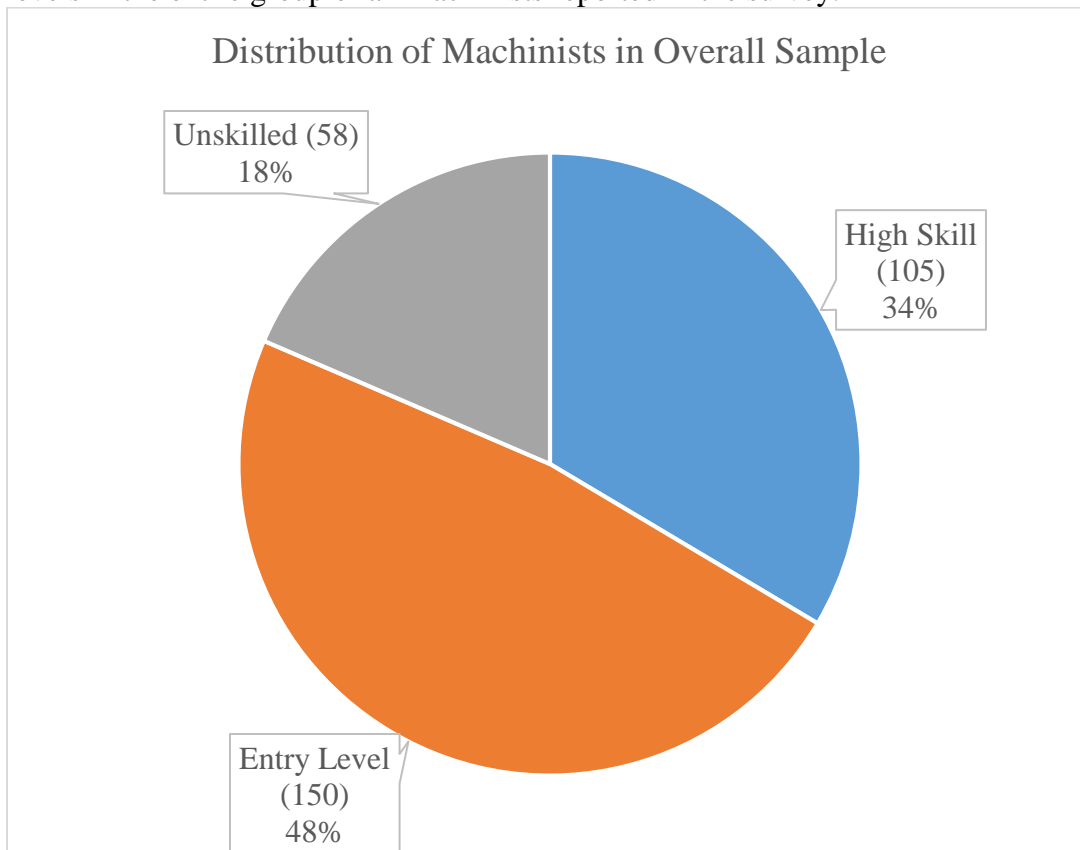


Based on the percentages above, it would appear that there are more machinist in the region in the high skill bracket than the other two levels. Further analysis reveals this is not the case, as shown in Figure 4, for the overall distribution. By adding up the total number of



machinists reported by all companies, 313, and comparing that to the number reported in each category, the numbers look quite different. The unskilled category represented 58 of the 313 machinists or 18.5%. Entry level machinists were 150 of the 313 reported or 47.9%. Finally, the high skill category included 105 of the 313 total, making them 33.5% of all the employees represented in the survey.

*Figure 4 – Distribution of Machinists Overall Sample* – The graph shows the distribution of skill levels in the entire group of all machinists reported in the survey.



The difference between the average make-up of the company and the percentage of the entire sample is most likely because every company feels that they have high-skill workers, but not every company says they have entry level or low-skill machinist. Four companies reported no low-skill employees, and two companies said they had no entry level workers.

### *Open Positions*

Next, the survey asked companies if they had any currently open positions and at what skill level. Six of the fourteen respondents stated they had open positions right now. The companies reported 9 open positions for the lowest skill bracket, 9 positions for entry level personnel, and 12 for the highest skill level. This is a total of 30 open positions compared to the total of 313 machinists in the survey. One company reported having 15 open positions at a single facility, while another company had 12 machinists employed, but is looking to fill 7 more openings.

While open positions could indicate that companies are having a hard time finding good candidates to hire, this isn't a definitive cause and effect. Therefore, companies were also asked to describe their success in finding new employees. Only two companies selected that they were "usually successful in finding a qualified candidate quickly" on the survey. While four companies said they hadn't filled an open position recently enough to judge, seven companies reported they have difficulty filling open positions. Some of these have so much difficulty, they have been forced to hire inexperienced personnel and train them in house.

Regarding the number of open positions, the next questions asked for the average time to find a qualified candidate to fill an entry level position. While the range of answers varied from 1 week up to 40 weeks, on average it took companies 7 and a half weeks to fill an open position. The primary reason reported at all skill levels for this was a "Lack of technical or job specific skill." For high skill positions, companies reported the second most common factor to keep applicants from being hired, was an unwillingness to work at the offered compensation level. Entry level applicants were most frequently not hired because of their poor soft skills that limited

their success. This survey question included examples of poor soft skills, such as unprofessional in the interview, won't show up to work, uninterested in work, or easily distracted.

As companies try to find the employees they need to fill open positions, more companies used online job posting boards such as Indeed.com or Monster than any other medium.

Respondents were asked to mark all responses that apply on this question, with newspapers and staffing agencies tying for second place. Three companies also reported that their employees help spread the word about available job openings.

In determining what employers were looking for in potential employees, the next question asked about their preference for applicants to have a college degree or technical certificate when applying. Over half of the company's responded that it was important to some level that potential hires have a degree. Only two said it was not important to them, while the remaining 4 were indifferent.

For anyone looking towards machining as a career path, the implication is that it is important to start with a formal training program. One of the most common paths is an associate degree at a community college, that gives the student the necessary skills to begin working as a machinist. With over half of the responding companies valuing a degree, completing college prior to employment will allow a new employee to quickly begin growing their skillset. Helping them to advance rapidly, not only in their position but in pay and benefits as well.

#### *Retirement*

When asked about employees being eligible to retire, companies responded that as many as 45% of their current machinists were retirement eligible at the time of the survey. Even with 3 companies responding that they had no one eligible to retire, the average of responses was almost 15%. The implications of this number are that there are over 45 machinists that could

choose to retire at any time. This number alone shows a major need for more machinist, but when combined with the current job openings and the struggles companies are already having filling positions, the outlook is that filling these openings will not be easy. Further complicating this fact, is that retirees are more likely to be senior members of the staff with years of experience and knowledge that cannot be quickly replicated.

### *Summary Results of Survey*

Retirement eligible employees, stable growth, and an already insufficient workforce indicate that companies are going to struggle to find the machinist they need to stay competitive. These three factors are the most compelling results to suggest that the skills gap should be a major concern for local industry that employs machinist. While many reports and studies forecasted a future shortage of workers, this survey finds it is a current issue that is already creating challenges for our local industry. (Giffi, et al., 2015; National Association of Manufacturers, 2020)

The survey respondents were quite similar in describing the state of their companies. Of the companies surveyed, 64% said they were currently growing at a steady rate, while seven percent said they were growing at a significant rate, and another 21% said their company was stable. Therefore over 90% of the companies surveyed reported growth at the company level, further reinforcing the need for more machinist to fill openings at growing companies. While steady growth may not require every company's workforce to increase immediately, the overall growth of so many companies indicates that as a whole, they will need more qualified workers to keep pace with their growth.

Almost half of the responding companies had open positions in their facilities. Some with numerous openings they were trying to fill, indicating a current need for machinists. Not

only did they have open positions, but the average time to fill an open position was over 7 weeks. Long enough that half of the companies said they have a difficult time filling positions and the job stays open for a long period of time, or that they must hire unqualified people and train them to fill open positions. This means not only are the companies struggling to find qualified workers, but they may have to work shorthanded for long periods of time, potentially affecting their overall business.

Struggling to find the qualified candidates they need, while trying to grow a business is a major concern for manufacturers, not only in this area but throughout the country. (National Association of Manufacturers, 2020) Based on just these two parts of the survey, it is obvious that machinists are a needed resource for our local manufacturers. A lack of machinists could become significant enough to impair their growth or force them to seek out another solution, such as relocating.

Retirement is also a major concern for employers, as almost 15% of the machinist represented by the sample are already retirement eligible. Retirees are also more likely to be in the high skill category as a result of their years of experience, further complicating the problem. From employers who visit NSCC, many have voiced the concern that they will lose a significant amount of “knowledge” in the coming years will be irreplaceable as their most senior people retire. Knowledge that cannot be quickly passed down or relearned by new hires, leaving them with a team that overall has a lower average skill level. Furthermore, the survey found an average of 15% of employees are retirement eligible which indicates that out of the 313 machinists represented in the survey, 47 could retire at the time of the survey. If all these employees retired, the number of open positions would more than double, creating even more demand and making positions stay open even longer than the average 7 weeks they are now.

A need also exists to continue encouraging students to pursue an associate degree or similar training in machining. With over half of the respondents saying the degree is important to some extent, and the continued growth of computer skills in the machine shop, some formal training could help those students start a career. The current five-year placement rate for Northeast State's Associate Degree with a concentration in Machine Tool is 98% indicating a demand for machinists in this area (Northeast State Community College, 2019-2020).

## CHAPTER 5. CONCLUSIONS

In seeking to determine the current state of the machining industry in the Tri-Cities region, an industry survey was created and sent to local companies. Fourteen companies responded, giving insight on the machinist they employ, the current needs of the company, the challenges they face as they look for new employees, and the eligibility of their current machinist to retire. The survey results were compiled and analyzed, showing there is a major need for machinists in the Tri-Cities region, both to support the current growth of local companies and to offset the significant number of machinists who are eligible to retire.

The survey showed almost half of the companies had open positions for machinists they were trying to fill, with the average time for companies to fill an open position being 7 weeks. Furthermore, almost all the companies, 93%, said their companies were stable or growing, indicating the workforce will continue to grow.

The retirement of senior workers will also create a gap that needs to be filled, with approximately 47 machinists in this region able to retire right now. Further exacerbating this problem is the high probability that retiring workers are in the higher skill group, taking significant skill and experience with them. For companies that may already be having a hard time filling open positions, losing their most senior employees to retirement could be devastating to the company.

Additionally, this survey only received responses from about half of the identified companies. With the consistency of the responses from this group, the entire set would likely double the numbers from this survey. Approximately sixty currently open positions and almost one hundred machinists with the option to retire could be the real numbers for this region. While these companies didn't respond to the survey, their inclusion would not have increased the

number of graduates that are entering the job market each year. Making an even more dire need for machinists to enter the job market and fill the open positions.

### *Final Thoughts and Future Research Recommendations*

From the survey results, it is obvious that machining is a strong part of manufacturing in our region. There will still be a need for machinists, not just in the short term, but for decades to come. Unfortunately, the challenges in continuing to educate and encourage young adults to pursue a career in machining don't have an easy solution. While the jobs are available and possess an enjoyable challenge, the entry level wage may be a barrier to entry for many young people who are looking to start a family and gain their independence. Of course, as demand increases for qualified machinist, the wages will most likely increase to attract more employees. Based on these results, companies and educators need to work together to recruit more young people, who are preparing for college, to choose a career as a machinist.

Based on the need for machinists, future research should focus on the supply of new machinists entering the field. This research should have an emphasis on what barriers exist that keep students in high school from pursuing a career as a machinist. Is it simply an awareness issue that since most homeowners would never hire a machinist as they would a plumber, electrician, or mechanic, this career is unknown to young people? Are there other challenges, such as the availability of higher education opportunities, or some other obstacle that keeps young people from choosing this career? A survey of high school students' knowledge of the field, as well as a survey of people who have recently started a machining career, could provide valuable insight into the challenges that are making machinist so scarce in our area.



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APPENDICES

*Appendix A: List of Responding Employers*

Companies Responding to Survey	
American Precision Machine Johnson County	Baird Machine Shop Washington County
Brackins Machine Shop Unicoi County	Duncan Mechanical Unicoi County
Eastman Chemical Co. Sullivan County	Kintronic Laboratories Sullivan County
Nakatetsu Machining Technologies Washington County	Performance Machining Inc. Sullivan County
Quality Tool Works, Inc. Sullivan County	Snap-On Tools Corporation Carter County
Tsubaki Nakashima Unicoi County	Universal Machine & Tool Inc. Sullivan County
Universal Tool and Engineering Washington County	Wright Tool Inc. Sullivan County

*Appendix B: Email Sent to Employers*

Below is the email sent to employers, asking them to complete the survey.

Hello, my name is Brad Stufflestreet and I am currently working on my Master's Degree in Engineering Technology at East Tennessee State University. I am in the process of writing my thesis in order to graduate later this year. My thesis is titled the "Current and Future Need for Machinist in the Greater Tri-Cities Area."

My goal is to determine the real state of the machining industry in the Tri-Cities area. I also currently work as the lead instructor for the Machine Tool program at Northeast State Community College. With my work at Northeast, I have seen a significant growth in the number of companies who are coming to us looking for candidates to fill open positions. My hope is by surveying the companies in this area, everyone will have a better understanding of where our industry really is. The best way I know to do this it to ask the companies in this area.

Listed below is a link to a survey asking about the machinist your company employs and if you are looking for new machinists to hire. I have tried to make the survey as short and simple as possible while still gathering useful data. I would greatly appreciate your time in filling it out. The information you provide will not be linked back to you or your company in the final report in any way. I plan to only list company names in a table of responding companies, without any responses. If you find there would be someone in your company who is better qualified to answer these questions, please feel free to forward this email to them.

I want to thank you for your time and accuracy in filling out this survey. If I can be of any assistance to you or your company, please do not hesitate to contact me. My email is [bastufflestreet@northeaststate.edu](mailto:bastufflestreet@northeaststate.edu) and my office phone is 423-354-5195.

Regards,

Brad

Brad Stufflestreet  
Assistant Professor Machine Tool and Manufacturing Engineering  
Northeast State Community College

You may open the survey in your web browser by clicking the link below:

Questions

If the link above does not work, try copying the link below into your web browser: [survey-url]  
This link is unique to you and should not be forwarded outside your company.

### *Appendix C: Copy of the Survey*

Below is the survey as sent to employers. The first page required the respondent to agree to have the information used in this thesis, before they could move on. All the remaining questions were presented on a single page. Some multiple part questions, such as “Does your company currently have any open positions for machinist, at any experience level?” only revealed the next three questions if the company replied “Yes”.

## Questions

Please complete the survey below.

Thank you!

---

What company do you represent?

\_\_\_\_\_

---

Do you agree to participate in this study, and have the information used anonymously in the thesis?

- Yes  
 No

**Thank you for your time and accuracy in completing this survey.**

Which of the following best describes the machined products produced by your company

- Machined products are our primary business, and are sold to a third party
- Machined products are a portion of our business and are sold to third parties
- Machined parts are a portion of our business, used to produce a final part or assembly that is then sold to a third party
- Machined products are produced to support other business functions, such as repair parts, and are not routinely sold to a third party

What percentage of your business produces machined parts or products? \_\_\_\_\_

For each of the following questions, please consider the employees you have doing machinist type work and divide them into one of the following three categories:  
 Unskilled or Untrained Machinists - Individuals who run production machines and are not responsible for major adjustments or significant process control. These employees are not part of a training process (formal or informal)  
 Entry Level/ Apprentices - Individuals with some training (formal or informal) who generally can be self-sufficient, but still require close supervision. Individuals enrolled in an apprenticeship or other training program would fall in this category, whether that training is regimented and formal like a DOL apprenticeship or not.  
 High/ Journeymen Skill - Individuals who setup and maintain processes without the need for frequent supervision. Able to make significant adjustments and repairs without assistance. Journeymen level and above machinists would fall in this category.

Based on the above divisions, how many employees does your company currently have that fall into the Unskilled or Untrained Machinists category? \_\_\_\_\_

Based on the above divisions, how many employees does your company currently have that fall into the Entry Level/ Apprentices Machinists category? \_\_\_\_\_

Based on the above divisions, how many employees does your company currently have that fall into the High Skill/ Journeymen Machinists category? \_\_\_\_\_

Considering the Unskilled or Untrained Machinists category, what is the average wage for those individuals in your company? (hourly wage please) \_\_\_\_\_

Considering the Entry Level/ Apprentice Machinists category, what is the average wage for those individuals in your company? (hourly wage please) \_\_\_\_\_

Considering the High Skill/ Journeymen Machinists category, what is the average wage for those individuals in your company? (hourly wage please) \_\_\_\_\_

Does your company currently have open positions for Machinists, at any experience level?

- Yes, we currently have open positions.
- No, we do not currently have open positions.

How many open positions does your company currently have for Unskilled or Untrained Machinists? \_\_\_\_\_

How many open positions does your company currently have for Entry Level/ Apprentice Machinists? \_\_\_\_\_

How many open positions does your company currently have for High Skill/ Journeymen Machinist?

\_\_\_\_\_

How long (in weeks) does it take your company to find an employee to fill an entry level position as a machinist?

\_\_\_\_\_

How would you describe your company's recent success in finding machinist to fill your open positions?

- We are usually successful in finding a qualified candidate quickly
- We are able to find a qualified candidate, but not always as quickly as we would like.
- Qualified candidates are difficult to find and jobs stay unfilled for long periods of time.
- We are unable to find qualified candidates and our business suffers as a result.
- We are unable to find any qualified candidates and have to hire and train someone to fill open positions.
- We have not filled any open positions recently enough to answer accurately.

For job openings in the higher skill level, what do you find to be the most significant factors that disqualifies applicants from being offered a job by your company? (check all that apply)

- No applicants
- Lack of technical or job specific skill
- Unable to pass pre-employment testing (including a drug test)
- Poor soft skills (i.e., unprofessional in interview, won't show up to work, uninterested in work or easily distracted)
- Unwilling to work at offered compensation level
- We haven't hired anyone at this level recently

For job openings at entry level, what do you find to be the most significant factors that disqualifies applicants from being offered a job by your company? (check all that apply)

- No applicants
- Lack of technical or job specific skill
- Unable to pass pre-employment testing (including a drug test)
- Poor soft skills (i.e., unprofessional in interview, won't show up to work, uninterested in work or easily distracted)
- Unwilling to work at offered compensation level
- We haven't hired anyone at this level recently

Where does your company look for potential applicants or advertise? (choose all that apply)

- Newspaper
- Online job posting (Indeed, etc.)
- Online classifieds (Craigslist, etc.)
- Job postings at local schools
- Staffing Agencies (Temp Agencies)

Any additional resources your company uses to find potential applicants? (please list)

\_\_\_\_\_

How important does your company feel that an Associate's Degree or Technical Certificate in Machining is for an entry level position in machining?

- It is very important     It is somewhat important     Neither important or unimportant     It is somewhat unimportant     It is unimportant

Looking towards your future hiring needs, what percentage of your workforce (specifically machinist) are currently eligible to retire? Please use your best estimation and include any employee that could retire, whether they will or not.

\_\_\_\_\_



---

Overall how would you describe the current state of your company as a whole?

- As a company our business is growing significantly and we are enjoying a very successful time period right now
- As a company our business is moving in a positive direction, but that growth is moderate and sustained
- As a company our business is stable and is not showing any real growth or decline
- As a company our business is slowly declining
- As a company our business is suffering a major decline right now

*Appendix D: Survey Responses*

The attached tables show all responses to the survey as they were provided. No normalizing of the data or converting to percentages has been done.

Question	Answers	Responses Received <sup>2</sup>
Which of the following best describes the machined products produced at your company?	Machined products are our primary business, and are sold to a third part	7
	Machined Products are a portion of our business and are sold to third parties	1
	Machined parts are a portion of our business, used to produce a final part or assembly that is then sold to a third party	3
	Machined products are produced to support other business functions, such as repair parts, and are not routinely sold to a third party	3
What percentage of your business produces machined parts or products		100, 98, /,90, 100, 25, 100, 17, 75, 20, 100
Based on the above divisions, how many employees does your company currently have that fall into the Unskilled or Untrained Machinists category?		0,5,0 ,1, 5, 30, 2, 3, 3, 0, 0, 2, 3, 4

<sup>2</sup> Number of occurrences of a given response. “/” used when a question was not completed.

Based on the above divisions, how many employees does your company currently have that fall into the Entry Level/ Apprentices Machinists category?		2,9, 0, 7, 5, 90, 2, 1, 3, 25, 0, 1, 0, 5
Based on the above divisions, how many employees does your company currently have that fall into the High Skill/ Journeymen Machinists category?		3,41, 3, 9, 10, 10, 4, 3, 1, 11, 5, 1, 1, 3
Considering the Unskilled or Untrained Machinists category, what is the average wage for those individuals in your company? (hourly wage please)		/, 22, 10, 13, 12, /, 16, 12, 14, /, /, 13, 18, 14
Considering the Entry Level/ Apprentice Machinists category, what is the average wage for those individuals in your company? (hourly wage please)		10.00, 24, 12, 16, 15, /, 19, 15, 15.50, 17.76, /, 14, 0, 17
Considering the High Skill/ Journeymen Machinists category, what is the average wage for those individuals in your company? (hourly wage please)		15.50, 30, 20, 30, 22, /, 23, 21, 18, 23.12, 20, 20, 28, 22
Does your company currently have open positions for Machinists, at any experience level?	Yes, we currently have open positions	6
	No, we do not currently have open positions	8
How many open positions does your company currently have for Unskilled or Untrained Machinists? <sup>3</sup>		1, 0, 0, 5, 0, 3
How many open positions does your company currently have for Entry Level/ Apprentice Machinists? <sup>2</sup>		0, 0, 0, 5, 2, 2
How many open positions does your company currently have for High Skill/ Journeymen Machinist? <sup>2</sup>		0, 3, 2, 5, 0, 2
How long (in weeks) does it take your company to find an employee to fill an entry level position as a machinist?		2, 5, 4, 6, 40, 8, 2, 3, 11, 6, 4, 6, 1, 6

<sup>3</sup> These questions only appeared if respondents said they had open positions to fill.

How would you describe your company's recent success finding machinist to fill your open positions?	We are usually successful in finding a qualified candidate quickly	2
	We are able to find a qualified candidate, but not always as quickly as we would like.	1
	Qualified candidates are difficult to find and jobs stay unfilled for long periods of time.	5
	We are unable to find qualified candidates and our business suffers as a result.	
	We are unable to find any qualified candidates and have to hire and train someone to fill open positions.	2
	We have not filled any open positions recently enough to answer accurately.	4
For job openings in the higher skill level, what do you find to be the most significant factors that disqualifies applicants from being offered a job by your company? (check all that apply)	No applicants	1
	Lack of technical or job specific skill	6
	Unable to pass pre-employment testing (including a drug test)	2
	Poor soft skills (i.e., unprofessional in interview, won't show up to work, uninterested in work or easily distracted)	3

	Unwilling to work at offered compensation level	4
	We haven't hired anyone at this level recently	3
For job openings at entry level, what do you find to be the most significant factors that disqualifies applicants from being offered a job by your company? (check all that apply)	No applicants	
	Lack of technical or job specific skill	7
	Unable to pass pre-employment testing (including a drug test)	2
	Poor soft skills (i.e., unprofessional in interview, won't show up to work, uninterested in work or easily distracted)	4
	Unwilling to work at offered compensation level	2
	We haven't hired anyone at this level recently	2
Where does your company look for potential applicants or advertise? (check all that apply)	Newspaper	6
	Online job posting (Indeed, etc.)	9
	Online classifieds (Craigslist, etc.)	4
	Job postings at local schools	2
	Staffing agencies	6
Any additional resources your company uses to find potential applicants (please list)	They come to us looking for work; call local technical schools for recent grads; employee referral, word of mouth, employee referral, internal	

How important does your company feel that an Associate's Degree or Technical Certificate in Machining is for an entry level position in machining?	It is very important	2
	It is somewhat important	6
	Neither important or unimportant	4
	It is somewhat unimportant	1
	It is unimportant	1
Looking towards your future hiring needs, what percentage of your workforce (specifically machinist) are currently eligible to retire? Please use your best estimation and include any employee that could retire, whether they will or not.		0,20,0, 12, 10, 20, 20, 0, 45, 5, 20, 25, 25, 0
Overall how would you describe the current state of your company as a whole?	As a company our business is growing significantly and we are enjoying a very successful time period right now	1
	As a company our business is moving in a positive direction, but that growth is moderate and sustained	9
	As a company our business is stable and is not showing any real growth or decline	3
	As a company our business is slowly declining	1
	As a company our business is suffering a major decline right now	0

## VITA

### BRADLEY STUFFLESTREET

Education: East Tennessee State University  
Master of Science: Technology, Engineering Technology  
concentration  
Graduation December 2020

East Tennessee State University  
Bachelor of Applied Science Interdisciplinary Studies  
Emphasis in Engineering Technology  
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Northeast State Community College  
Associate of Applied Science: Industrial Technology  
Concentrations in Machine Tool *and* Manufacturing Engineering  
Graduated December 2010

Professional Experience: Assistant Professor Machine Tool and Manufacturing  
Northeast State Community College  
January 2013 – Present

Department Head; Technologies Division  
Northeast State Community College  
December 2019 - Present

CNC Machinist  
Wright Tool Inc.  
July 2006- August 2013