ALLEGHENY COLLEGE

BRUCE R. THOMPSON
CENTER FOR BUSINESS & ECONOMICS

Trends in the Tooling and Machining Industry of Crawford County, Pennsylvania

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I. Executive Summary

The Tooling and Machining (T&M) industry in Crawford County has experienced strong growth during the past five years. Most of the 28 tool shops surveyed in this study reported an average sales increase of about 23%, with only a few firms experiencing declines in sales. Employment in the industry, however, has not grown as much as sales. Our study found that one firm in the county has been a major driver of employment in the county's tooling and machining industry. If this firm is removed from the study, employment in our sample shops decreased by 18% between 2008 and 2018, a trend that reflects declines in manufacturing employment both in the United States and globally. This decrease in employment in Crawford County is not due to falling demand for toolmakers. Rather, many shops are still having difficulty finding skilled toolmakers. Technological change and automation in the industry have resulted in less need for skilled toolmakers. Most of the shops interviewed have invested heavily in new equipment, about $320,000 per shop within the past two years. Employment in the industry has not grown because many of the shops believe they have reached their optimal size, and are therefore not very interested in growing further.

The industry has been doing so well in the past five years that firm closures or layoffs have been very rare occurrences in the industry. Going forward, all of the tool shops surveyed said they have no plans to lay workers off anytime soon. They see the industry as being very stable in the next 10 years. While they do not anticipate a major growth in overall sales in the future, they see increasing opportunities in the medical equipment and device segment of the industry.

Shop ownership is in the process of changing. Only a very few shops are passing their business to children and relatives. In fact, many owners discourage their children from careers in tooling and machining. Instead, most shops are now purchased by employees and outside investors whenever the owner decides to retire. As a result, acquisition rather than inheritance is a growing form of succession in the industry. But many tool shops do not have well-articulated succession plans, and this may make retiring difficult and poses risks for the continuation of the business.

The industry is now transitioning to a third generation set of owners, who bring new attributes to the industry. Many of these new owners, unlike the second generation, are not family members of the original founders of the tool shops. For the first time in the history of the industry, women are either the CEOs or operations managers of an increasing number of tool shops. While women are increasingly becoming part of the leadership of tool shops, the same is not true of female toolmakers. Workers in the industry are overwhelmingly male, middle-aged, and white. The new owners of tool shops also bring considerable managerial experience into the industry. Some have

successfully managed other businesses, while others have earned undergraduate, and in some cases, graduate degrees in engineering, business, management, accounting, and related fields.

Similar to previous years, there are not enough young people entering the field, and many of those undergoing training do not have the soft and hard skills to make immediate, significant contributions. Due to increasing sales in the industry, shops are looking to hire toolmakers; yet there is a dearth of qualified new workers. This raises questions about the effectiveness of educational and training programs in the area, as well as the quality of students being trained by the area's institutions. This is an important issue, given the fact that many of the area's toolmakers are in the process of retiring. The competitiveness of the county's tooling and machining industry would be undermined if young toolmakers are not being trained to replace the retiring ones.

A surprising result from the survey is that the tariffs on steel and aluminum imposed by the Trump administration in 2018 have not been detrimental to most of the tool shops. While the tariffs have raised production costs for many shops by as much as 25%, those increases have not been significant enough to affect their performance in substantive ways. Most shops said that they have been able to pass on cost increases to their customers, with little or no consequences. Some shops are unaffected by the tariffs because they don't use imported steel and aluminum. This is true especially for precision machinists who service the aerospace and defense industries. Regulation requires them to use steel and aluminum from approved sources certified by the U.S. government, including domestic. There are also some shops that prefer domestic steel and aluminum because they find the imported ones to be of very low quality.

The two biggest challenges that tool shops face are skills shortages and costly regulations imposed by the Occupational Safety and Health Administration (OSHA). While most of them recognize foreign competition as a problem, they do not view foreign competition and the lack of a level-playing field to be nearly as challenging as 20 years ago. In previous reports, this was the number one issue faced by firms. Instead, many firms are seeing an increase in competition from domestic firms. Despite still being a problem, the narrative on foreign competition seems to have changed for a significant number of firms.

II. Introduction

Manufacturing is the bedrock of the Crawford County economy, accounting for about a quarter of employment in the county. As Figures 1, 2, and 3 show, as of 2018, the county relies more on manufacturing as a source of employment than the State of

Pennsylvania (9.7%) and the United States as a whole (7.9%). Consistent with national trends, there are concerns that manufacturing in Pennsylvania and Crawford County is being threatened by several factors, including foreign competition, inappropriate government policies, too much regulation, and skills shortages. Within the manufacturing sector, the Tooling and Machining (T&M) industry is very important for Crawford County. Starting in the early 20th century, the Talon Company started the production of area toolmakers. Through their apprenticeship programs, workers learned the art of toolmaking. Many workers at Talon spun off to create their own companies. Since then, the tooling and machining industry has helped sustain the county as a major source of employment, revenue generator, and an important factor in the vibrancy of the real estate and retail sectors. For decades, the T&M industry has provided opportunities for thousands of Crawford County residents. This is why it is important that all stakeholders in the county should take interest in the survival and development of this vital industry.

Figure 1:

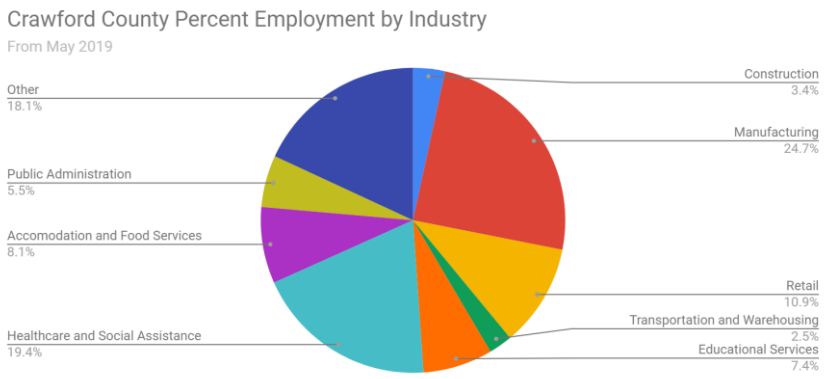
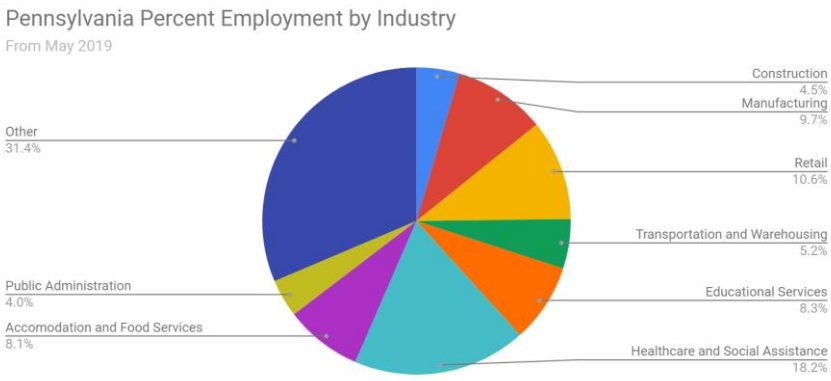


Figure 2:



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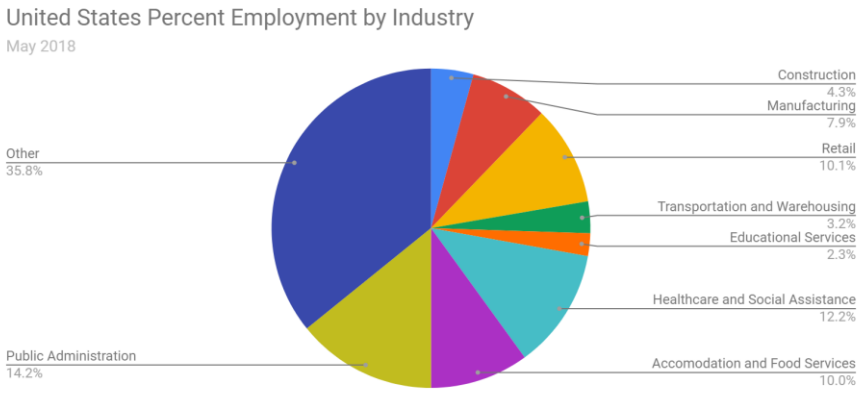


As a major stakeholder in the local community, the Department of Economics at Allegheny College has been studying the T&M industry since 2002. Every five years or so, we focus on issues, problems and challenges that confront the industry. We employ student research assistants to work with faculty to interview tool shop owners, and write a report based on information gathered through surveys, face-to-face interviews, and secondary data gathered from various sources. The focus of this year's report is on the impact of Trump administration's tariffs on steel and aluminum. A major rationale for focusing on tariffs is they could affect production costs and impact the competitiveness of local tool shops, especially at a time when there are complaints about the lack of a level playing field with foreign competitors. Steel is a major production input used by virtually every tool shop, though in different quantities and for various purposes. Also, tariffs may affect the availability and quality of steel used by local tool shops.

In the process of analyzing these impacts, we also explore trends, performance, opportunities, and challenges in the T&M industry. When speaking with people in Crawford County, the questions on their minds include the following: Will the tool and die industry survive? Should Crawford County "kiss" the industry goodbye and explore alternative economic drivers? What will happen to the industry and the community when toolmakers in the county retire? Do shop owners have succession plans for when they retire? Is China still competing unfairly with our local shops? How might we get high school students interested in tooling and machining? In the next section, we discuss our data gathering process, the attributes of the firms we interviewed, and some of the challenges we encountered in the information-gathering process.

III. Methodology

This study is based on a survey of 31 firms and organizations in the Crawford County tooling and machining industry, with 28 being tool shops. The firms were randomly selected through a combination of different methods. Some firms were interviewed through cold visits without a prior appointment. Others were done via pre-arranged appointments. A total of nine surveys were completed online. Due to the randomized nature of selecting companies, firms of various sizes were included in the sample, ranging from those employing between one to 500 workers. We divided the sample firms into five categories (Figure 4), based on the number of employees: Micro (1-6), Small (7-20), Medium (21-30), Large (31-40), and Macro (40+). In addition, the firms surveyed serve a variety of industries (see Figure 5). Both these factors ensured there was no selection bias based on size or industries served.

Figure 4:

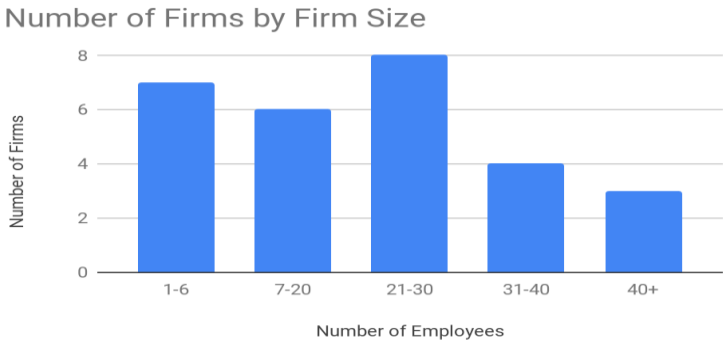
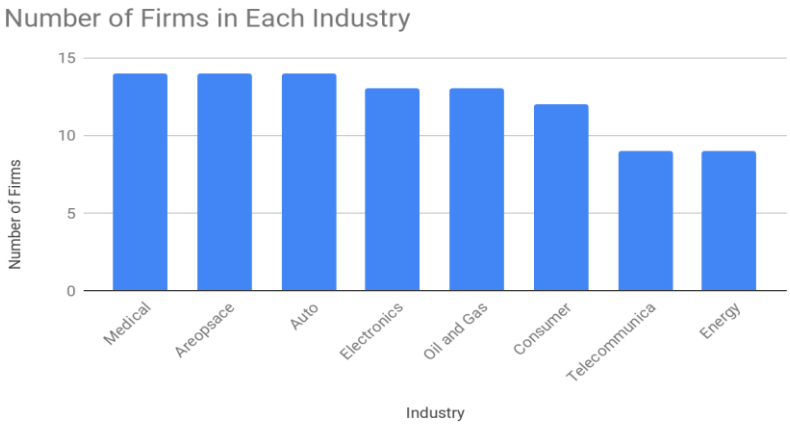


Figure 5:



Out of the 28 shops interviewed, 19 were incorporated as S-corps. A distinctive feature of an "S Corp," as Table 1 shows, is that the firm's profit is reported as income to the owners, which is in turn reported on the owners' income tax forms. The firm itself does not pay a corporate tax. Many tool shops prefer this type of incorporation because of the tax advantage.

Table 1: S-Corp vs. C-Corp

	S Corp	C Corp
Owners pay personal income tax	X	X
Business pays corporate income tax		X
All yearly profit/loss from the business is passed on to the owner	X	
100 shareholders or less	X	
Shareholders are US citizens or legal residents	X	

We solicited the assistance of the Northwest PA chapter of the National Tooling and Machining Association (NTMA) in administering the survey to its members. The NTMA sent out the survey via email to their members, eight of which completed the survey. Overall, NTMA members were 41% of our survey indicating there was not a selection bias.

To help generate useful information from our sample firms, a survey that initially contained 76 questions was designed. The initial survey was tested by interviewing four firms. Based on those interviews, the survey was revised and 38 questions were subsequently included in the final version (see appendix: 2). The revised survey includes background information on the firms: company name, year of establishment, number of employees, sales, capital investment, etc. Questions about production materials, steel and aluminum, and tariffs were also included. To keep the report focused and concise, we did not consider issues about healthcare costs, though some tool shops mentioned

rising healthcare costs as one of their challenges. Throughout the interviewing process, unclear questions or questions that turned out to not be relevant were removed. By the end, the survey was structured to provide meaningful information and require a minimal amount of time. An average interview took anywhere from 30 minutes to an hour depending on how in depth the interviewee went when answering questions. Interviewees consisted mainly of Presidents and owners of tool shops, and occasionally leading shop managers. Interviews and surveys of firms took place from June 14 - August 5, 2019.

Data Sources:

In addition to the survey, supplementary information was collected from a variety of sources. Information breakdowns of state and county employment by sector came from the Pennsylvania Department of Labor and Industry. Similar national data came from the Bureau of Labor Statistics. Within the survey we asked for sales and employment figures from 2018 and 2008. This was meant to get an idea of how the industry has performed in the last ten years. For sales we had data from both years for 20 companies. For employment data we had 17 companies provide numbers from 2008 and 2018. Only the firms that were able to provide data from both years were used in calculating percentage changes in sales and employment respectively. Finding state and national information on tool and die making was equally difficult. IBISWorld had the most accurate information. The data they provided was for the NAICS code 33351, Metalworking and the tool and die NAICS code is 333514, making the IBISWorld data slightly broader than the data collected.[1] That being said, the information was a very close approximation and the best figures available. Similarly, the IBISWorld data was reported as revenues whereas our survey collected sales data, which amounts to a negligible difference and at the very least a good approximation. Calculations of percent change for national and Pennsylvania Metalworking come from IBISWorld.

In general, obtaining information from tool shops proved to be very challenging at times. As a result, all figures, charts, and data exclude firms that were not able to appropriately give the information required. On the whole, this was a rare occurrence

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[1] NAICS 333514: This U.S. industry comprises establishments, known as tool and die shops, primarily engaged in manufacturing special tools and fixtures, such as cutting dies and jigs

NAICS 33351: This industry comprises establishments primarily engaged in manufacturing metalworking machinery, such as metal cutting and metal forming machine tools; cutting tools; accessories for metalworking machinery; special dies, tools, jigs, and fixtures; industrial molds; rolling mill machinery; assembly machinery; coil handling, conversion, or straightening equipment; and wire drawing and fabricating machines.

with only a couple of instances. One obstacle was the time burden placed on shops. All shops we interviewed, or attempted to interview, were busy, with all employees having work to be done, making it hard to find the time to sit down and talk. Besides this, some shops did not want to participate in the study. Occasionally getting in touch with companies was a challenge, as stated before, many of these contacted are busy, and may not check emails, return calls, etc. Another obstacle, as previously mentioned, was that of the questions asked, many were about specific figures/numbers, going several years back. Not every interviewee was able to provide this kind of information. This was attributed to a variety of reasons such as, being new to the company, just acquiring the company, someone else within the company is tasked with knowing the information requested, or just not remembering. Along with this, some of the information asked was of a sensitive nature, and some shops did not want to reveal this information. And lastly, one pitfall of collecting data is that the interviewee may report inaccurate data.

IV. Sales and Employment

For the past two years or so, Crawford County's tooling and machining shops having been experiencing their best performance (in terms of sales) in over 20 years. As one shop owner remarked, "the industry is returning to its golden era." Other shop owners described the industry's performance in the following ways:

"The industry is not going to go away."

"This is our best year in 22 years".

"A comeback story is in line"

"The industry is stronger than 10 years ago and I expect it to continue".

"We are stuck. Tyco and Delphi have moved away. We are now looking to try and get into a different field like medical"

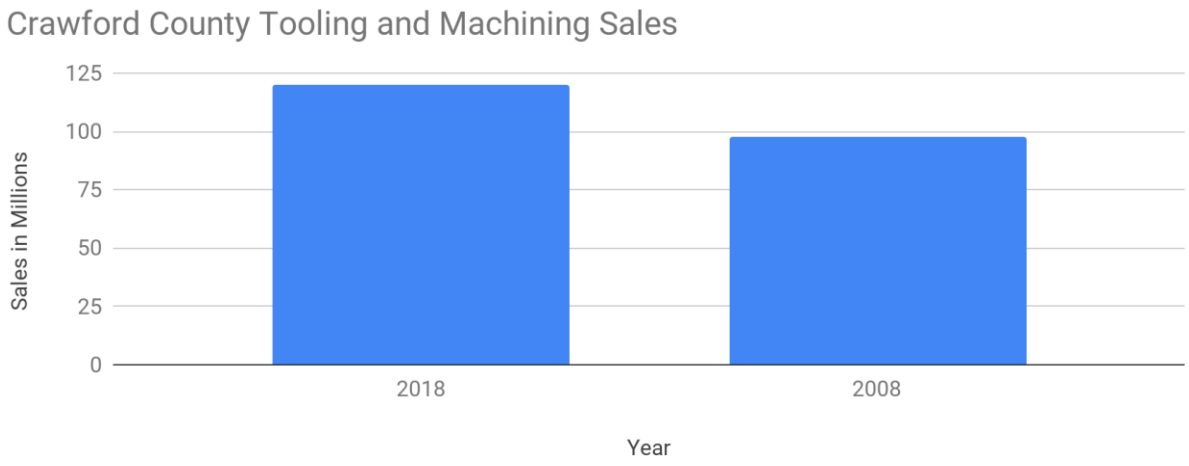
"We are one fourth the size of what we used to be"

"I like what we are doing; we are making good money and we don't want to get bigger."

"This is a very good time to buy a tool shop."

While shops in other regions are struggling, those in Crawford County are having a good time. Twenty out of the 28 tool shops surveyed in this study provided information on sales in 2008 and 2018. Sales for these firms increased from $97.48 million in 2008, to $119.84 million in 2018, an increase of 23%. Although different sizes of shops experienced growth in sales, those employing less than 10 workers saw a 1% decrease in sales between 2008 and 2018. The slight decrease in sales for smaller shops is not surprising, as most of their owners are in the process of retiring and are therefore not very proactive in taking on more jobs. Shops that are heavily reliant on the auto industry reported more difficulties with sales, and seem to also have a more pessimistic view of the future.

Figure 6:



The two firms in our sample who employ over 40 workers achieved a growth in sales of 36%, but firms employing between 21-30 workers experienced the highest growth. Their total sales increased from $11.5 million in 2008 to $20.45 million in 2018, an increase of 78%. This is an unprecedented increase in sales, considering that sales by Pennsylvania tooling and machining shops rose by only 4% between 2009 and 2018. If the sales performance of our sample firms reflects the trend in Crawford County, it implies that sales by the county's tool shops grew more than five times those of Pennsylvania's tool shops. Nationally, however, sales of tool shops increased by about 25%, just about the rate for Crawford County shops [2](see Figures 6, 7, and 8).

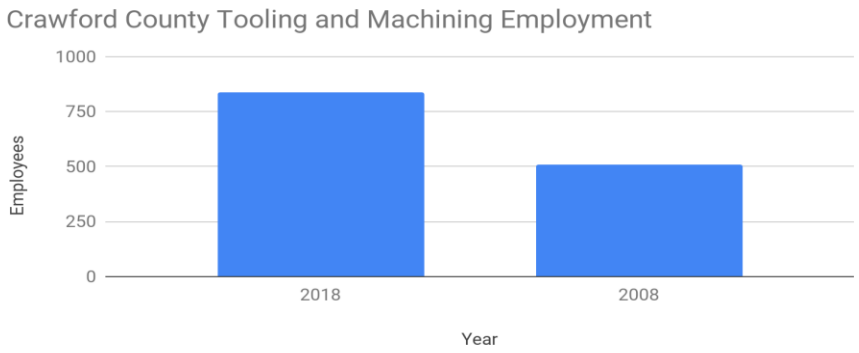
[2] Data for state and national sales are for a slightly broader classification than tool and die. Tool and Die is NAICS Code 333514 whereas the state and national data is NAICS Code 33351.

Figure 7:

Figure 8:

In contrast to sales increases, employment in the industry has not grown very much. Employment amongst the 17 firms that provided information on employment rose from 502 in 2008 to 773 in 2018, representing a 54% increase. It appears, however, that one shop is mainly responsible for much of the growth in employment amongst the firms. If we exclude the 194% increase in employment by this one shop, employment amongst our sample shops fell by 18% between 2008 and 2018.[3] Thus, one tool shop is a major driver of employment in Crawford County's tooling and machining industry. Decreases in employment in the county's tooling and machining industry is not due to layoffs, as happened in the early to mid-2000s. Layoffs in the industry have not been widespread within the past decade, and none of the tool shops interviewed indicated any plans for future layoffs.

Figure 9:



[3] It should be noted that this observation is based on a very small sample of shops, and may not reflect general trends in the county's tooling and machining industry. But it does reflect trends in manufacturing employment in the United States and globally. The number of people working in manufacturing in the United States fell from about 17.6 million in 1997 to 11.5 million in 2010, but rose slightly to 12.8 million in 2018 (Lund, Manyika and Spence, 2019, p.126).

Why are tool shops not adding more jobs, despite impressive sales performance? Some shops may not be replacing retired workers because they are trying to become leaner and more technology-intensive. Many shops that want to hire are unable to find suitable employees, and also unwilling to train new employees because of the high cost (we discuss skills shortages in Section VI of this report).

Declining employment in tooling and machining is also taking place across the State of Pennsylvania. At the state level, the number of workers in the industry decreased from 8,842 in 2009, to 8,216 in 2018, a 7.1 percent decrease. In contrast to declining employment at the county and state levels, employment in the national tooling and machining industry rose from 128,408 in 2010 to 144,857 in 2018, a 12.8 percent increase. The increase in employment at the national level may be because of the existence of bigger tool shops in the production segment of the industry, which is typically labor-intensive and requires less skills.

Figure 10:

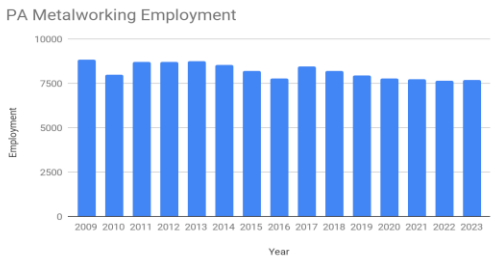
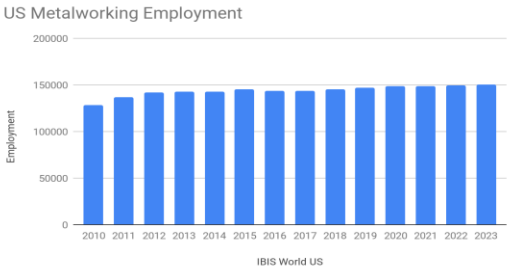


Figure 11:



Business has been so good in the county's tooling and machining industry that entrepreneurs in other sectors are buying tool shops. Some retirees are also investing their retirement incomes in tool shops. The impressive performance of Crawford County's tooling and machining industry is in sharp contrast with what happened in the industry about 20 years ago. According to the U.S. International Trade Commission (ITC), the industry's total net sales fell from $1.7 billion in 1999 to $1.5 billion in 2001, a fall of almost 12 percent. In 2002, sales fell further by more than 20 percent. Gross profit for the industry also plummeted by 26 percent, from $369.5 million in 1999 to $274.1 million in 2001. Between 2001 and 2003, one in five members of the National Tooling and Machining Association (NTMA) left the association, mainly because their businesses failed. During the same period, 35,700 jobs were lost in the tooling industry. Crawford County had its own share of the crisis, with almost 1,000 jobs lost in the early 2000s.

Why Crawford County Tool Shops are Doing so Well:

Why are tool shops in Crawford County doing so well, compared with their counterparts in other regions of Pennsylvania and country? Tooling and machining shops in Crawford County have become more competitive within the past 15 years or so. Their ability to compete, even with low-cost producers like China, has been enhanced by the following:

- *Rising Costs in Competing Countries:* The cost differences between area tool shops and foreign competitors like China have narrowed, due mainly to rising costs in these foreign countries. Many of the shops we interviewed said that their previous customers that went to China in search of low-cost molds and tooling are now coming back because of the narrowing of cost differences between Chinese tool shops and those in Crawford. They have found that the narrow cost differences, especially when shipping costs are considered, no longer justifies the patronage of foreign competitors. Tyco and Delphi have steadily moved production to India recently, which is becoming a growing tool producer. Multiple shops reported this new trend, and believe it is in response to increasing labor costs in China. Similarly, some segments of the industry, such as production, have also been outsourced to Vietnam, given that country's low labor costs. Area shops do enjoy some cost and price advantages. The price advantage comes from low cost of living in the area, including low housing costs, low local taxes, and stable wage rates. Wages have remained stagnant in the industry because, historically, shops don't compete with one another for toolmakers. It is atypical for tool shops to poach toolmakers from other shops, which helps keep wages low and stable.

- *Quick Turn Around in Meeting Customers' Demand:* Most tool shops we interviewed said that turnaround time is critical for competitiveness, and that the time lag between when orders are placed and when customers expect the orders to be filled has shrunk considerably. In the past, turnaround time used to be in months, but they are now in weeks and in some cases days. The shortening of turnaround time has given area shops an advantage, as foreign competitors are unable to deliver in good time and with the right quality. But some shop owners interviewed complain that shorter lead times put too much pressure on local shops. As we walked through some tool shops, we could feel the pressure that these shops are facing to supply their customers quickly. Shop owners often told us they need to finish up a job very quickly, as their customers are expecting prompt deliveries. Crawford County tool shops have a competitive advantage in price, quality, and delivery time. Delivery time of products is dependent on both

the proximity of the tool and die shop to the customer, and the time it takes for the tool shops to receive inputs. Tool shops in Crawford County have nearly all their customers within the United States, which may provide them with a competitive advantage over other shops in Pennsylvania and nationally. Additionally, the source of inputs such as steel and aluminum come from suppliers located in Meadville or within a couple hours away in Pennsylvania or Ohio. This allows tool shops to order and access materials in a relatively quick manner, as they do not hold large inventories. Many tool shops reported that the ability to offer a quick turnaround was very important to customers. This would make doing business with tool shops in Crawford County potentially a more attractive option and may also be a possible explanation for the success of shops in the area, compared with state and national trends.

- *Quality Advantage*: Crawford County shops have continued to maintain the high quality they have been known for, a distinction that earned Meadville the enviable title "Tool City USA." (Aeppel, 2009). This high-quality reputation is partly due to the existence of very experienced, creative, imaginative, and talented toolmakers. As management experts would say, these tool makers possess competencies and capabilities that are idiosyncratic, tacit, and inimitable. The quality advantage of Crawford County's tool shops can also be attributed to the fact that other regions may be experiencing more severe skills shortages than the county. While the county's tool shops have maintained their quality, the same is not true of Chinese tool shops. There is a general perception that the Chinese make inferior tooling and parts, but many of the shops interviewed said that the Chinese are getting better in terms of technology and skilled toolmakers.

- *Product and Market Diversification:* About 20 years ago, most shops in the county relied on one or two customers, most especially on big companies like Tyco, Delphi, Packard- Hanafin, and Lord Corporation. The 28 tool shops in our survey have an average of 36 customers. The lowest number of customers reported by the shops was one, while the highest number was 200 customers. Not only that, they have also diversified into new markets and industries. In the past, dominant industries served by Crawford County tool shops were automotive, electronics, consumer products, and aerospace. Area tool shops now serve new industries like medical, oil and gas, nuclear, telecommunications, transportation, and recycling/shredding equipment. Only 11 out of 28 shops

reported relying on a single customer for over 50 percent of sales. This is in contrast with many years ago, when most shops relied on one or two customers for 100 percent of sales. Our study reveals that diversification has taken place across all segments of the county's tooling and machining industry.

- *Cluster Effects:* Tool shops in Crawford County operate in a cluster, the largest of which is located in the Meadville area. Clusters are defined as a "geographically proximate group of inter-connected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 1998, p.199). Pointing out the role of clusters in business success, Porter argues that ""what happens *inside* companies is important, but clusters reveal that the immediate business environment *outside* companies plays a vital role as well." In his explanation of the so-called "globalization paradox," Porter argues that the easy movement of factors of production has increased the salience of unique and inimitable local advantages, such as those found in clusters. The benefits of clusters come by way of the traditional economies of agglomeration, which include access to skills, inputs, markets, capital, and economic development agencies. Another advantage of being in a cluster is access to a network of suppliers of various intermediate goods, who can deliver goods and services in a timely fashion. This eliminates the need to carry large inventories of intermediate goods, thus saving inventory costs. For instance, most tool shops in Crawford County get their supply of steel from Meadville. They usually would pick up the phone and call for supply, and their orders are ready for pick-up, almost instantaneously. Input suppliers, due to their long-term relationships with area tool shops, know exactly what the tool shops need and therefore respond promptly to their demand. Customers also prefer to patronize shops in a cluster, as this minimizes coordination and transaction costs, as well as making it easier for them to conduct business with several shops simultaneously. Anecdotal evidence suggests that other regions no longer have big clusters of shops like Crawford County. These regions now have a few big shops, who don't enjoy the advantages of clusters and agglomeration.

- *Existence of Training Centers for Toolmakers:* Although Crawford County is still facing the challenges of skills shortages, it has training centers for toolmakers. Within Crawford County there are training centers such as the Precision Machining Institute and VoTECH which produce graduates that are given the basics to start a career in tooling and machining, along with programs such as

NTMA-U and a youth robotics program which are designed to get the youth interested in the manufacturing industry. These active attempts at getting more potential workers into tooling and machining in Crawford County is an additional explanation as to why employment has been growing in the industry despite feeling the effects of the skill shortage.

- *Weakening of Foreign Competition:* Foreign competition is no longer a major threat for tool shops, in contrast to what happened about two decades ago. While shops still compete with low cost producers in China, Vietnam, Mexico, and more recently in India, Crawford County tool shops are not losing too much work to foreign competitors. During our interviews, we hear conflicting narratives about the threat posed by China. Almost every shop said China is improving their quality, but how it compares to American tooling is still up for debate. Some shop owners say that Chinese products are "garbage." There are numerous stories about mold making being moved to China in an attempt to save money on cheap, Chinese labor. These molds turned out poorly and were sent back to local firms to be repaired. In the long run, this cost more money than if the parts had been made locally to begin with. Shop owners also cite their precision and tolerances as why they no longer fear foreign competition. They claim the Chinese cannot match their quality. This narrative makes sense when looking at highly precise industries like medical and aerospace. Similarly, some shops say that labor costs have been increasing in China, and it is no longer as cheap to produce in China as it once was. And finally, with turnaround time being important to customers, the longer shipping times from China are not favorable. However, at the same time, other tool shops reported that the Chinese have great quality, implying the claims of unmatched domestic precision is from a preconceived bias of Chinese skills. Those who believe in China's quality cite their better equipment, which is subsidized by the government, as a substitute for any lack in tooling knowledge. Additionally, China has improved their training programs and has received help from U.S. toolmakers. Obviously, both these stories cannot be true. It is likely that the story varies across a myriad of factors. Product type plays a big role. Stories from highly precise producers will be different from the accounts of shops that produce generic auto parts. Similarly, there will likely be variation among individual Chinese firms. While some shops believe that language barriers are impediments to doing business in China, other shops applaud their English language abilities. Even if the Chinese are improving their quality, local firms have gone into specialized markets.

Aerospace and medical are very hard for foreigners to compete because of the high barriers to entry erected by regulations. It seems, however, that low labor costs has enabled the Chinese to gain competitive advantage in the production segment of tooling and machining, while US shops have an advantage in design and precision machining. Job shops are benefiting from this model. This further explains the relative decline in the performance of tool shops that serve the auto industry, as most parts are simple in design and need to be mass produced.

V. Impact of Tariffs on the Tooling and Machining Industry in Crawford County

The 2018 imposition of tariffs on steel and aluminum by the Trump administration has generated much controversy. Originally, the tariffs covered countries such as China, Europe, Mexico, and Canada, the latter two have been recently excluded[4]. Rates, under the ad valorem tariffs, have been consistent for affected regions, 10% for aluminum and 25% for steel. Historically, and in accordance with economic theory, the imposition of tariffs has proven to be inefficient and harmful in aggregate, despite protecting domestic producers. Our survey shows that all of the tool shops in Crawford County use steel in various quantities, and several of them also use aluminum (especially those that serve the aerospace market), but in smaller quantities compared to steel. Tariffs on steel and aluminum, however, have had little or no impact on most area tool shops. In fact, many shops reported that they have been busier despite the tariffs. Only one of the shops said unambiguously that the tariffs have hurt his business, so much so that the survival of his business is being threatened.

There are a number of reasons why the tariffs have not had adverse effects on most of Crawford County's tool shops. First, although every tool shop uses steel, expenditure on steel makes up a small percentage of their total cost, typically 10%-25% (see Appendix: 1). This is especially true for job shops, where products are only made one time and then produced elsewhere. Second, many tool shops don't use imported steel and aluminum. Some of their customers, especially in the aerospace industry, require them to use domestic steel and aluminum. Similar regulations are found in the medical industry. Third, many shops pass on increases in the prices of steel and aluminum to their customers. Customers are willing to accept price increases because they know that steel and aluminum prices have increased, as a result of tariffs.

[4] For more information see *Trump's Trade War Timeline: An Up-to-Date Guide* by the Peterson Institute for International Economics

Shops that rely heavily on foreign steel reported price increases of approximately 25%. This is consistent with price changes at local steel distributors of foreign products and the original tariff. Domestic steel saw a slight increase in prices, due to an increase in its demand after the tariff, of around 5%. Generally, shops are able to include increases in the price of steel when quoting for jobs, and therefore pass those increases on to customers. Only two companies indicated they are unable to pass on rising costs. The ability to pass on costs is a surprising result. As recent as 15 years ago, customers like Tyco and Delphi used their market power to dictate prices to tool shops. It appears diversification is solving this problem. Tool shops now provide unique services for which there is no readily available substitutes. Once customers find a tool shop they like, they are willing to stay with them, despite price increases. This is because of the high search costs, not just finding new shops but also verifying quality and customer service, associated with switching tool shops. Upon closer scrutiny, the two shops that could not pass on costs did not fit this model. One of the shops provide very generic machine parts with many competitors unaffected by tariffs; the other serves the auto industry, a similar market.

Some tool shops owners who said that tariffs have raised their production costs believe that President Trump did the right thing by imposing tariffs, in an attempt to protect the steel industry. Part of the logic is that there will be an increase in domestic steel production since domestic inputs will be comparatively cheaper than foreign inputs. The majority of owners argue that the tariffs are in the long-term interests of the country, though they might hurt the tooling and machining industry in the short-run (see Figures 12, 13 and 14). Most shops owners have reported that there have been no noticeable benefits to their firms, while still being in support of the tariffs, which may be attributed to the perception that the industry needs protecting. Even shop owners who question the effectiveness of the tariff appreciate what it stands for. Many shop owners feel there is an uneven playing field and often times, tool shops seem forgotten. As a result, they are happy the President is making an attempt to address their problems, regardless of whether or not they think the policy is good for their business.

Figure 12:

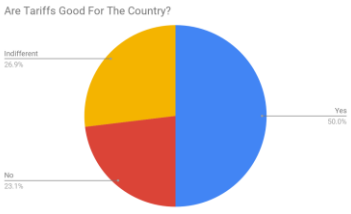


Figure 13:

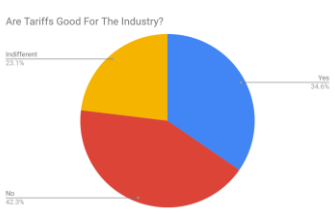


Figure 14:

VI. Skill Shortages Still a Problem

Although technology is very important for competitiveness, the principal assets of Crawford County's tool shops are skilled toolmakers. But these critical assets are eroding very rapidly, as the area's toolmakers retire in large numbers and are not being replaced at the same pace as retirements. This has caused severe shortages of skilled toolmakers in the county. Skill shortages have been an ongoing problem, not only for tooling and machining shops in Crawford County, but also across the United States. At one time, the problem was thought to be temporary, caused mainly by the negative publicity generated by the closure of tool shops in the 2000s, following two recessions and foreign competition (especially by China). The problem appears to have become unrelenting, and a huge threat to the competitiveness of local tool shops.

Of the 28 tool shops interviewed, almost 90 percent identified skill shortages as a major challenge[5]. About 46 percent indicated that shortages of skilled toolmakers is their number one problem. Almost every firm that identified skills shortages as their number one problem service either the aerospace or medical businesses. This may be attributed to the fact that there are regulations about the quality of products in this industry, which then require tool shops to be very precise in their production process. We also found that the shops that listed skill shortages as their overarching problem are more diversified than other firms. Diversified firms usually require a broader array of skills to compete in different markets.

There are Shortages of Skilled Toolmakers in the County because of:

- *Retirement of toolmakers:* many experienced toolmakers have either retired, or are in the process of doing so. Almost all of the toolmakers trained by Talon have either passed on or retired. Those that went through apprenticeship programs in the 1960s and 1970s are next in line for retirement. But new toolmakers are not being trained at the rate of retirements, creating severe shortages of skills in the industry.

- *Falling Numbers of Students at VoTECH and PMI*: Our study shows that the Crawford County Career and Technical Center (VoTECH) and the Precision Machining Institute (PMI) are enrolling fewer students partly because shops are hiring and training their own toolmakers. As well, when the economy is doing

[5] Two shops were removed due to inadequate data so the percentages are with respect to 26 firms

well and there are job opportunities, prospective students tend to be less interested in enrolling at the PMI. Many of the students enrolled in local training institutions are not employable because of their lack of soft skills. According to an official involved in training toolmakers, "many of our young kids lack accountability and responsibility. Some of them don't even want to work." They enroll in these institutions either as a requirement for receiving some government benefits, or they receive full tuition scholarship to train as toolmakers.

- *Career Advice:* There has been an increase in students being told to go to college after they finish high school. This may be attributed to the misconception that only those with college degrees can be successful. This is wrong, however, because trade jobs can offer a very good living and does not lead to the accumulation of a large amount of student debt. It is not just guidance counselors, but also parents, including parents in the tooling and machining industry themselves. Parents believe the future of the industry is uncertain and do not want their children in a position where they may not have work. Aside from pushing college onto students who may be a good fit for tooling and machining, guidance counselors also encourage kids that struggle in school to go into the trades. Just because a kid does not excel in traditional school settings does not mean they will be a good toolmaker. Important soft skills like basic math, punctuality, ability to learn, and attention to detail are skills required of toolmakers. As a result, lower achieving students may in fact not be equipped handle tooling and machining work. When struggling students are sent to vocational programs, those programs receive stereotypes as being for kids who struggle in school. This has the effect of driving away strong students who have an interest in the industry.

- *Disappearance of Apprenticeship Programs*: Crawford County tool shops no longer have apprenticeship programs, as they did decades ago. None of the 28 tool shops we interviewed had an apprenticeship program. Tool shops are unwilling to train young toolmakers for a number of reasons. First, training toolmakers takes time away from the company's main jobs, and often results in losses. Second, shops believe that a toolmaker may leave for another shop, after being trained. More importantly, some shops are impatient in training new toolmakers. For instance, one industry leader remarked that tool shops want new employees to be making them money within the first week of their hiring.

- *Skills Mismatch:* Tool shops are unwilling to employ toolmakers trained by local technical institutions. They claim that the skills acquired by trainees from these schools are often not suitable for the needs of the tool shops. In other words, a skills mismatch problem exists in the tooling and machining industry. Many shops said that they have had to retrain graduates from local technical training schools, in order to be relevant to their particular needs. This, according to the shops, takes time and money. Some even said that they prefer to hire and train their own toolmakers, as long as the trainees have the required soft skills.

- *Inflexible Wages:* Wage rates in the industry have not risen fast enough to reflect shortages of skills. The average wage rate for an experienced toolmaker in Crawford County is about $22 per hour. A top executive of a tool shop in the county, who has several years of experience in the industry, said the wage rate ought to be $32 an hour. He suggests that the wage rate should rise significantly, in order to attract those who would not consider tooling and machining as a career path. Some consider toolmaking not to be a high-paying job. Entry-level toolmakers make just about the same as workers employed by Home Depot, Sheetz, and Walmart.

How the Tooling and Machining Industry is Addressing the Skills Shortages Problem:

- *Investment in New Technology*: Shops are increasing their investments in multi-axis and other machines, as a substitute for skilled toolmakers. New vintages of multi-axis CNC machines enable shops to perform multiple tasks with one machine. Likewise, one machine operator can program and run multiple machines simultaneously. Newer machines can also be programmed to run 24 hours, thereby eliminating the need for many toolmakers. Despite the trend toward automation, some of the tools shops believe that skilled toolmakers are still very important for the industry to remain competitive. This is because the productivity and performance of a machine are as good as the programmer of the machine. A good toolmaker is one who can start and complete a job, who can read and interpret a design, and who can translate the design into a final product. This is in contrast to what are referred to as “button pushers”. These workers only know how to operate a preprogrammed machine as they do not understand the tooling process the machine undergoes. While investment in new machines may alleviate some of the problems associated with skills shortages, the trend toward automation is really not good for the local economy.

First, all of the suppliers of new tooling equipment are from outside Crawford County, which implies that money spent on new technologies is being received by other regions. Second, the declining number of toolmakers may have the effect of driving up the wages of the few remaining toolmakers, as well as increase production costs in the industry. For instance, a significant number of shops surveyed said that labor is a major component of their production costs.

- *NTMA Pre-Apprenticeship Program: The* NTMA is exploring a new online program to help prepare aspiring toolmakers for apprenticeship programs. This program includes courses design for precision machining and other related occupations. While online, there are practice problems, assessments, and certificates awarded for the completion of sections which ensures a student's understanding of a concept. The program also includes National Institute of Metalworking Skills specific content, and is approved by the Federal Bureau of Apprenticeship Training, demonstrating the accreditation of the program. Another aspect of the program includes the potential for students to receive college credit from the University of Akron, which is an additional benefit and attraction of the program. Within the program, a variety of skills and topics are covered including: blueprint reading and shop math, quality processes and procedures, manufacturing processes, manual/electronic measuring instruments, and basic shop equipment operation. The program also includes Mechanical Aptitude Tests which measure students' comprehension of topics such as mechanical/spatial relations, mechanical reasoning, applied mathematics, and theoretical reasoning. The program is viewed as a way to target both high school students who may be interested in the field, and also older students who may have decided that college was not for them, or are returning from military service. This program in sum, is an accredited pre-apprenticeship program that would prepare students to participate in an apprenticeship program in a shop. While brand new in Crawford County, it has been successful in Butler County and will potentially attract more young people into the field here in Crawford County.

- *Focus on Soft Skills:* One reason for skills shortages is that there are too many potential workers who lack basic soft skills that are needed in the tooling and machining industry. Tool shops are looking for young people with the following soft skills: showing up on time to work, wanting to work, willing to learn on the job, ability to take initiative, quantitative aptitude, and ability to pass a drug test.

We heard of a technical school that had 80% of their welding program graduates fail a drug test. One shop owner said he has to interview 5-6 workers in order to find one that can pass a drug test. Being able to pass a drug test in the tooling and machining industry is important because of the high- powered equipment used by shops. Being intoxicated on the job can put the worker and their co-workers in danger. Potential tool workers struggle with timeliness and are often late to work and miss days. Since training at programs like PMI or VoTECH only cover general skills, good workers learn on the job how to do specifics pertaining the shops operation. Time is money and shop owners do not want to waste the hour's senior workers on training new employees. A local training facility, the Precision Machining Institute (PMI) has introduced an "Employability Skills" course that teaches potential toolmakers proper etiquette, hygiene, dress attire, cooking, and other general life skills. Specifically, the courses teaches students how to: wash clothes, shake hands, how to interview, how to fill-out job applications, how to speak proper English, how to get ready for work, how not to curse. This raises questions of the dysfunctionality of kids going into tool making. Ultimately, this creates a stigma around tool and die work. Despite new shops being highly equipped, the perception of the industry is still one of rugged manual labor. Many parents, including shop owners themselves, do not want their kids to enter the industry. They would rather see their kids go off to college. Part of what drives people away from the industry is job stability. After watching globalization in the early 2000's and the Great Recession, people are weary of job prospects in the industry. However, this is not consistent with the findings of this report as those interviewed demonstrated not just stability but expansion of the industry. We believe the largest driver of the negative stereotype associated with the industry is that it is for kids that cannot make it in college. In some ways, poor government policy is to blame for this. It is true that some students who do not excel in the traditional classroom settings find a calling in technical careers. However, this notion has been over expanded. Now, the lowest achieving students are sent to technical schools. Students do not show up at VoTECH and become unfit to work. Their dysfunction is a bigger problem of society. Placing these students in technical schools is a disservice to the industry by wasting limited resources and promoting the stereotype that only kids that cannot make it in college undertake careers in tooling and machining.

- *Tool Shops are Becoming More Proactive in Their Hiring Practices:* Successful shops in Crawford County have become more proactive in hiring new workers in order to offset the retirements that many shops are dealing with. Locating these workers has changed from putting out a hiring notice to a much more hands on approach. Shops that have been successful in gaining new employees are actively involved with the training centers such as PMI and VoTECH. They are visiting such places and identifying potential employees. Shops are also continuing to invest in their youth by offering co-ops and providing them with quality training and shaping them to be career ready employees. The era when tool shops waited for students from the VoTECH to apply for jobs or apprenticeships is over. There are fewer students enrolled in the tooling and machining program at the VoTECH. One reason is that many of the students who could come toolmakers are being told by guidance counselors that the college-path is the best for them. Of the few high school students who choose to go to VoTECH, only a handful are passionate about toolmaking. Some tool shops, however, have begun to seek out high school students on their own. Through word of mouth and a network of friends and family members, shop owners try to find young kids who might be mentored to become toolmakers. One particular shop owner goes personally to the Meadville Area Senior High School and the VoTECH to speak with students about opportunities in tooling and machining. He has been able to attract about five of these students to work in his company. One of the students now programs and operates a 5th-axis CNC machine.

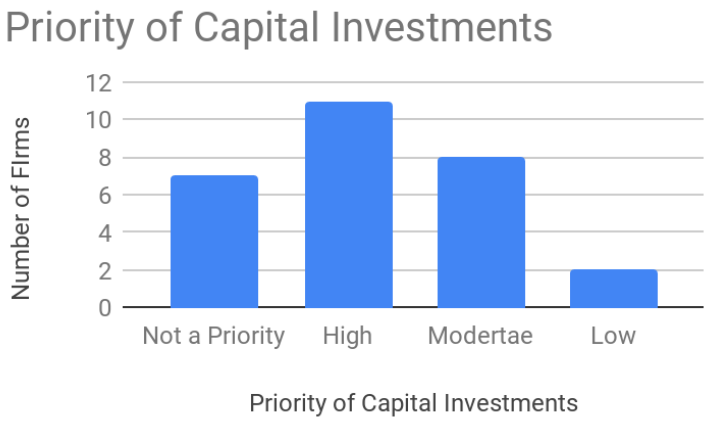
- *Robotics Competition:* RoboBOTS is an educational program introduced in Crawford County by the NTMA. Students design and build their own robots and gain scientific, mathematics, and engineering skills. The program also raises awareness for manufacturing careers for kids who enjoy hands-on and technical work and may have not known it was an option. In the years that the program has been around in the area, shops have reported that they believe it is a great program to encourage kids to explore manufacturing. As shops become more sophisticated, a new nexus is emerging for kids who are interested in computers, software, and engineering and shops with advanced technological capabilities.

VII. Investment in Technology

Our study suggests that technology has become very important for competitiveness in the tooling and machining industry. When asked how important investment in new

technology is to them, about 40 percent of the firms said it is of high priority, while almost 30 percent said it is of moderate importance. In other words, about two-thirds of the firms surveyed said investment in technology is very important for their competitiveness (see Figure 9). The 22 shops that provided information on equipment purchase spent a total of $7.1 million on new equipment during the past two years, representing an average of $320,000. Shops that consider investment in technology to be of low priority are typically those whose owners are about to retire, or firms that have just been bought by new owners. The latter firms may have taken loans from banks to finance the purchase of the firm, and therefore may not have adequate funding for new equipment. The new owners may also be preoccupied with learning about the business, and hence may perceive investment in new technology as something that would come later.

Figure 15:



The importance of technology can be observed from statements made by some of the tool shops:

> "Capacity requirements are changing and 5-axis machining is becoming standard"
>
> "We need the best technology to sell to high up medical companies"
>
> "Employees are difficult to find so we have to use automation"
>
> "Everyone becomes more productive. All of our people run multiple machines"

Technology has become Important in the Industry because of:

- *Growing Sophistication Requirements by Customers Makes Precision Key*: One shop owner told us that they go from 500 competitors to 5 by increasing precision. Another company told us how their technology holds tolerances of 1/10th. Keeping such tight tolerances makes it hard for their foreign competitors to compete. In order to survive in highly regulated fields like medical and aerospace, tight tolerances must be maintained as these products will be used in high-end activities, like surgeries and aviation, where malfunctioning products can be fatal. Without the correct sizes, electronic gadgets will not work. The addition of new technologies has allowed for an enhancement in precision. New machines like multi-axis CNC machines allow for companies to run shifts overnight and on the weekends, greatly enhancing productivity. Wire EDM's have also had large improvements. Most shops engage in subtractive manufacturing, essentially stripping away material until you are left with the product. A couple shops are now beginning to get involved with additive manufacturing, which layers on material from scratch, until left with the final product. A prime example of this is 3D printers which are gaining popularity in the industry. As a result, many shops look nothing like those of the 1960's warehouses filled with bridge ports; instead mirroring high-tech laboratories. Not all shops have been able to fully capitalize on technological advancements.

- *Shop Size:* Smaller shops tend to be behind when it comes to investing in new machinery. The bigger a tool shop, the more likely that investment in technology would be a top priority. Smaller shops typically use older equipment for various reasons. Given their small sales volume, they are able to meet their customers demand despite using old equipment. Most of the owners of the smaller shops are close to retirement, and therefore do not see the need for investment in new technology. The owners of smaller shops were trained in the old apprenticeship system, which makes them unfamiliar with the intricacies of new technologies. Some shops that have recently been purchased are not investing in new equipment. Their new owners have just invested huge sums of money purchasing the shop, and expensive investment in new equipment is not a high priority at the moment. Furthermore, not all shops need high tech equipment. The nature of the parts these firms produce prevent the production process from being fully automated. When it comes to financing capital improvements, most firms went through their bank. Few have trouble with this process. Those

who have existing debts, usually from purchasing the company, tended to have a harder time obtaining funds. Some shops were able to take advantage of loan programs. One that continued to reappear was the Northwest Commission who provides low interest loans for equipment purchases. Another popular option for financing machine purchases was to lease the machine. In this case, the sellers would reposes the machine under payment failures.

- *Complexity of Products*: The industries that tool shops serve are increasingly producing complex products that require close-tolerance machining. A mistake in the process of machining these complex products could cost a tool shop several thousands of dollars. The use of new technology, such as multi-axis CNC machines, new vintages of wire EDM machines, and 3-D printing, helps minimize errors in machining and enhances the quality and productivity of the shops. New technologies also save labor cost, which means that local shops can now compete better with low-cost countries like China, Mexico, and Vietnam. Multi-axis CNC machines enable shops to machine different parts of an equipment, whereas in older technologies, various parts are machined by different machines. New technology is needed to compete in new markets such as tooling and production for medical equipment, telecommunications, and oil and gas.

- *Easy Access to Finance:* Various financing options (equipment leasing, low-interest bank loans, low-interest financing by economic development agencies, etc.) allow shops to easily acquire new equipment. Although most of the tool shops said they have no trouble obtaining loans from local banks to purchase new equipment, a common mode of financing new equipment through leasing over a period of time. Under this arrangement, a tool shop leases equipment from a finance company (such as the US Bank Corporation) for about five years, and then pays $1 at the end of the lease to purchase the equipment.

VIII. New Patterns of Ownership and Succession Problems

The T&M industry in Crawford County has witnessed significant changes in ownership patterns in the past 15 years or so. Originally, the industry was pioneered by about eight tool shops (Gray, 1963), whose owners were apprentices and later toolmakers at the Talon Zipper Company. These first-generation tool shops became very successful and expanded their sales and employment. Most of them retired in the 1980s and early 1990s, and passed on their businesses to family members, who then became second-

generation owners. There are a few second-generation shops that are owned by non-family members, but this is not a common mode of ownership. Now, the second-generation owners are in their late 60s and 70s, and they have been grappling with succession issues. The second-generation owners are retiring at a time when, unlike their youth, it is no longer fashionable to be a tool maker. In fact, second-generation owners have been telling their children not to consider a career in tooling and machining due to uncertainty and instability. Children of the second-generation owners have taken up other careers, and many have opted to go to college. Thus, the second-generation owners have found themselves in a quandary: they do not have family members to pass on the business.

The transfer of tool shops to non-family members has both pros and cons. One advantage is that it enables new ideas to be infused into the business, and those new ideas can be instrumental for the success of the business. Second, it enables tool shops that have been doing the same things for years to break-out of their path-dependency and explore new opportunities. In other words, it breaks the culture of complacency and conservatism that sometimes plague tool shops. But there are also downsides to ownership by non-family members. For instance, non-family members may not have the emotional commitment for the success of a shop. Despite their new perspectives, some wonder whether new owners can be as effective as family owners, because they lack the same experience and historical insights needed to operate the shop. The new owners may lose long standing customers, who may not trust the competency of the new owners. Trust is a major factor in business success, and it is often established after several years of interaction with customers. To maintain trust in the business, it is not uncommon for former owners to stay on after selling a tool shop, so as to assist the new owners gain experience, understand the business, and gain the trust/confidence of customers. Lastly, non-family members may purchase a tool shop for reasons that may not be in the interest of the local community. For instance, there was a recent purchase in which an outside firm bought a Crawford County tool shop and stripped it of its valuable assets. Not only that, the purchaser sold the property, then shut down the company causing employees to lose their jobs.

The most common type of succession in the T&M industry is one in which shop owners pass the business along to some of their employees. This may be a one-time transfer or done gradually over time where employees are incrementally sold portions or shares of the firm. The goal is for the owner to eventually sell his or her ownership to the employees, and retire completely from the business. Gradually allowing employees to own shares of a tool shop enables them to learn about management the business, which then enables the shop owner to relinquish ownership and control of the business later on.

However, another option is to sell the business to out-of-town companies, some of whom are customers of the tool shop. These out-of-town firms, not wanting to lose their long standing suppliers, prefer instead to buy them out. Letting tool shops go out of business for lack of succession is not in the best interest of firms that rely on these parts. At the moment, this is not a common occurrence, but could become more prevalent. Recently, a trend has been for shops to be purchased by other shops. Typically, the purchasing shop is looking to expand and acquiring an existing shop is easier than expanding their existing production facility. Sometimes, a purchase is made so a firm can diversify into a new market.

As a manifestation of changes in ownership patterns in the T&M industry, , about 60 percent of the firms surveyed for this study are jointly owned by either members of the same family, by employees of the firm or jointly between employees and outside investors. The other firms are owned by one person. For the most part, the firms that are owned by a single person appear to be those that are small in size, usually employing less than 15 workers. In fact, over 70% of shops surveyed with a single owner met this criteria. The tooling and machining industry has transited from the era in which there was a single owner, who was usually the original founder.

The lack of succession plans is a major issue in the T&M industry. [6] Of the 28 shops interviewed, only five firms had definitive succession plans. Table 2 summarizes the succession plans of these tool shops. Company D had the best plan for succession. Not only have they identified young workers with the potential to run the company in the future, they are actively finding ways to integrate these employees as leaders in the business. However, lacking a succession plan is not necessarily indicative of failing to prepare for the future. Some interviewees are new owners, or younger and have significant time to plan the future of the company for when their time at the firm comes to an end. Also, a significant number of firms are open to selling or merging, but these decisions are contingent on market conditions and prices. Lacking a well thought out succession plan can be problematic. Thus, succession must be seriously considered, even if the firm does not plan to have family takeover the business. At the same time, assuming a family member will takeover can be a dangerous assumption.

[6] So important is the issue of succession that the Northwest PA Industrial Resource Center (NWIRC) decided to organize a workshop on succession planning for Crawford County manufacturers in July 2019.

Table 2: Companies with Succession Plans

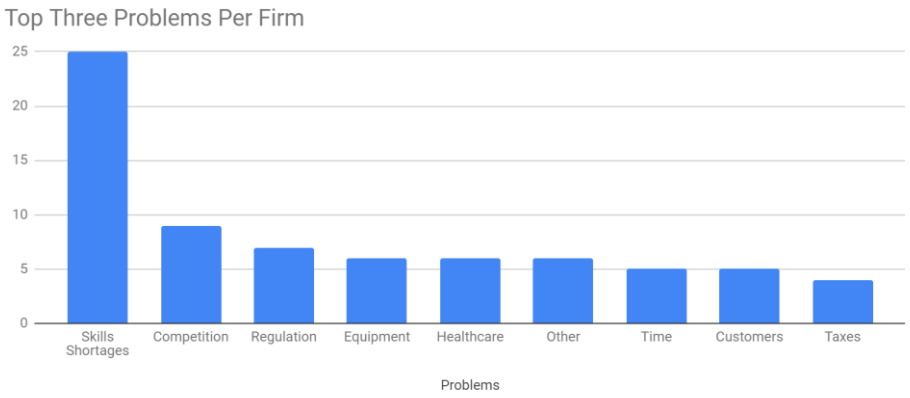
Company A	Plans to sell shares to a younger partner.
Company B	Will pass along the company to the next family generation
Company C	Has identified 3 potential employees who would be able to take over.
Company D	Identified a group of employees who have demonstrated leadership qualities and has begun grooming them through weekly leadership meetings and training.
Company E	Has next generation already in place and prepared to take over when current leadership decides to retire.

It appears that the era of one or two-man shops is almost over. From the 1980s – the 2000s, there were many micro tool shops (those employing between 1 -5 employees) in Crawford County. Hit by the recessions of 2001 and 2008, many of these tool shops shrank to one-man shops. Now, their owners are at retirement age and in the process of winding up. Potential buyers of tool shops are typically not interested in very small shops, as they often offer very little by way of value –either of assets, reputation or number of customers. These one man shops are likely to auction off their equipment and sell their building and real estate.

IX. Major Challenges in the Tooling and Machining Industry

The shops surveyed were asked to identify the three top challenges they face. As previously mentioned, skills shortages are a major problem and 23 out of 28 firms indicated it was one of their top three biggest challenges (Figure 16).

Figure 16:



Next to skills shortages, the other challenge is local and foreign competition. In the past, tool shops in Crawford County complained of only foreign competition and the lack of a level-playing field with Chinese tooling and machining shops. Many of them now say that foreign competition, while still a challenge, is no longer as onerous as in the past. Rather, domestic competition has become more formidable. Within the United States, local tool and die shops are facing more competitors. Local shops are moving into more specialized production and it appears competition in these markets takes the form of high quality domestic products. Thus, a significant number of firms listed domestic competition as a major challenge.

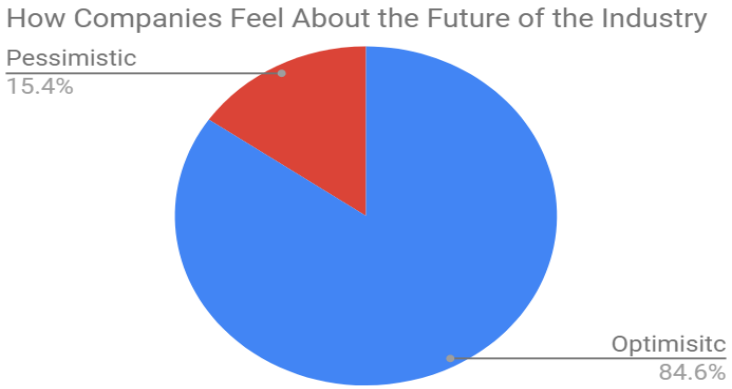
Regulation is another challenge identified by many of the firms we surveyed. Most shops feel the industry is appropriately regulated, but the Occupational Safety and Health Administration (OSHA) is causing problems for many shops. OSHA never used to be a problem for many shops in the past, but our interviews with tool shops suggest OSHA has increased their presence. One shop that was recently audited said that his company had not been audited in 50 years. But tool shops are typically able to negotiate OSHA fines, and sometimes succeeded in having OSHA waive the entire fine. Often, micro (1-6 employees) and small (7-20 employees) sized firms do not attract much attention from OSHA because of their small number of employees. At the same time, large (31-40 employees) and macro (40+ employees) firms may experience more OSHA audits, but because of their size, they have the resources to hire managers and consultants for the purpose of OSHA compliance. Medium (21-30 employees) sized shops have enough employees to attract regular OSHA visits but are not large enough to hire someone to deal with OSHA regulations. For medium sized firms, 75% had trouble with OSHA. When looking at small, medium, and large firms, over 60% of them had OSHA trouble. Problems with OSHA seem to be concentrated on average sized firms, with larger and smaller firms avoiding OSHA problems. For instance, only one of each of

the micro and macro sized firms had OSHA trouble. With regard to OSHA, a significant number of shop owners felt that OSHA was "out to get them." Shop owners value their employees and want to have a safe work environment. Despite having the same goal, shop owners feel OSHA is more interested in entrapping tool shops, in order to impose fines, than worker safety. For instance, OSHA has imposed fines up to $50,000 for violations such as not having updated color coding or not having labels on everything. Tool shops believe that OSHA should play a more constructive role and help educate firms on how to keep employees safe. Instead, OSHA opts to surprise firms by using new regulation updates as excuses to impose fines. In order to ensure OSHA compliance, one shop hires an outside organization to come in and do a yearly audit, based on OSHA standards, to reduce the chance of infractions.

X. Conclusions and Recommendations

About fifteen years ago, most of the county's tool shops were very pessimistic about the future of the industry. This pessimism arose from the fact that foreign competition was becoming unbearable, demand for tooling was falling, manufacturing in the country was declining, skills were being lost in the county, and government policies were hurting the industry. During our current survey, we asked tool shops about their perspectives and expectations of the industry's future. A vast majority, 85%, of the shops expressed optimism about the future of the industry.

Figure 17:



Some shops responded as follows:

"Small tool shops will go away."

"We plan to double in size in the next 10 years."

"Incredibly bright future."

"Fewer shops, fewer toolmakers, but better margins for owners through M&A and automation."

"The industry is stronger than 10 years ago."

"It is not going to go away. We would like to take advantage of a niche, limit our debt and reinvest in technology."

"We are planning to double our manufacturing space, purchase larger machines, grow employees and gain productivity."

"We are planning to purchase more machines and employ more workers."

"Hopefully still in business."

To sustain the gains achieved by Crawford County tool shops in the past few years, we suggest the following:

- Among shops that employ a large number of young workers, a common trend is that they actively recruit students. This allows shops to select kids with good preexisting soft skills. As previously mentioned, soft skills are lacking among young toolmakers. By recruiting kids that demonstrate these skills, shops can get better quality employees. When talking to shops that actively recruit, all of them were impressed with the work ethic and ability to learn demonstrated by their young workers. Further, having younger workers is the best way to attract new young workers, meaning active recruitment can go a long way in creating a younger workforce.

- We recommend greater collaboration between tool shops and local institutions responsible for training toolmakers, especially the Precision Machining Institute (PMI) and the Crawford County Career and Technical Center (VoTECH). It appears there is miscommunication between these institutions and tool shops, with regard to the needs and expectations of the shops. Consequently, tool shops complain that graduates from these institutions are not employable in tool shops, until they have been retained by the shops.

- One of the most effective ways for training toolmakers is in house, mainly through apprenticeship programs. But in house training takes production time away from experienced toolmakers, and hence costly to shops. The state and federal governments should give subsidies or tax credits to tool shops that train toolmakers.

- One way of encouraging young kids to enter the industry is to offer more competitive wages. This would make the T&M industry more attractive than working a job at a gas station or supermarket. One interviewee said he would encourage his child to enter the industry if they could make at least $30,000 annually, about $15/hr.

- A problem identified in the report was the lack of succession plans for companies. Company owners should craft their plans early to chart a path for the future. One suggestion is to identify potential successors and begin to train them to be leaders and teaching them to operate a business. Business skills are becoming more important and popular in the T&M industry, and should be considered in succession plans. Local economic development agencies should hold workshops and seminars on succession planning, for the purpose of educating tool shops on issues to be addressed in planning the future ownership of their companies.

- Technology is continuing to be of importance to shops in the area. To help pay for new technology, shops should take advantage of leasing programs to help pay for, and eventually take ownership of new technology. With always advancing technology this could be crucial in staying competitive in the industry and shops should be mindful of both updating and maintaining their technological capital.

- OSHA has become an increasing problem for tool shops. We recommend that OSHA work more with tool shops as consultants and advisors instead of disciplinarians. If the goal is about keeping workers safe, tool shops could benefit from constructive feedback from OSHA with fines being a last resort option in truly unsafe environments.

- There appears to be a mismatch between what shops are looking for in employees and the skills taught by PMI and VoTECH. It is commonly said that the top kids in these programs are good but outside of these few, the quality drops off. In some ways, these education institutions are limited by the quality of their students. To qualify for funding, they have to meet certain quotas which can undermine the quality of their graduates. We suggest state policy makers looking into alternative forms of funding. One option is to set up co-ops with shops where new workers can get on the job training. Under the co-op, a fraction of the employee's salary would be paid by the state, partially offsetting the high cost of training new employees.

In conclusion, we expect shops to become more consolidated in the future. We are seeing this now with acquisitions, either by other shops or by a customer. Smaller firms will have a harder time competing with larger firms as technology advances. The high cost of capital will create a barrier to entry for small firms. Smaller tool shops, especially those employing less than 10 workers, will gradually disappear. As technology becomes more important in the production process, tool makers will be replaced with high skilled engineers who can program machines. In this system, one programmer can operate multiple machines at once, becoming more efficient. This will result in fewer jobs in tooling but increased wages for remaining workers, who will likely have a very high marginal product. While there will be less tool making jobs, it is probable that shops will expand employment in administrative positions, finance and accounting, customer service, and marketing and sales.

Appendix 1:

Materials and Percent Cost

Company	Major Materials Used	Cost of Steel and Aluminum as % of Total Cost	Use of Foreign Steel or Aluminum
A	Steel and Aluminum	10	Yes, aluminum
B	Steel, Aluminum, Brass	10	Yes
C	Steel and Aluminum	10	Yes
D	Steel, Aluminum, Plastics	0	No
E	Steel, Iron, Haynes, Aluminum	17.5	Yes
F	Steel, Plastics, Brass, Aluminum	25	No
G	Steel and Aluminum	12.5	Unsure
H	Steel and Aluminum	10	No
I	Steel, Aluminum, Nickel. Plastics, Copper/Bronze	24	Yes
J	Steel and Aluminum	15	No
K	Steel	26	Yes

L	Steel, Aluminum, Plastic	80	Yes, steel
M	Steel and Aluminum	20	Yes
N	Steel and Plastic	50	Yes
O	Steel, Aluminum, Carbides	18	No
P	Steel, Aluminum. Wire	25	No
Q	Any type of metal	30	No
R	Steel and Aluminum	80	Unsure
S	Steel, Aluminum, Plastics	10	No
T	Steel, Aluminum, Plastics, Inconel	5	No
U	Steel, Aluminum, Plastics	10	Unsure
V	Steel and Aluminum	30	Yes
W	Steel	25	Yes
X	Steel and Aluminum	9	No
Y	Steel, Aluminum, Plastics	10	Yes

Appendix 2:

Tool and Machine Shop Survey

As a summer research project through Allegheny College, we are doing an economic analysis of the Tool and Die industry in Northwest Pa. We understand the industry has a strong history in the area and is one of the major job providers. In light of this, we want to see how the industry is currently performing. Specifically, we wish to explore the impact of tariffs on steel and aluminum on the tool and die industry. Information from this survey is for academic purposes only. Confidentiality will be provided for all completed surveys. Company names and figures will not be revealed. At any time during the survey, if you do not feel comfortable giving a specific value or piece of information, please provide a range. If absolutely necessary, skip the question. Depending on your answers, some questions will have follow up questions. If the follow up questions are not applicable, feel free to skip them. We thank you for your participation. Upon the completion of our research, we will share our general findings in a report with those who completed the survey. Thanks again!

1. **What is the name of your company, and when was your company founded?**

2. **What is your role in the company?**

3. **Is the company publicly or privately owned?**

Public

Private

4. **Who are the owners of the company?**

5. **What type of incorporation do you have?**

6. **What products does the company produce? (Molds, Precision Machinery, etc)**

7. **What industries does your business serve? If other, please specify.**

Medical

Auto

Electronics

Aerospace

Consumer Goods

Oil and Gas

Telecommunications

Energy

Other:

8. **How many firms (customers) do you serve?**

9. **Do you sell more than 50% of your sales to one of these customers?**

Yes

No

10. **Where do you get your**

customers?

They come to me

I have to find them, but it is relatively easy

I have to find them, and it is difficult

Other

11. **How many employees do you have?**

12. **How has your employment changed over the last 10 years?**

13. **What were your sales in 2018? (Company sales will not be revealed in final report)**

14. **What were your sales in 2008? (Company sales will not be revealed in the final report)**

15. **How much of a priority are capital investments for your firm?**

High priority

Moderate Priority

Low Priority

Not a priority

16. **How often do you purchase new equipment?**

Annually

Every 1-2 years

Every 2-5 years

Over 5 years

Not applicable

17. **If you have purchased new equipment in the past 1-2 years, how much have you spent on purchasing the new equipment?**

18. **If you haven't purchased new equipment recently, why?**

Difficulty financing

Trouble identifying useful technology

Limited storage capacity

Not necessary

Other:

19. **Please list some of the main production materials used.**

20. **Check all that apply:**

	One Supplier	Multiple Suppliers	Domestic	Foreign
Steel				
Aluminum				

21. **If possible, can you provide where you buy your steel and**

aluminum from?

22. **What percentage of your production costs comes from aluminum and steel?**

23. **Have the tariffs on steel and aluminum made it difficult for you to obtain these materials?**

Yes

No

Unsure

24. **By what percent, if any, will the new steel and aluminum tariffs raise your costs?**

25. **If so, what actions have you taken, or plan to take, to reduce costs?**

Lay off workers

Cutback hours

Reduce employee benefits

None, pass on costs to consumers

Other

26. **Do you feel there are benefits of the tariffs to your firm?**

Yes

No

Yes and no, it depends

27. **Do you feel that the tariffs benefit or harm the tool and die industry? Please Explain:**

28. **Do you feel that the tariffs benefit or harm the country? Please Explain:**

29. **In your opinion, how should the government support the tool and die industry?**

30. **Do you think the tool and die industry is:**

Over regulated

Appropriately regulated

Under regulated

31. **If over regulated, which parts of the industry are over regulated?**

32. **Do you face competition from foreign firms? If yes, please describe the nature of the competition.**

33. **How would you describe the quality of foreign tool and die products and inputs?**

34. **What are your three biggest challenges? Please feel free to include challenges that have not been previously mentioned.**

35. **Have you, or do you anticipate your firm experiencing succession problems?**

Yes

No

Unable to Tell

36. **Have you considered selling your business? If so, why?**

37. **Where do you see your company and the tool and die industry in the next 10 years?**

38. **Do you see opportunities for future growth of your company? If so, explain.**

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