Skilled Trades Gap Analysis Report: Final Report

October, 2007

A Study Commissioned by the
Virginia Manufacturers Association,
Virginia Workforce Council, and
Virginia Manufacturing Advisory Council

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October 17, 2007

Dear Friends:

The Skilled Trades Gap Analysis Report is the culmination of years of collaboration between the public and private sector aimed at documenting the precise gap between the supply of and demand for skilled workers in Virginia's manufacturing sector. The Report is the product of nearly two years of research by some of the best economists, survey researchers, workforce development professionals and manufacturers in the Commonwealth. This research will give decision-makers actual "real time" data about the workforce needs and experiences of the manufacturing sector.

Retirements, technology and markets are driving change faster than our current workforce development system can respond. Coupled with the image problems facing the industry, this report outlines some significant challenges in our immediate future. That being said, our industry is moving ahead to meet these challenges directly. Systemic change is never easy and is rarely accomplished alone; therefore, the manufacturing sector invites all stakeholders to join us in this effort.

I would also like to acknowledge the outstanding research conducted by Mangum Economic Consulting and Alan Newman Research. Their independent expertise enabled us to produce this report. I would also like to thank Governor Kaine and his Administration, the Virginia Workforce Council, the Manufacturing Advisory Council's Skilled Trades Committee and the hundreds of manufacturers across this Commonwealth that took the time to participate in the survey research process.

In closing, the Skilled Trades Gap Analysis Report is an important tool in helping us chart our future workforce development path. It is up to each of us to use this tool and share in the development of immediate and meaningful solutions that will close the skilled trades gap. Ultimately, the conclusions in this report clearly detail that the "wealth" in our Commonwealth may very well depend upon our collective actions.

Sincerely,

Brett Vassey
President and CEO

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Executive Summary

This report presents the findings from the Virginia Manufacturers Association (VMA) Skilled Trades Study. This study was conducted in two phases. Phase 1 involved using existing labor and education databases to provide a preliminary analysis of the scope and magnitude of the problems associated with meeting the demand for skilled trades workers in Virginia. Phase 2 involved surveying Virginia manufacturers to obtain primary data on skilled trades employment, evaluate potential refinements in the occupational categories used to define skilled trades, and compile information on various hiring and training issues.

This study was commissioned by the Virginia Manufacturers Association through a grant from the Virginia Workforce Council and in cooperation with the Virginia Manufacturing Advisory Council, an ad hoc group of representatives from private sector employers, Virginia's Commerce and Trade Secretariat, Virginia Tech, the Virginia Philpott Manufacturing Extension Partnership, the Virginia Employment Commission, and the Virginia Manufacturers Association. The analysis presented in this report also benefited greatly from advice and directed provided by the Virginia Manufacturing Advisory Council's Skilled Trades Committee.

The adequacy of the skilled trades pipeline has become an issue of increasing importance to manufacturers because a general slowdown in the growth of the U.S. labor force, coupled with a large pending wave of retirements and the increasingly high-tech nature of manufacturing, are making it increasingly difficult to find adequate numbers of skilled trades workers. Absent proactive policy solutions, this combination of events is very likely to create crippling bottlenecks that have the potential to forestall economic growth.

The most salient findings to emerge from the Phase 1 empirical analysis are:

1. There are several instances where the current statewide educational pipeline for skilled trades appears inadequate to meet future needs:
   - Overall, the average percentage of statewide need met across all twelve of the skilled trades evaluated in this portion of the study was only 44 percent.
   - The cumulative gap between 2007 and 2012 (the shortfall in needed skilled trades workers) is estimated to be 12,894 trained workers.
   - In two of the twelve skilled trades evaluated (*i.e.*, Chemical Equipment Operators and Chemical Technicians) the percentage of statewide need met was zero.
   - In six (*i.e.*, Extruding and Drawing Machine Setters; Machine Maintenance Specialists; Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic; Stationary Engineers and Boiler Operators; Tool and Die Makers; and Welders) the percentage of statewide need met fell below 25 percent.
   - In one (*i.e.*, Machinists) the percentage of statewide need met fell below 75 percent.
   - Only in three of the skilled trades evaluated (*i.e.*, Computer-Controlled Machine Tool Operators; Electrician and Electrical Technicians; and Printing Machine Operators) was the percentage of statewide need met above 75 percent. Moreover, for one of these skilled trades, Electricians and Electrical Technicians, this finding is largely attributable to the fact that a large number of the graduates in that educational pipeline are actually not typically employed in manufacturing.

2. In addition, there appear to be several regional imbalances in the demand and supply for specific skilled trades:
   - *Chemical Equipment Operators and Chemical Technicians* – there appears to be a potential need for additional training programs in Central Virginia.
   - *Computer-Controlled Machine Tool Operators* – there appear to be potential unmet needs in Southwest Virginia and Hampton Roads.
   - *Machine Maintenance Specialists* – there appear to be opportunities for enhancing the educational pipeline for these workers in Northern Virginia and Hampton Roads.
   - *Multiple Machine Tool Setters, Operator, and Tenders, Metal and Plastic*, and *Printing Machine Operators* – there may exist unmet needs in the Valley Region.
   - *Welders* – there appear to be opportunities for enhancing the educational pipeline for these workers in Hampton Roads.
3. Analysis of institutional capacity within the Virginia Community College System, one of the major providers of trained skilled trades workers, indicates that 10 of the system's 23 colleges are already operating at, or above, capacity. This constraint likely inhibits their ability to add to the skilled trades educational pipeline with existing resources. Moreover, it bears notice that these ten institutions primarily serve the urban centers of Northern Virginia, Central Virginia, Hampton Roads, the Valley Region, and Roanoke, where the bulk of the demand for skilled trades workers takes place.
4. Several factors were revealed in this portion of the study that point to the need for a survey of Virginia manufacturers to obtain primary data on skilled trades employment.
   - In certain skilled trades occupations (*e.g.*, Electricians and Electrical Technicians) it is difficult to accurately assess the manufacturing-specific demand and supply of the skilled trade workers from existing data. There are three reasons for this. First, on the demand side,

with some additional adjustments, industry-specific occupation data are imputed using the average proportion of industry employment comprised of that occupation, not measured directly. This raises questions of accuracy, particularly at the regional level. Second, on the supply side, existing crosswalks between occupations and related training programs are insufficient to identify the proportion of graduates from specific training programs that go into specific occupations. As a result, it is difficult to gauge the true educational pipeline of trained workers for specific skilled trades. Third, the outsourcing by manufacturers of certain skilled trade functions to other industries (*e.g.*, construction) also makes it difficult to quantify the manufacturing-specific demand and supply of the skilled trade workers, because those numbers are credited to the other industry in existing data.

- The Virginia Employment Commission (VEC) does not forecast occupational employment directly. Instead, with some adjustment, the occupational forecast is derived from the VEC's forecast of industry employment. Any errors associated with this derivation are likely to be exacerbated in "small numbers" situations where a specific occupation comprises a small proportion of the overall employment in a given industry – a characteristic exhibited by many of the skilled trades.

The most salient findings to emerge from the Phase 2 survey of Virginia manufacturers are:

1. Growth in skilled trades employment is likely to far outstrip employment growth in most other occupations:
   - Total employment in the nine skilled trades evaluated in Phase 2 is expected to climb by about 4.1 percent per year between 2007 and 2010, for a total increase of 12.8 percent. To put this growth rate in perspective, the Virginia Employment Commission currently projects that, over the same period, statewide growth across all occupations in Virginia will only be 1.6 percent per year.
   - In seven out of the nine skilled trades evaluated, annual employment growth is expected to be substantially above the statewide average.
   - At 5.2 percent per year, *Manufacturing Technicians* are expected to experience the largest growth in employment.
2. Based on the survey data, the cumulative number of skilled trades openings could be much higher than estimated in Phase 1:
   - The cumulative number of skilled trades openings from 2007 through 2010 is estimated to be 46,870.
   - 10,837, or 23.1 percent, of these openings will be driven by retirements.
   - *Manufacturing Technicians* are expected to experience the largest number of openings, accounting for 22,606 of the 46,870.
3. The magnitude of the gap, or shortfall, in trained skilled trades workers may also be much greater than was revealed in Phase 1 of the study:
   - Where the Phase 1 analysis showed an annual gap in trained workers of approximately 2,441[1], data from the survey indicate that this number may be as high as 11,751 (although, it is important to note that much of this increase is attributable to the introduction of the new job category *Manufacturing Technician* in the Phase 2 analysis – a job category for which no corresponding educational pipeline data is available).
   - Where the Phase 1 analysis showed that the cumulative gap between 2007 and 2012 was around 14,646[2], data from the survey indicate that this number could be as high as 70,506 (although, again, it is important to note that much of this increase is attributable to the introduction of the new job category *Manufacturing Technician*).
   - Where the percentage of the statewide need for trained skilled trades workers accommodated by the current educational pipeline was 33 percent according to the findings from the Phase 1 analysis[3], data from the survey indicate that this number could be as low as 12 percent.
4. An overwhelming majority of manufacturers approved of the proposed *Manufacturing Technician* job category.
   - 96 percent of manufacturers who responded to the survey thought that *Manufacturing Technicians* captured a class of manufacturing jobs that are not adequately represented in the traditional definition of skilled trades occupations.
   - 70 percent of the manufacturers who responded to the survey were supportive of adding *Manufacturing Technicians* to the official BLS occupational taxonomy.
5. Entry-level workers suffer from low skills:
   - Nearly half of the manufacturers who responded to the survey rated the soft skills and measurable skills preparation of recent entry-level hires as fair to very poor.
   - Seven out of ten rated recent entry-level hires' knowledge of basic manufacturing principles as fair to very poor.
6. Statewide credentialing could greatly improve the hiring process:
   - 83 percent of the manufacturers who responded to the survey agreed that there should be additional requirements for career and technical education in Virginia's K-12 education system.
   - 66 percent of respondents agreed that Virginia should institute a standardized manufacturing skills credential system that would certify the competencies of entry-level and advanced manufacturing workers.

1 This number has been adjusted to reflect differences in the specific skilled trades evaluated in Phase 1 and Phase 2.

2 *Ibid.*

3 *Ibid.*

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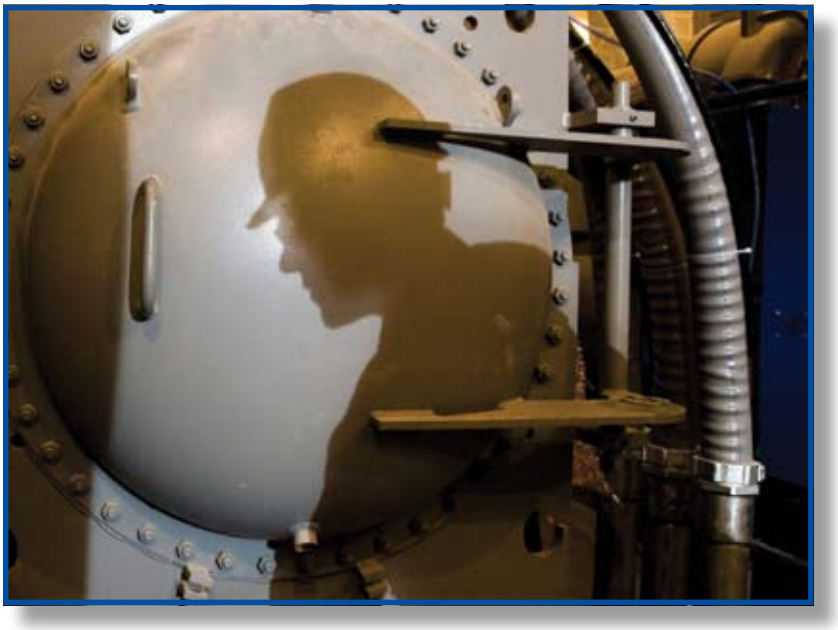


Introduction

This report presents the findings from the Virginia Manufacturers Association (VMA) Skilled Trades Study. This study was conducted in two phases. Phase 1 involved using existing labor and education databases to provide a preliminary analysis of the scope and magnitude of the problems associated with meeting the demand for skilled trades workers in Virginia. Phase 2 involved surveying Virginia manufacturers to obtain primary data on skilled trades employment, evaluate potential refinements in the occupational categories used to define skilled trades, and compile information on various hiring and training issues.

This study was commissioned by the Virginia Manufacturers Association through a grant from the Virginia Workforce Council and in cooperation with the Virginia Manufacturing Advisory Council, an ad hoc group of representatives from private sector employers, Virginia's Commerce and Trade Secretariat, Virginia Tech, the Virginia Philpott Manufacturing Extension Partnership, the Virginia Employment Commission, and the Virginia Manufacturers Association. The analysis presented in this report also benefited greatly from advice and direction provided by the Virginia Manufacturing Advisory Council's Skilled Trades Committee. This project would not have been possible without the support of former Secretary of Commerce & Trade Mike Schewel, Virginia Employment Commissioner Dee Esser and Senior Advisor to the Governor for Workforce Danny LeBlanc. Further, it should be recognized that former Governor Mark Warner and current Governor Tim Kaine expended funds for this project from the Governor's discretionary funds included in the Virginia Workforce Investment Act.

The remainder of this report is divided into four sections. The *Background* section provides information that frames the issues surrounding skilled trades employment within the manufacturing sector and explains the important role that these jobs play in promoting Virginia's continued economic prosperity. The *Phase 1: Empirical Analysis* section presents findings from Phase 1 of the study. The *Phase 2: Survey of Virginia Manufacturers* section presents findings from Phase 2 of the study. This is followed by a *Conclusions* section that draws together and distills the major findings from the preceding sections.

Background

Virginia's Manufacturing Sector

Manufacturing remains a critical and evolving component of Virginia's economy. In 2006, 296,054 individuals were employed in Virginia's manufacturing sector. Manufacturing accounted for 8.1 percent of all statewide employment that year, down from 14.8 percent as recently as 1990.[4] However, this decline in employment is indicative of both weakness and strength. On the one hand, it is partly attributable to low-skilled manufacturing (*e.g.*, textiles and furniture) moving off-shore in search of cheaper labor. On the other hand, it is also reflective of technology-driven increases in labor productivity (*e.g.*, in electronic equipment, paper, semi-conductor, steel, and transportation equipment production) that have significantly enhanced industrial efficiency and reduced the need for labor, including new lean manufacturing techniques that have resulted in the outsourcing of some traditionally in-house operations, such as information technology.

Even with these reductions in employment, manufacturing still plays a major role in the state's economy. It remains the state's 4th largest sector in terms of private employment.[5] It also ranks 8th with respect to average monthly earnings.[6] Moreover, these statewide statistics do not adequately convey the extent to which manufacturing continues to serve as the backbone of several of the state's regional economies. For example, where manufacturing constitutes only around 8.1 percent of statewide employment, in Southside Virginia it accounts for 18.6 percent of employment, in Southwest Virginia 18.3 percent, in the Valley Region 16.4 percent, and in Hampton Roads 9.6 percent.[7] In addition, these jobs pay wages that are significantly above the average for these regions. In Southside Virginia the average annual wage in manufacturing is 36.3 percent above the regional average, in Southwest Virginia 26.9 percent above, in the Valley Region 26.1 percent above, and in Hampton Roads 36.2 percent above.[8]

Finally, it is important to note that the true impact that manufacturing has on Virginia's economy far exceeds its own direct employment. Because of the nature of manufacturing, manufacturers tend to purchase more inputs (*e.g.*, raw materials, intermediate manufactured goods, energy resources, and labor) than other sectors of the economy (*e.g.*, the service sector) and they tend to purchase a larger proportion of those inputs locally. As a result, the ripple effects that manufacturing has on the state economy tend to be much greater than those generated by other sectors.

In addition, because most local and state tax regimes were first created and implemented more than a century ago, they were designed to capture tax revenue from an economy that was almost solely comprised of agriculture and manufacturing. The residual effect of this artifact of history is that the instruments of state and local taxation tend to disproportionately target manufacturing relative to other sectors of the modern economy, such as the ever burgeoning professional services sector. Because of this, manufacturing also tends to contribute proportionately more in tax revenue than do

4 *Data Source*: Virginia Employment Commission, "Quarterly Census of Employment and Wages."

5 *Data Source*: U.S. Census Bureau, Data Integration Division, Longitudinal Employer-Household Dynamics Project. Manufacturing ranked 4th out of 19 industry sectors in terms of average quarterly non-government employment for the period spanning the third quarter of 2005 through the second quarter of 2006 (the most recent four quarters of data available). Only Retail Trade; Professional, Scientific, and Technical Services; and Health Care and Social Assistance exhibited higher quarterly private employment.

6 *Data Source*: U.S. Census Bureau, Data Integration Division, Longitudinal Employer-Household Dynamics Project. Manufacturing ranked 8th out of 19 industry sectors in terms of average monthly non-government earnings for the period spanning the third quarter of 2005 through the second quarter of 2006 (the most recent four quarters of data available).

7 *Data Source*: Virginia Economic Development Partnership, "Manufacturing Impact and Economic Diversification Plan (FY 2007 – 2011)," Senate Document Number 19, Commonwealth of Virginia, 2006.

8 *Ibid*.

other sectors of the economy.

For these reasons, it is not surprising that according to a recent study by the Virginia Economic Development Partnership, the combined direct (*i.e.*, expenditures by manufacturers on wages and other inputs) and indirect (*i.e.*, the ripple effects that the direct expenditures have as they spread out across the state's economy) economic impact of Virginia's manufacturing sector is $172.0 billion in annual economic output, $6.3 billion in state and local tax revenue, and 1,015, 971 jobs.[9] Put simply, this means that some 27 percent of the total number of jobs in Virginia are tied to, and dependent on, the manufacturing sector.

The Skilled Trades Issue

There are at least three factors driving heightened concern within the manufacturing sector regarding the future supply of skilled trades workers – a general slowdown in the growth of the U.S. labor force, a large pending wave of retirements, and the increasingly high-tech nature of manufacturing and the changing labor force requirements that such a change entails. Each of these factors is addressed in turn.

GROWTH IN THE U.S. LABOR FORCE IS SLOWING

As shown in Figure 1, where the U.S. labor force grew at an average of 1.7 percent per year between 1950 and 2000, current projections anticipate a precipitous decline in that growth rate, falling to 0.3 percent between 2020 and 2030.[10] In fact, if not for immigration, growth in the U.S. labor force would probably fall below zero.

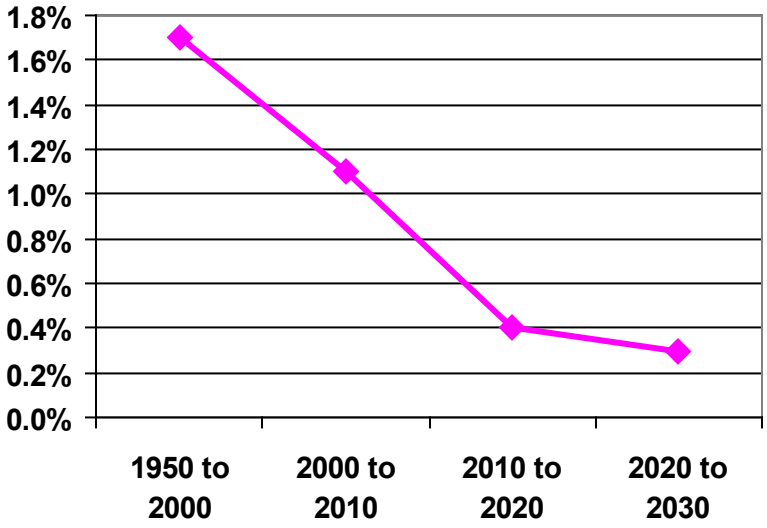


Figure 1: Growth in the U.S. labor Force - 1950 to 2030

The primary effect of this decline will be a tightening of the U.S. labor market, making all types of workers more difficult to find and potentially creating severe shortages in certain key occupations, like skilled trades workers.

There are two main factors driving this change. The first, the aging of the baby-boom generation, is relatively well known. As the baby-boom generation begins to enter retirement, the proportion of the U.S. population 65 years of age and older will increase from 13 percent in 2000 to 21 percent in 2030.[11] This will drive a concomitant decline in the proportion of the U.S. population in their working years (20 to 64), falling from 59 percent in 2000 to 53 percent in 2030.[12]

A second factor affecting the size of the U.S. labor force is not as commonly perceived. Between 1950 and 2000 female labor force participation rates in the U.S. increased from 34 percent to 60 percent.[13] This dramatic flow of women into the workforce was responsible for the bulk of the increase in the U.S. labor force over that period. Future projections, however, anticipate that female labor force participation rates in the U.S. will not rise appreciably above the 60 percent mark and may actually decline. As a result, this driving force in recent labor force expansion is expected to flatten out.

9 *Ibid.*

10 *Data Source*: U.S. Bureau of Labor Statistics.

11 "After the Baby Boom: Population Trends and the Labor Force of the Future," Timothy Schiller, Business Review, Q4, 2005.

12 *Ibid.*

13 *Ibid.*

MANUFACTURERS FACE A WAVE OF FUTURE RETIREMENTS

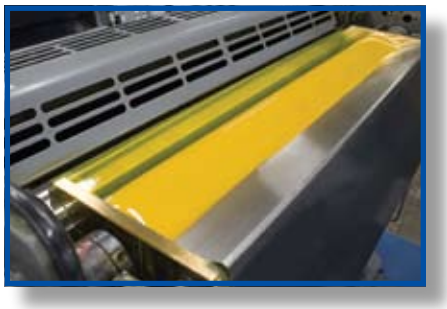
Due to the pending retirement of the baby-boom generation, all sectors of the economy face a problematic wave of retirements. Some sectors will be more adversely affected than others, however, and current data indicate that manufacturing is likely to be the most adversely affected of all. According to data from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics project, Virginia's manufacturing sector has the largest absolute number of employees between the ages of 55 and 64 (47,037) of any sector within the state's economy.[14] These data imply that around 15.4 percent of the current workforce employed in manufacturing in Virginia will likely retire within the next ten years.

INCREASINGLY HIGH-TECH NATURE OF MANUFACTURING

To paraphrase a classic new car ad, "today's manufacturing plant is not your father's manufacturing plant." Driven by intense global competition, manufacturers are increasingly using high-tech production processes to enhance industrial productivity. Productivity increases have been particularly pronounced in the manufacture of iron and steel, computer and electronics products and peripheral equipment, communication equipment, audio and visual equipment, semi-conductors, transportation equipment, and pharmaceuticals.[15]

As will become more apparent in subsequent sections where workforce skill requirements and postsecondary training requirements are discussed, this increased use of high-technology has driven a significant increase in the general skill level required of manufacturing workers. Today's manufacturing worker must possess applied math skills, reading and locating information skills, and training in computer technology. As a result, manufacturers increasingly find themselves competing with other sectors of the economy to find adequate supplies of these types of workers.

Whereas independently any one of these factors – a slowdown in the growth of the U.S. labor force, a wave of pending retirements, and the increasingly high-tech nature of manufacturing – could have a negative impact on the ability of the manufacturing sector to obtain the skilled trades workers it requires to prevail in today's global market, in combination they are very likely to create crippling bottlenecks that have the potential to forestall economic growth. For this reason, moving proactively to ensure an adequate supply of skilled trades workers has become an imperative goal for manufacturers.



PHASE 1: EMPIRICAL ANALYSIS

This portion of the report presents the findings from Phase 1 of VMA's Skilled Trades Study. Phase I was conducted by Mangum Economic Consulting, LLC and employed existing labor and education databases to illuminate the characteristics of skilled trades employment within the Commonwealth, and identify areas where the educational pipeline for skilled trades workers may be inadequate to meet future needs. The findings from Phase 1 were first published in January 2007.[16]

The purpose of this initial phase of the VMA Skilled Trades Study was twofold. First, to provide a preliminary analysis of the scope and magnitude of the problems associated with meeting the demand for skilled trades workers in Virginia. Second, to better prepare us for Phase II of the study – a survey of Virginia manufacturers to obtain primary data on skilled trades employment – by illuminating areas where existing data might be inadequate to address some of the more pressing issues associated with skilled trades employment.

Twelve skilled trades were selected by the Skilled Trades Workforce Development Committee for analysis in Phase 1. These were: 1) Chemical Equipment Operators, 2) Chemical Technicians, 3) Computer-Controlled Machine Tool Operators, 4) Electricians and Electrical Technicians, 5) Extruding and Drawing Machine Setters, 6) Machine Maintenance Specialists, 7) Machinists, 8) Multiple Machine Tool Setters, Operators, and Tenders, 9) Printing Machine Operators, 10) Stationary Engineers and Boiler Operators, 11) Tool and Die Makers, and 12) Welders.

The remainder of this portion of the report is divided into four sections: 1) the demand for skilled trades workers in Virginia, 2) the supply of skilled trades workers, 3) an assessment of the gap between the two, and 4) a summary of the most salient findings derived from Phase 1 of the VMA Skilled Trades Study.

Demand for Skilled Trades Workers

This section uses existing labor data and projections to evaluate the likely future demand for skilled trades workers within the Commonwealth and provides additional information on the specific industries that hire these workers, the exact nature of the skills these jobs require, and the regional distribution of employment demand for each skilled trade.

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14 *Data Source*: U.S. Census Bureau, Data Integration Division, Longitudinal Employer-Household Dynamics Project. Manufacturing ranked 1st out of 19 industry sectors in terms of the absolute number of employees between the ages of 55 and 64 (47,037) for the period spanning the third quarter of 2005 through the second quarter of 2006 (the most recent four quarters of data available). Retail Trade ranked 2nd with 46,092 employees and Professional, Scientific and Technical Services ranked 3rd with 42,396. It is probably worth noting, however, that manufacturing's 47,037 employees comprised 15.4 percent of its total workforce, where the comparable percentages for Retail Trade and Professional, Scientific and Technical Services, due to their larger employment base, were only 10.6 percent and 12.5 percent respectively.

15 *Data Source*: Bureau of Labor Statistics.

16 *See* "Skilled Trades Gap Analysis," produced by Mangum Economic Consulting, LLC, and commissioned by the Virginia Manufacturers Association, Virginia Workforce Council, and Virginia Manufacturing Advisory Council, January 2007.

DATA AND METHODS

The data for this portion of the study were obtained from four primary sources. Wage data were taken from the Virginia Employment Commission's (VEC's) *State Wage Survey*. Data on the distribution of occupational employment across various industries were taken from the VEC's *Virginia Industry-Occupation Employment Matrix*. Occupational skills profiles were taken from the U.S. Department of Labor's *O-NET* database. Employment data and projected average annual openings by occupation were taken from the VEC's 2002-2012 occupational projection.

Because of the importance of the VEC's occupational forecast to the conclusions drawn in this study, it is probably worthwhile to briefly discuss the method the VEC uses to obtain those projections. The VEC does not forecast occupational employment directly. Instead, it first uses historical data (primarily obtained from the *Quarterly Census of Covered Employment and Wages*) to project future trends in industry employment. With some adjustment, these industry employment forecasts are then mapped through the *Virginia Industry-Occupation Employment Matrix* to derive an occupational employment projection.

This means that the accuracy of the occupational forecasts is dependent on two things: 1) the accuracy of the VEC's industry employment projection, and 2) the accuracy of its industry-occupation employment matrix. To the extent that either is off, the occupational projection will be off, and where both are off that error will be cumulative. In addition, the magnitude of these errors is likely to be exacerbated in "small numbers" situations where a specific occupation comprises a small proportion of the overall employment in a given industry, or where that proportion is subject to extensive inter-regional or inter-firm variation. Importantly, this condition characterizes many of the skilled trades.

OVERVIEW

Table 1 lists the twelve skilled trades selected for analysis in Phase 1. For each occupation, Table 1 provides data on: 1) the estimated employment within that occupation in 2002, 2) the amount of that employment which was within the manufacturing sector, 3) occupational employment within manufacturing as a proportion of total occupational employment, and 4) occupational employment within manufacturing as a proportion of total manufacturing employment.

For example, as depicted in the first row of Table 1, it is estimated that the number of Chemical Equipment Operators employed in Virginia in 2002 was 1,506. Of that 1,506, 1,445, or 95.9 percent, were employed in manufacturing. In addition, these 1,445 workers made up 0.5 percent of the total manufacturing workforce. In sum, total employment in the twelve skilled trades listed in Table 1 is estimated to have been 109,837 in 2002, with 51,969, or 47.3 percent, employed in the manufacturing sector. These twelve skilled trades are also estimated to have accounted for approximately 16.2 percent of total manufacturing employment in Virginia in 2002.

Table 1: Aggregate Statewide Skilled Trades Employment

Occupation	Estimated 2002 Employment	Estimated 2002 Employment in Manufacturing	as % of total Occupation Employment	as % of total Manufacturing Employment
Chemical Equipment Operators	1,506	1,445	95.9%	0.5%
Chemical Technicians	1,388	919	66.2%	0.3%
Computer-Controlled Machine Tool Operators	1,378	1,378	100.0%	0.4%
Electricians and Electrical Technicians	26,869	4,329	16.1%	1.3%
Extruding and Drawing Machine Setters	2,225	2,098	94.3%	0.7%
Machine Maintenance Specialists	43,562	15,551	35.7%	4.8%
Machinists	4,846	3,938	81.3%	1.2%
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	6,718	6,630	97.3%	2.1%
Printing Machine Operators	7,515	5,796	77.1%	1.8%
Stationary Engineers and Boiler Operators	911	304	33.4%	0.1%
Tool and Die Makers	979	950	97.0%	0.3%
Welders	11,940	8,631	72.3%	2.7%
Total	**109,837**	**51,969**	**47.3%**	**16.2%**

The twelve skilled trades listed in Table 1 map into 25 U.S. Bureau of Labor Statistics (BLS) *Standard Occupational Classifications* (SOC), a standard taxonomy that the BLS uses to classify jobs. A complete listing of the Standard Occupational Classifications associated with each of the selected skilled trades is provided in Table A1 in the Appendix of this report.

OCCUPATION DETAIL

In the pages that follow we provide additional detail on employment in each of the twelve skilled trades listed in Table 1.

Chemical Equipment Operators

As shown in Table 2, the skilled trade Chemical Equipment Operators maps into two SOCs – 1) *Chemical Equipment Operators and Tenders* and 2) *Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders*.

Chemical Equipment Operators and Tenders comprise the bulk of the employment in this skilled trade. As graphically depicted in Figure 2, 99 percent of these workers are employed in manufacturing. The most significant skills required in this SOC pertain to operation monitoring, operation control, and science.[17]

With regard to *Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders*, 73 percent of these workers are employed in manufacturing (*see* Figure 2) and the most significant skills required in this SOC are in operation monitoring, operation control, and equipment maintenance.

As shown in Figure 3, regional demand for this skilled trade tends to be concentrated in Central Virginia, with smaller concentrations in Southwest Virginia and the Valley Region.

Table 2: Chemical Equipment Operators – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Chemical Equipment Operators and Tenders	1,334	43	-1.7%	$22.79
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	172	6	-0.8%	$21.22

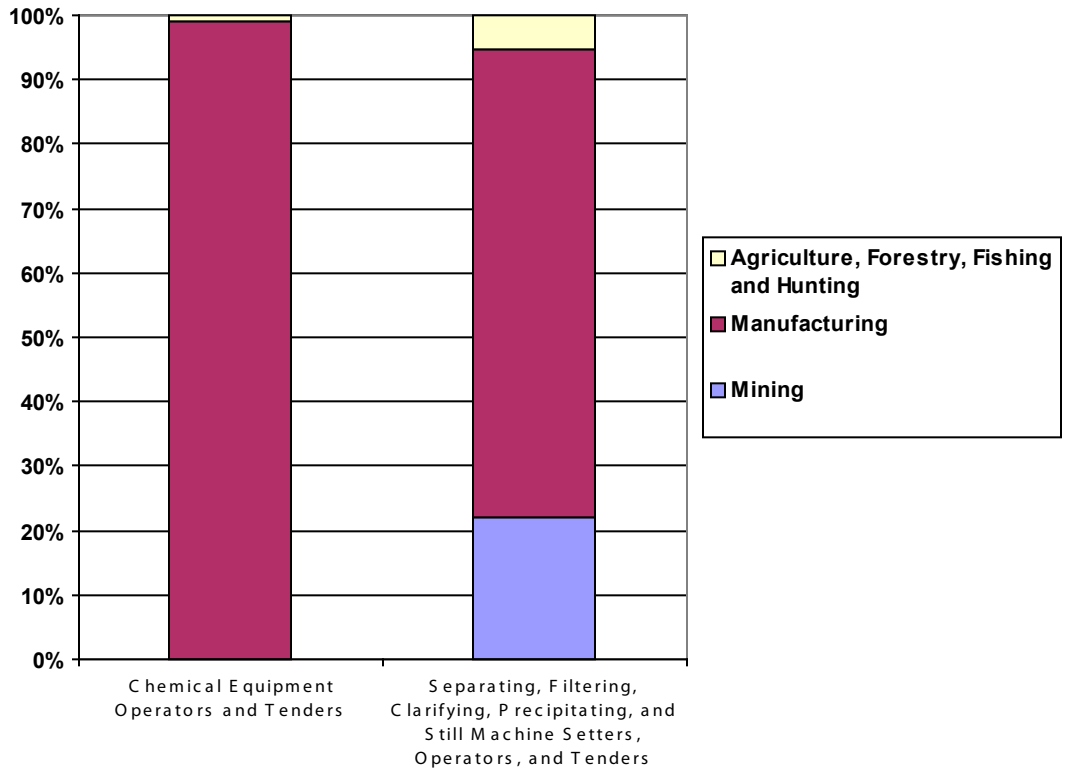


Figure 2: Chemical Equipment Operators – Employment by Industry

17 The U.S. Department of Labor, as part of its *O-NET* database, accesses the skills required for given occupations across 35 skill categories (*e.g.*, Active Learning, Mathematics, Speaking, and Writing). Required skilled levels are classified according to a seven point scale where one is the lowest skill level and seven the highest.

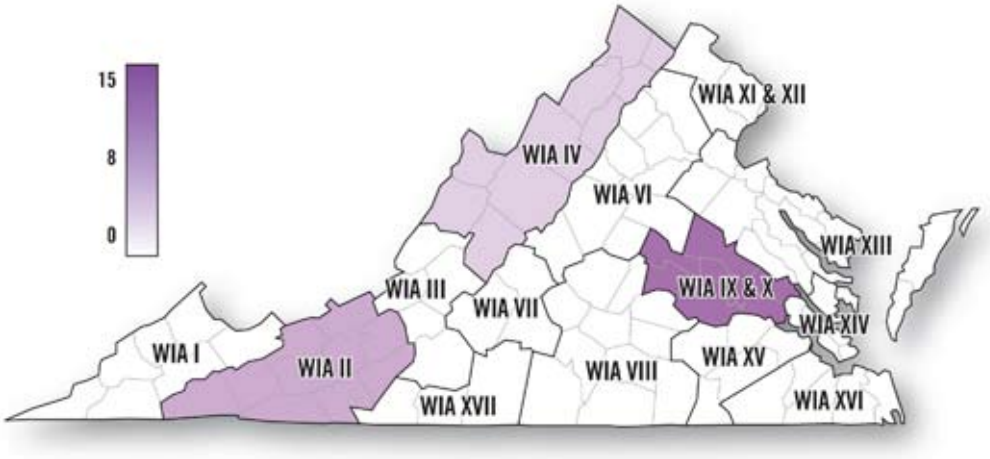


Figure 3: Chemical Equipment Operators – 2002-2012 Average Annual Openings by WIA

Chemical Technicians

As shown in Table 3, there is only one SOC associated with the skilled trade Chemical Technicians – *Chemical Technicians*. As graphically depicted in Figure 4, 66 percent of these workers are employed in manufacturing. The most significant skills required in this SOC are in operation monitoring, reading comprehension, and active learning .

As shown in Figure 5, from a regional perspective demand for this skilled trade tends to be concentrated in Central Virginia and Northern Virginia, with smaller concentrations in Southwest Virginia and the Valley Region.

Table 3: Chemical Technicians – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Chemical Technicians	1,388	35	-0.2%	$24.07

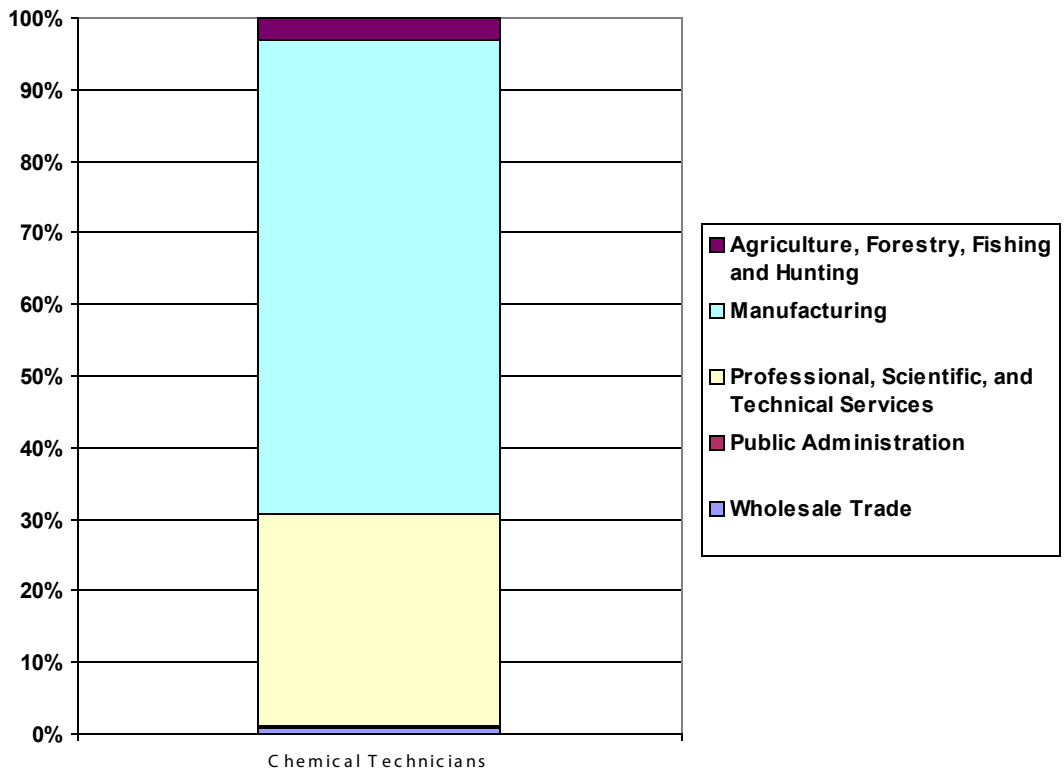


Figure 4: Chemical Technicians – Employment by Industry

Figure 5: Chemical Technicians – 2002-2012 Average Annual Openings by WIA

Computer-Controlled Machine Tool Operators

As shown in Table 4, the skilled trade Computer-Controlled Machine Tool Operators maps into two SOCs – 1) *Computer-Controlled Machine Tool Operators, Metal and Plastic* and 2) *Numerical Tool and Process Control Operators*.

Computer-Controlled Machine Tool Operators, Metal and Plastic comprise the bulk of the employment in this skilled trade. As graphically depicted in Figure 6, 100 percent of these workers are employed in manufacturing. The most significant skills required in this SOC pertain to operation control, mathematics, and operation monitoring.

Similarly, 100 percent of *Numerical Tool and Process Control Operators* are also employed in manufacturing (*see* Figure 6). The most significant skills required in this SOC are in mathematics, reading comprehension, and trouble shooting.

As shown in Figure 7, regional demand for this occupation tends to be concentrated in Southwest Virginia, with smaller concentrations in Southwest Virginia, Central Virginia, Hampton Roads, and around Lynchburg.

Table 4: Computer-Controlled Machine Tool Operators – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Computer-Controlled Machine Tool Operator, Metal and Plastic	1,148	26	0.6%	$17.61
Numerical Tool and Process Control Operators	230	6	0.7%	$30.12

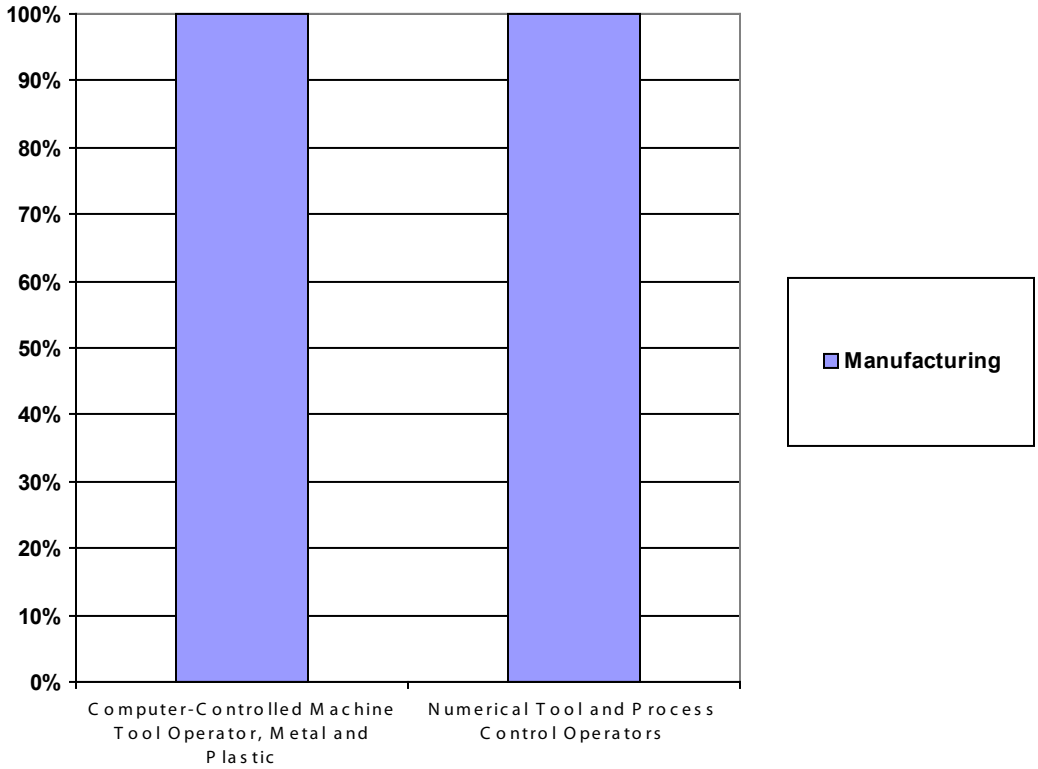


Figure 6: Computer-Controlled Machine Tool Operators – Employment by Industry

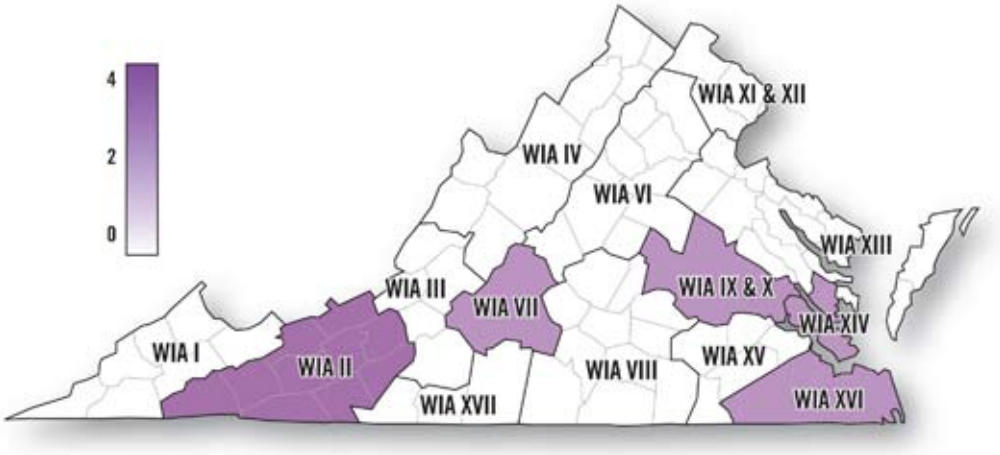


Figure 7: Computer-Controlled Machine Tool Operators – 2002-2012 Average Annual Openings by WIA

Electricians and Electrical Technicians

As shown in Table 5, the skilled trade Electricians and Electrical Technicians maps into three SOCs – 1) *Electrical and Electronic Engineering Technicians*, 2) *Electricians*, and 3) *Electrical and Electronic Repairers, Commercial and Industrial Equipment*.

Electrical and Electronic Engineering Technicians account for the second largest concentration of employment in this skilled trade. As graphically depicted in Figure 8, however, only around 20 percent of these workers are employed in manufacturing, while the largest proportion, 44 percent, are employed in Professional, Scientific, and Technical Services. The most significant skills required in this SOC are in repairing, troubleshooting, and equipment maintenance.

Electricians account for by far the largest amount of employment in this skilled trade. In this case, however, only 13 percent of these workers are employed in manufacturing, while 72 percent are employed in construction (*see* Figure 8). Although, as pointed out by several private employers on the Skilled Trades Workforce Development Committee, this disparity may be more apparent than real given that many manufacturing firms out-source electrical work to electrical contractors, many of whom would be classified within the construction industry. The most significant skills required in this SOC pertain to installation, reading comprehension, and troubleshooting.

Approximately 35 percent of *Electrical and Electronic Repairers, Commercial and Industrial Equipment* are employed in manufacturing (*see* Figure 8). The most significant skills required in this SOC pertain to installation, trouble shooting, and operation monitoring.

As shown in Figure 9, regional demand for this skilled trade tends to be concentrated in Northern Virginia, Central Virginia, and Hampton Roads, with smaller concentrations distributed widely across the state.

Table 5: Electricians and Electrical Technicians - Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Electrical and Electronic Engineering Technicians	5,592	175	1.0%	$27.47
Electricians	18,914	842	2.2%	$22.42
Electrical and Electronic Repairers, Commercial and Industrial Equipment	2,363	62	0.4%	$24.87

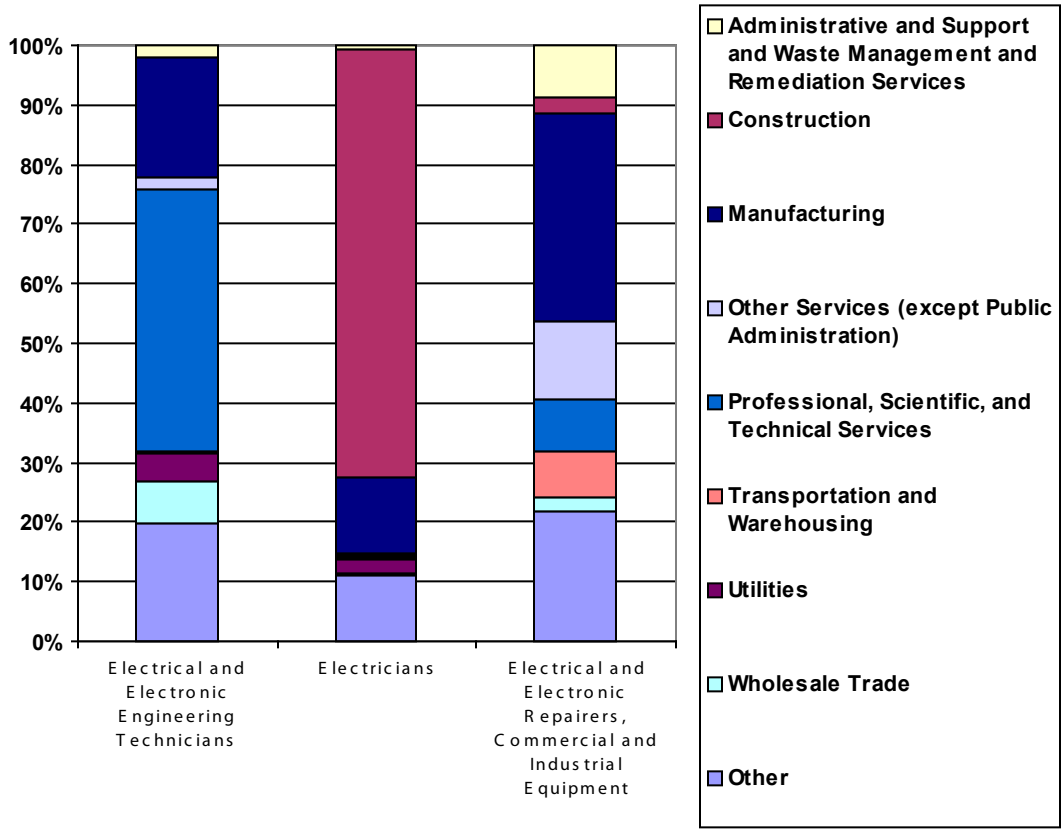


Figure 8: Electricians and Electrical Technicians - Employment by Industry

Figure 9: Electricians and Electrical Technicians - 2002-2012 Average Annual Openings by WIA

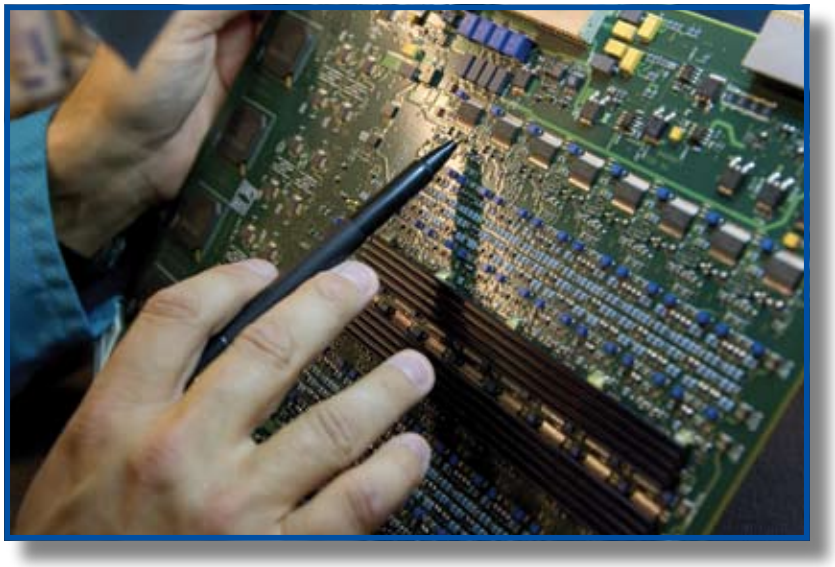
Extruding and Drawing Machine Setters

As shown in Table 6, there is only one SOC associated with the skilled trade Extruding and Drawing Machine Setters – *Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic*. As graphically depicted in Figure 10, 94 percent of these workers are employed in manufacturing. The most significant skills required in this SOC are in operation and control, quality control analysis, and operation monitoring.

From a regional perspective, demand for this skilled trade tends to be concentrated in Southwest Virginia, the Valley Region, and Central Virginia, with smaller concentrations in Hampton Roads and Northern Virginia, and around Roanoke, Lynchburg, and Danville/Martinsville (*see* Figure 11).

Table 6: Extruding and Drawing Machine Setters - Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Extruding and Drawing machine Setters, Operators, and Tenders, Metal and Plastic	2,225	99	1.1%	$15.16



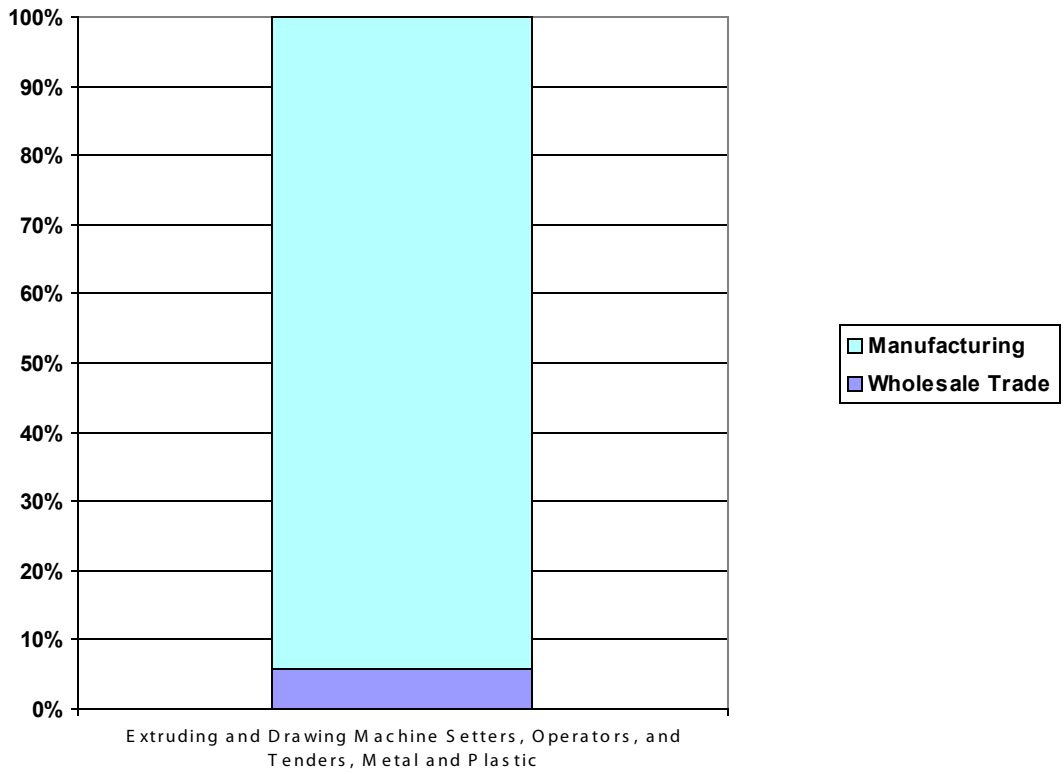


Figure 10: Extruding and Drawing Machine Setters – Employment by Industry

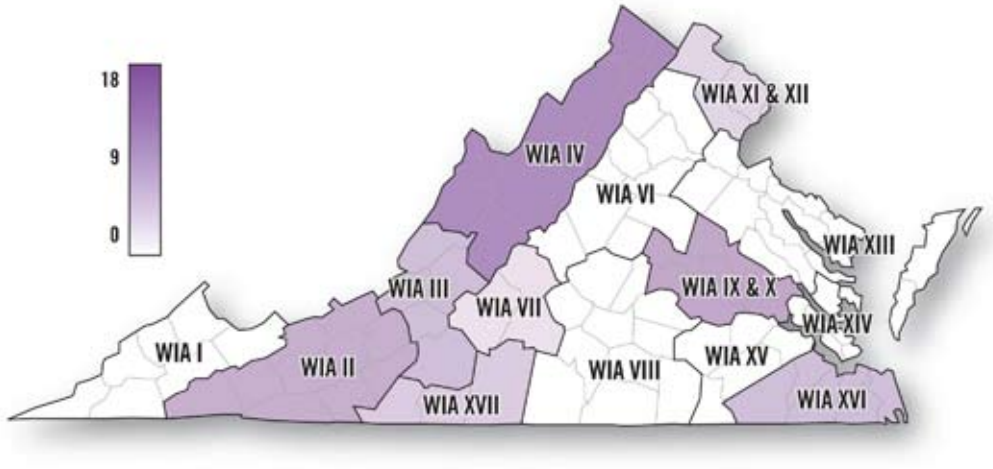


Figure 11: Extruding and Drawing Machine Setters – 2002-2012 Average Annual Openings by WIA

Machine Maintenance Specialists

As shown in Table 7, the skilled trade Machine Maintenance Specialists maps into three SOCs – 1) *Industrial Machinery Mechanics*, 2) *Machine and Repair Workers, General*, and 3) *Maintenance Workers, Machinery*.

As graphically depicted in Figure 12, 84 percent of *Industrial Machinery Mechanics* workers are employed in manufacturing. The most significant skills required in this SOC pertain to equipment maintenance, repairing, and troubleshooting.

Machine and Repair Workers, General account for the bulk of employment in this skilled trade. Only 24 percent of these workers are employed in manufacturing, however, while the remainder are broadly distributed across a large number of other sectors (*see* Figure 12). The most significant skills required in this SOC are in equipment maintenance, troubleshooting, and installation.

Approximately 83 percent of *Maintenance Workers, Machinery* are employed in manufacturing (*see* Figure 12). The most significant skills required in this SOC are in equipment maintenance, trouble shooting, and operation monitoring.

As shown in Figure 13, regional demand for this skilled trade tends to be concentrated in Northern Virginia, Central Virginia, and Hampton Roads, with smaller concentrations distributed widely across the state.

Table 7: Machine Maintenance Specialists – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Industrial Machinery Mechanics	5,997	144	0.4%	$22.82
Machine and Repair Workers, General	35,023	1,205	1.4%	$18.46
Maintenance Workers, Machinery	2,542	73	0.6%	$20.36

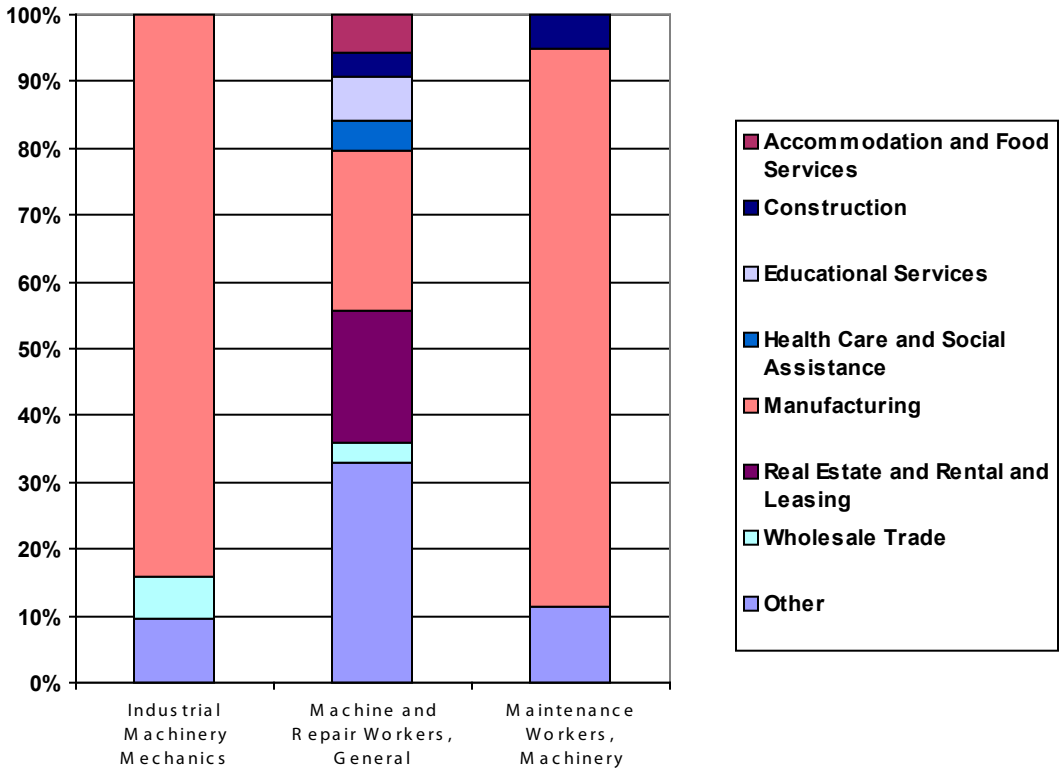


Figure 12: Machine Maintenance Specialists – Employment by Industry

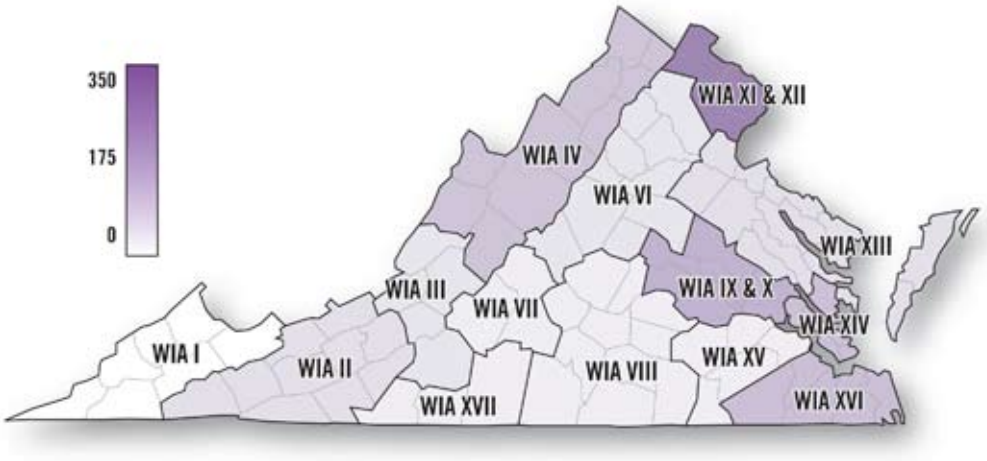


Figure 13: Machine Maintenance Specialists – 2002-2012 Average Annual Openings by WIA

Machinists

As shown in Table 8, there is only one SOC associated with the skilled trade Machinists – *Machinists*. As graphically depicted in Figure 14, 81 percent of these workers are employed in manufacturing. The most significant skills required in this SOC pertain to operation monitoring, operation and control, and equipment selection.

From a regional perspective, demand for this skilled trade tends to be distributed broadly across the state (*see* Figure 15).

Table 8: Machinists - Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Machinists	4,846	151	0.8%	$19.44

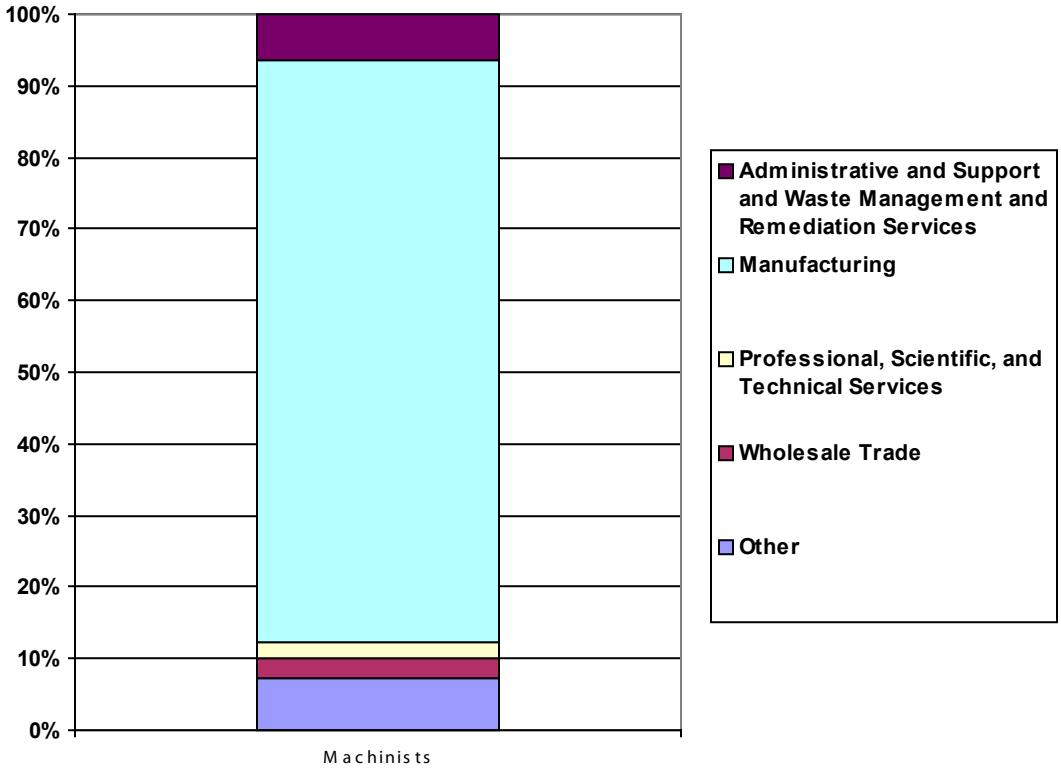


Figure 14: Machinists - Employment by Industry

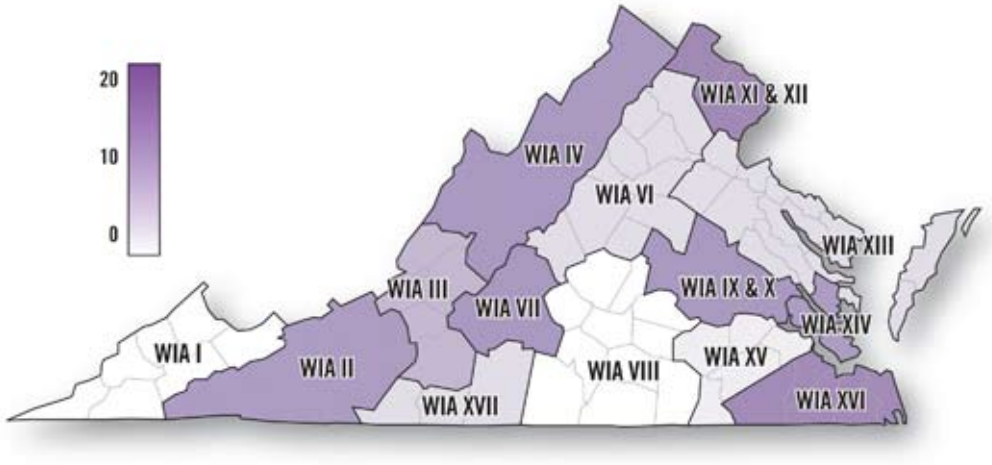


Figure 15: Machinists - 2002-2012 Average Annual Openings by WIA

Multiple Machine Tool Setters, Operators, and Tenders

As shown in Table 9, the skilled trade Multiple Machine Tool Setters, Operator, and Tenders maps into five SOCs – 1) *Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic*, 2) *Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic*, 3) *Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic*, 4) *Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic*, and 5) *Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic*.

Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic account for the largest concentration of employment in this skilled trade. As graphically depicted in Figure 16, 96 percent of these workers are employed in manufacturing. The most significant skills required in this SOC are in quality control analysis, operation and control, and operation monitoring.

One-hundred percent of *Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic* workers are employed in manufacturing (*see* Figure 16). The most significant skills required in this SOC pertain to mathematics, operation and control, and quality control analysis.

Similarly, 100 percent of *Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic* workers are employed in manufacturing (*see* Figure 16). The most significant skills required in this SOC are in quality control analysis, monitoring, and operation monitoring.

Also, 100 percent of *Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic* workers are employed in manufacturing (*see* Figure 17). The most significant skills required in this SOC pertain to mathematics, equipment maintenance, and equipment selection.

And finally, 100 percent of *Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic* workers are also employed in manufacturing (*see* Figure 17). The most significant skills required in this SOC pertain to quality control analysis, troubleshooting, and learning strategies.

As shown in Figure 18, regional demand for this skilled trade tends to be concentrated in Southwest Virginia, the Valley Region, and the Peninsula, with smaller concentrations distributed widely across the state.

Table 9: Multiple Machine Tool Setters, Operators, and Tenders - Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic	4,225	122	0.6%	$14.84
Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	548	17	0.2%	$14.95
Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic	1,248	24	0.0%	$15.43
Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic	167	3	-0.2%	$16.25
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	530	32	2.8%	$15.35

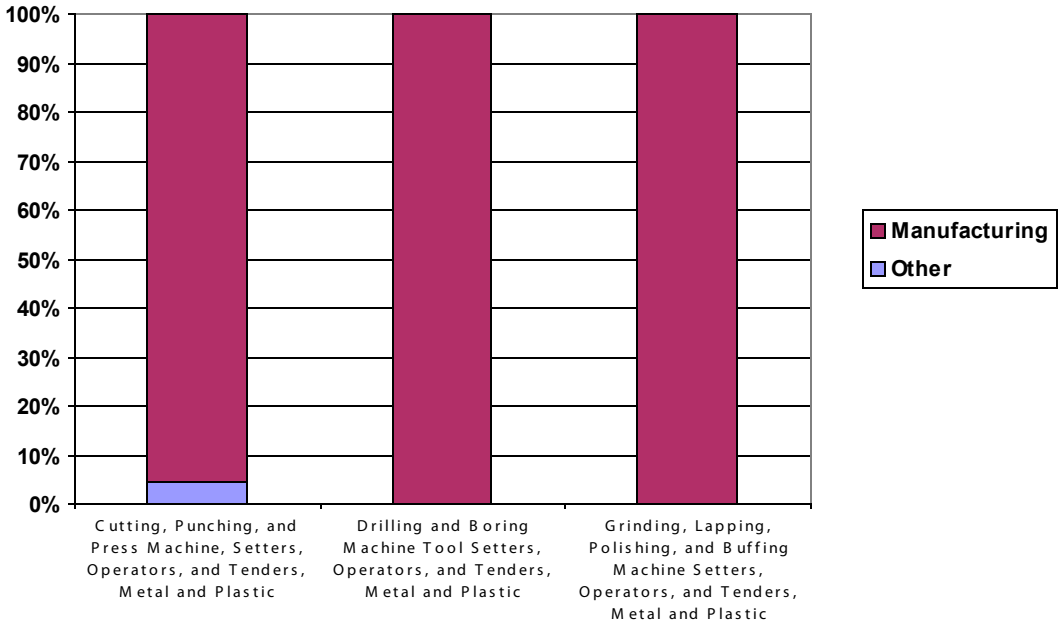


Figure 16: Multiple Machine Tool Setters, Operators, and Tenders – Employment by Industry

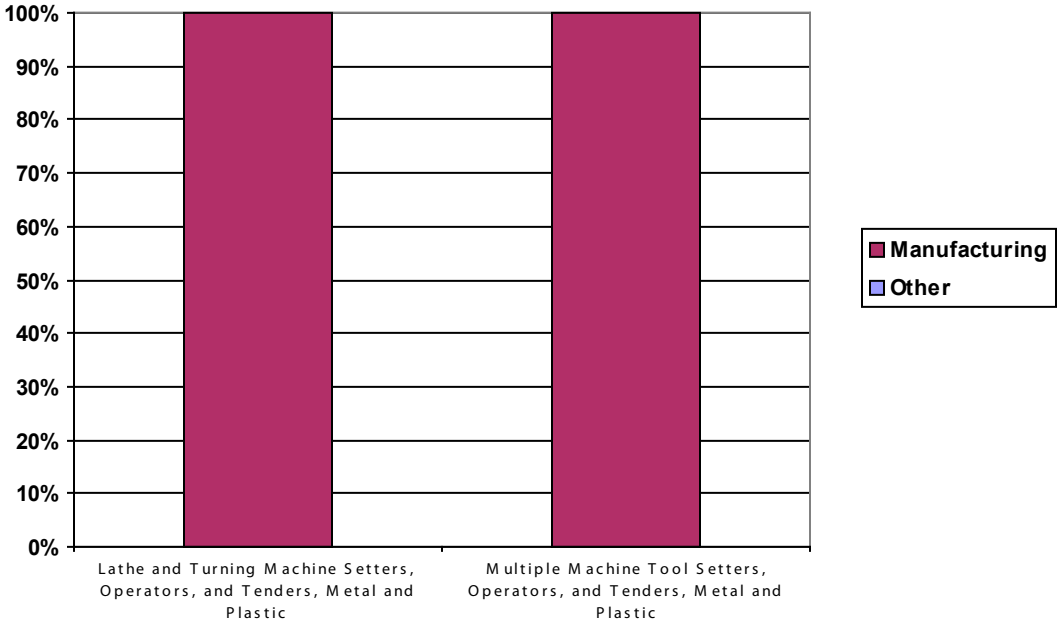


Figure 17: Multiple Machine Tool Setters, Operators, and Tenders – Employment by Industry

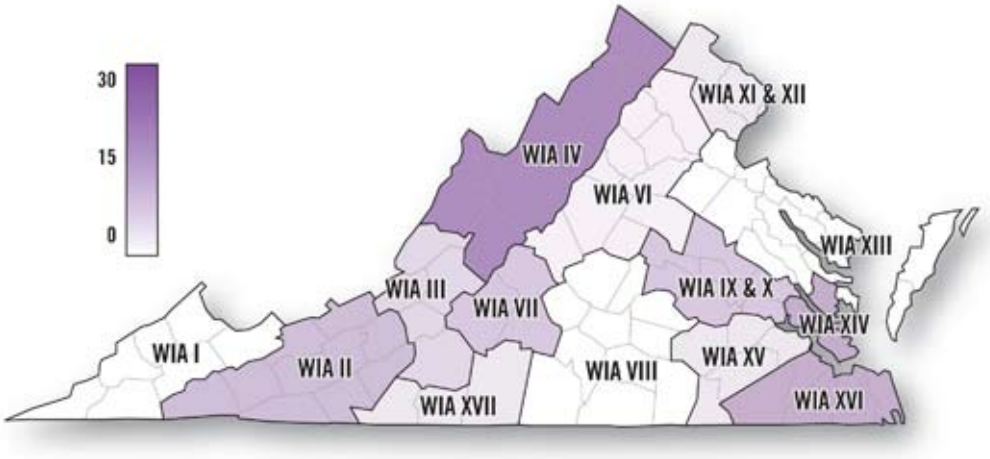


Figure 18: Multiple Machine Tool Setters, Operators, and Tenders – 2002-2012 Average Annual Openings by WIA

Printing Machine Operators

As shown in Table 10, the skilled trade Printing Machine Operators maps into three SOCs – 1) *Job Printers*, 2) *Prepress Technicians and Workers*, and 3) *Printing Machine Operators*.

As graphically depicted in Figure 19, 95 percent of *Job Printers* workers are employed in manufacturing. The most significant skills required in this SOC are in operation monitoring, operation and control, and equipment maintenance.

Prepress Technicians and Workers account for the second largest concentration of employment in this skilled trade. As graphically depicted in Figure 19, 72 percent of these workers are employed in manufacturing. The most significant skills required in this SOC are in coordination, equipment selection, and active learning.

Printing Machine Operators account for the largest amount of employment in this skilled trade. As shown in Figure 19, 78 percent of these workers are employed in manufacturing.. The most significant skills required in this SOC pertain to operation and control, operation monitoring, and equipment maintenance.

Regional demand for this skilled trade tends to be concentrated in the Valley Region, with smaller concentrations in Northern Virginia, Central Virginia, and Hampton Roads (*see* Figure 20).

Table 10: Printing Machine Operators – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Job Printers	571	23	1.6%	$26.89
Prepress Technicians and Workers	2,363	55	-0.7%	$18.36
Printing Machine Operators	4,581	160	1.1%	$17.29

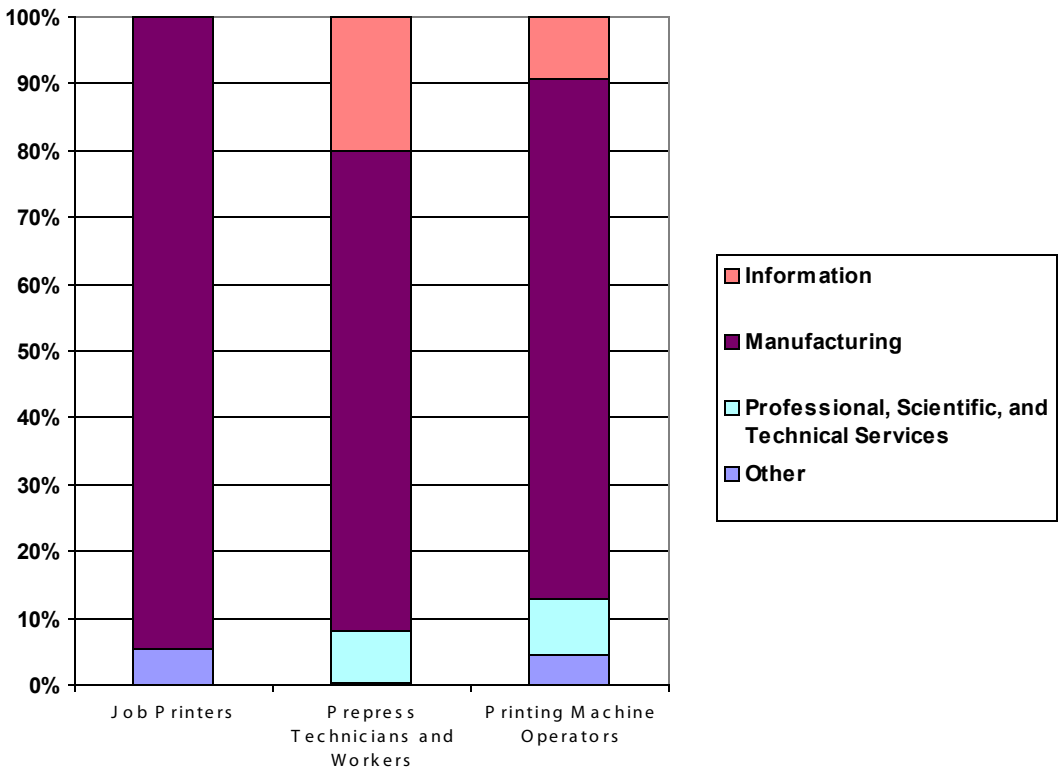


Figure 19: Printing Machine Operators – Employment by Industry

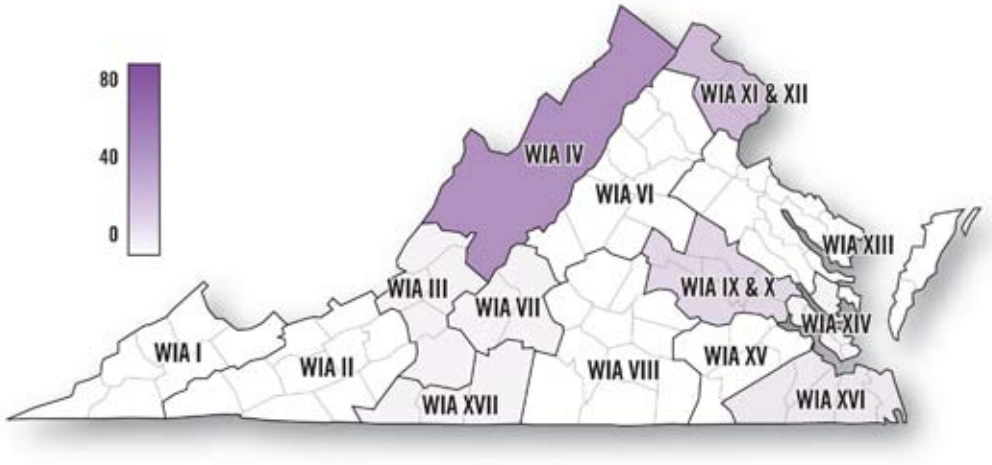


Figure 20: Printing Machine Operators – 2002-2012 Average Annual Openings by WIA

Stationary Engineers and Boiler Operators

As shown in Table 11, there is only one SOC associated with the skilled trade Stationary Engineers and Boiler Operators – *Stationary Engineers and Boiler Operators*. As graphically depicted in Figure 21, 33 percent of these workers are employed in manufacturing with the remainder broadly distributed across several other sectors. The most significant skills required in this SOC are in repairing, equipment maintenance, and operation monitoring.

From a regional perspective, demand for this skilled trade tends to be concentrated in Northern Virginia and Central Virginia (*see* Figure 22).

Table 11: Stationary Engineers and Boiler Operators – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Stationary Engineers and Boiler Operators	911	17	-0.3%	$21.91

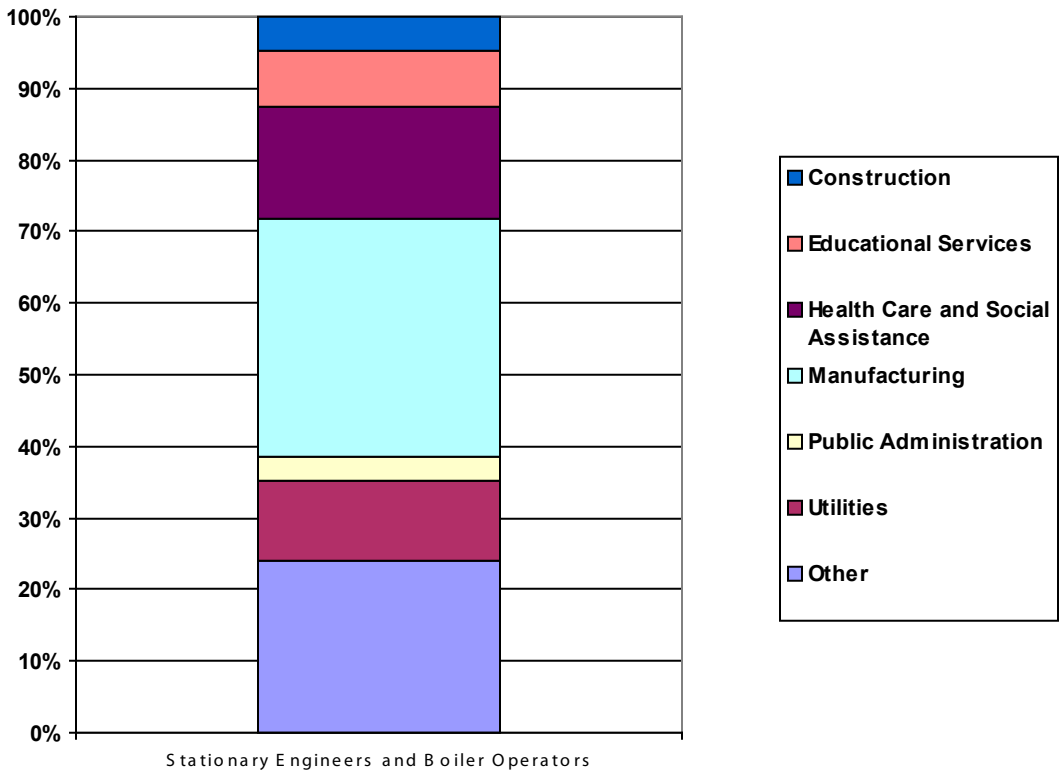


Figure 21: Stationary Engineers and Boiler Operators – Employment by Industry

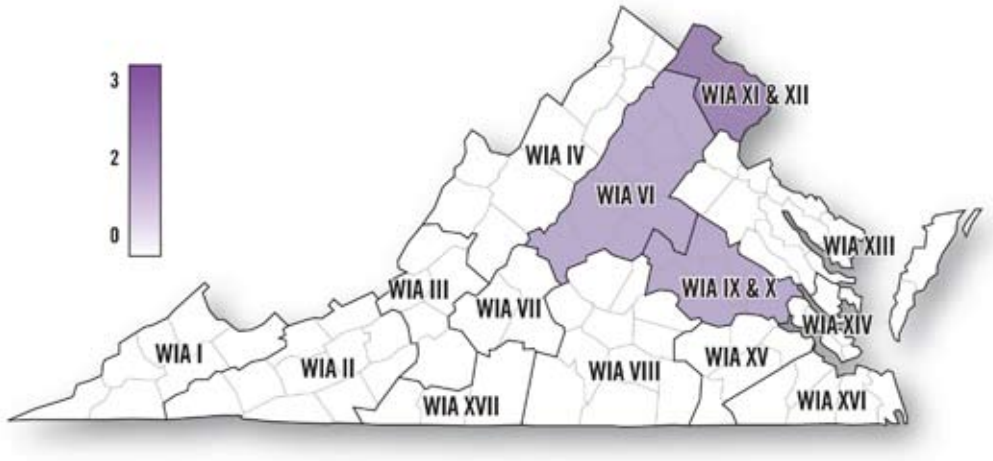


Figure 22: Stationary Engineers and Boiler Operators – 2002-2012 Average Annual Openings by WIA

Tool and Die Makers

As shown in Table 12, there is only one SOC associated with the skilled trade Tool and Die Makers – *Tool and Die Makers*. As graphically depicted in Figure 23, 97 percent of these workers are employed in manufacturing. The most significant skills required in this SOC pertain to mathematics, equipment selection, and troubleshooting.

Regional demand for this skilled trade tends to be concentrated in the Southwest Virginia and Hampton Roads (*see* Figure 24).

Table 12: Tool and Die Makers – Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Tool and Die Makers	979	22	-0.3%	$23.48

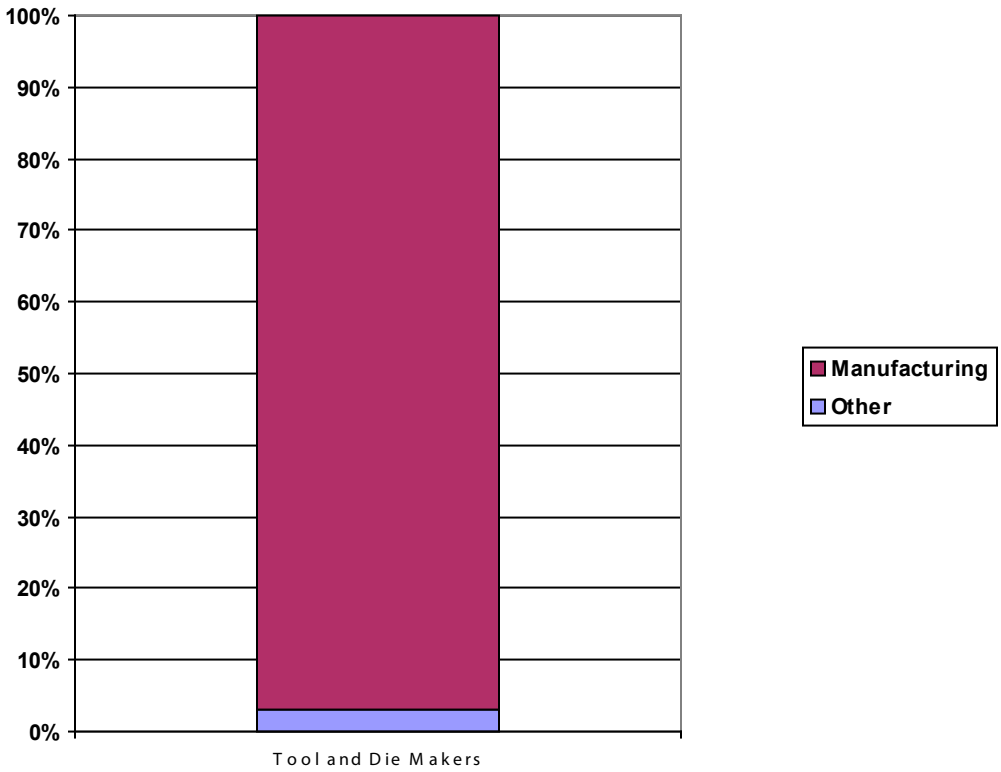


Figure 23: Tool and Die Makers – Employment by Industry

Figure 24: Tool and Die Makers – 2002-2012 Average Annual Openings by WIA

Welders

As shown in Table 13, the skilled trade Welders maps into two SOCs – 1) *Welders, Cutters, Solderers, and Brazers*, and 2) *Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders*.

Welders, Cutters, Solderers, and Brazers comprise the bulk of the employment in this skilled trade. As graphically depicted in Figure 25, 72 percent of these workers are employed in manufacturing. The most significant skills required in this SOC pertain to equipment selection, reading comprehension, and equipment maintenance.

With regard to *Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders*, 99 percent of these workers are employed in manufacturing (*see* Figure 25) and the most significant skills required in this SOC are in active learning, learning strategies, and coordination.

As shown in Figure 26, regional demand for this skilled trade tends to be concentrated in Hampton Roads, with smaller concentrations in Northern Virginia and Southwest Virginia.

Table 13: Welders - Statewide Employment Statistics

BLS Standard Occupational Classification (SOC) Title	Estimated 2002 Employment	Projected Average Annual Openings: 2002-2012	Projected Average Annual Growth: 2002-2012	Average Hourly Wage: 2005
Welders, Cutters, Solderers, and Brazers	11,683	471	1.1%	$18.42
Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders	257	7	0.1%	$17.05

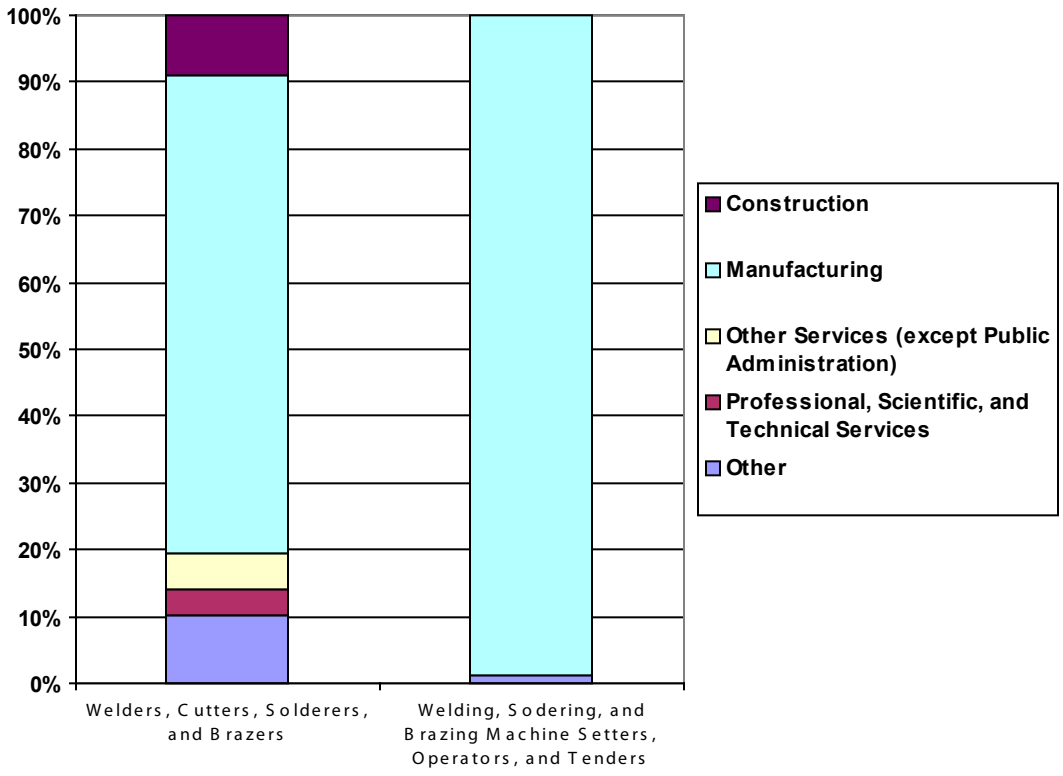


Figure 25: Welders - Employment by Industry

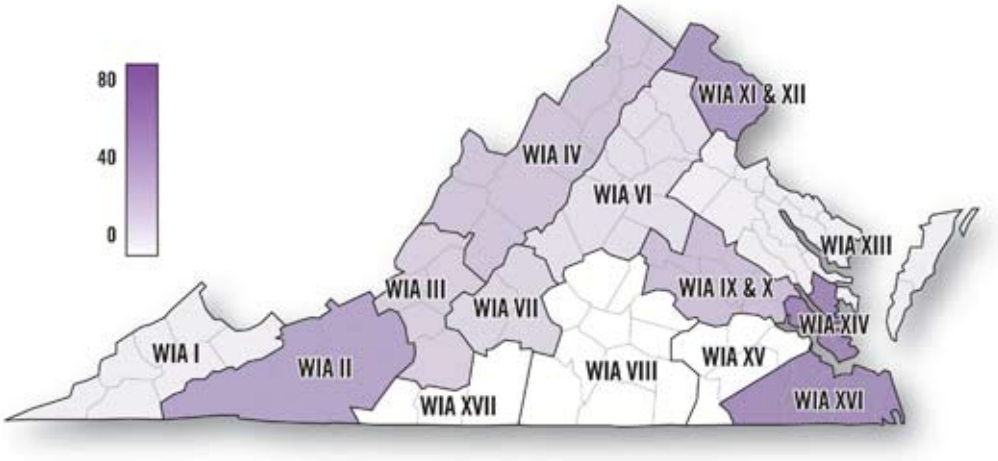


Figure 26: Welders – 2002-2012 Average Annual Openings by WIA

Supply of Skilled Trades Workers

This section uses existing educational data to evaluate the educational pipeline of skilled trades workers, including the distribution of graduates across various categories of institutions, and across the regions of the Commonwealth.

DATA AND METHODS

The data used in this portion of the analysis were obtained from three sources. Data on graduates with two-year Associates degrees or one-year or less postsecondary certificates were taken from the U.S. Department of Education's *Integrated Postsecondary Education Database System* and are for the 2004-2005 academic year. These data include all graduates from four-year, two-year, and one-year, public and private colleges, universities, and postsecondary schools operating within Virginia.

Data on graduates from registered apprenticeship programs were provided by the Virginia Department of Labor and Industry and are for calendar year 2005. These data include all graduates from registered apprenticeship programs within Virginia, including military sponsored programs. Registered apprenticeship programs combine classroom education with on-the-job training provided by a sponsoring employer.

Data on graduates from Career Studies programs were provided by the Virginia Community College System. These data are for the 2004-2005 academic year. Career Studies certificates are a one-year or less postsecondary vocational certificate that is unique to individual colleges within the Virginia Community College System.

To quantify the educational pipeline of skilled trades workers we use a crosswalk developed by the National Crosswalk Service Center to "map" occupations into the prerequisite education and training program(s) necessary for entry into that occupation.[18] The analysis is then further refined by using a classification scheme developed by the BLS to sort occupations according to the minimum degree or award required for employment in that occupation.[19] Through this combination of steps, we are able to link postsecondary education graduates from specific programs and degree levels to specific occupations. This enables us to quantify the pipeline of graduates associated with individual skilled trades. Detail on the specific postsecondary educational programs (identified according to their U.S. Department of Education *Classification of Instructional Programs* (CIP) designations) associated with each skilled trade evaluated in this report is provided in Table A2 of the Appendix. In addition, a listing of Virginia postsecondary education institutions, the Workforce Investment Areas they serve, and the skilled trades related graduates they produced in 2005 is provided in Tables A3 and A4 of the Appendix.

OVERVIEW

Table 14 details the educational pipeline associated with the twelve skilled trades evaluated in this portion of the study. For each skilled trade, Table 14 provides data on: 1) the education and training level typically required for entry into that occupation, 2) the number of related graduates produced in Virginia in 2005, disaggregated according to whether they received a certificate or Associate's degree from a Virginia college or university, were a graduate of a Virginia Registered Apprenticeship Program, or received an associated Career Studies certificate from a Virginia Community College,

18 The National Crosswalk Service Center (NCSC) is funded by the U.S. Department of Labor, Employment and Training Administration. This crosswalk identifies the prerequisite instructional programs (classified according to the National Center for Educational Statistics' *2000 Classification of Instructional Program*, or *CIP*, code) necessary for employment in 1,364 specific occupations (classified according to the Bureau of Labor Statistics' *2000 Standard Occupational Classification*, or *SOC*, code). Often, these are many-to-many relationships where a given instructional program can serve as an avenue into one of many jobs, or one of several instructional programs can serve as a prerequisite for a given job.

19 The Bureau of Labor Statistics classifies occupations according to eleven education and training categories. Five of these involve on-the-job training or work experience and the remaining six require some level of postsecondary education (*i.e.*, first-professional degree, doctoral degree, master's degree, bachelor's degree, associate's degree, or postsecondary vocational training).

and 3) the number of those related graduates who met the education and training level requirements for the occupation (*e.g.*, a two-year Associate's-level degree, a one-year certificate-level degree, etc.).

In total, there were 375 individuals who graduated from a Virginia college or university with a one-year or less postsecondary certificate in 2005 that was related to a skilled trade, 822 individuals who graduated with a related two-year Associates degree, 552 individuals who graduated from related Registered Apprenticeship programs, and 134 individuals who received a related one-year or less Career Studies Certificate from the Virginia Community College System. Of these graduates, a total of 1,671 met the required education and training threshold for entry into the related skilled trade.

Table 14: Aggregate Statewide Skilled Trades Pipeline

Occupation	Required Education and Training Level	2005 Pipeline				2005 Total Qualified Supply
		Certificates	Associates	Apprentices	Career Studies	
Chemical Equipment Operators	Moderate-term on-the-job training	0	0	0	0	0
Chemical Technicians	Associates Degree	0	0	0	0	0
Computer-Controlled Machine Tool Operator	Moderate-term to Long-term on-the-job training	38	30	0	12	80
Electricians and Electrical Technicians	Long-term on-the-job training / Certificate/Associates Degree	217	672	384	16	1,077
Extruding and Drawing Machine Setters	Moderate-term on-the-job training	6	0	0	0	6
Machine Maintenance Specialist	Short-term to Long-term on-the-job training	0	0	9	66	75
Machinists	Moderate-term to Long-term on-the-job training	6	0	81	7	94
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	12	3	21
Printing Machine Operators	Long-term on-the-job training	75	120	0	0	195
Stationary Engineers and Boiler Operators	Long-term on-the-job training	0	0	3	0	3
Tool and Die Makers	Long-term on-the-job training	0	0	0	1	1
Welders	Moderate-term to Long-term on-the-job training	27	0	63	29	119
Total		**375**	**822**	**552**	**134**	**1,671**

Figure 27 provides a breakdown of the graduates detailed in Table 14, according to the type of institution or program that supplied the graduate. As this figure shows, the largest proportion of these individuals, 34 percent, came out of Registered Apprenticeship programs. The second largest supplier, accounting for 30 percent of the skilled trades educational pipeline, was Virginia's four-year Career Colleges (although it is import to note that nearly all of the of the graduates from these institutions came out of a single Associates degree program – *Computer Technology/Computer Systems Technology* – that is related to *Electrical and Electronic Engineering Technicians*, a SOC within the skilled trade Electricians and Electrical Technicians where 76 percent of workers are not employed within manufacturing). The third largest supplier is the Virginia Community College System, accounting for 28 percent of the skilled trades educational pipeline. These are followed by two-year Career Colleges, accounting four percent of the skilled trades educational pipeline, and one-year public and private postsecondary schools, accounting for two percent each.

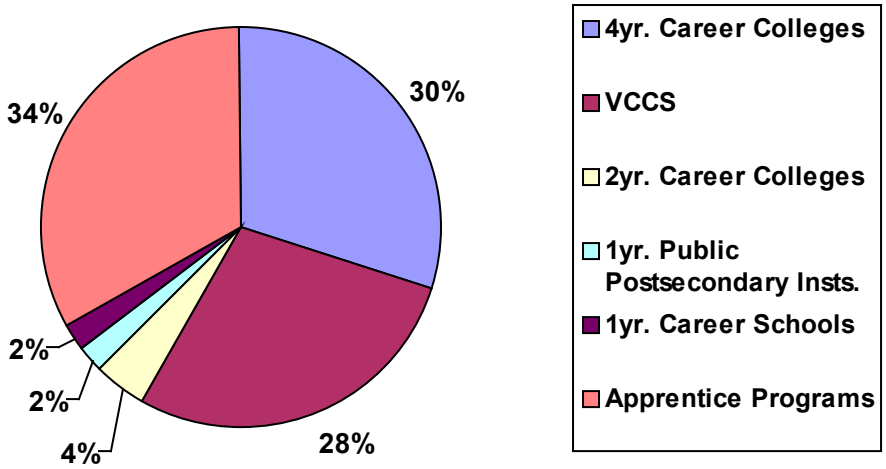


Figure 27: 2005 Total Qualified Supply of Skilled Trades Workers by Type of Institution or Program

In an effort to provide some sense of the capacity of Virginia's postsecondary education system to provide additional trained skilled trades workers, Figure 28 details reported classroom utilization rates for one of the largest suppliers of those workers – the Virginia Community College System.[20] Public colleges and universities in Virginia are required to report their classroom utilization rates to the State Council of Higher Education for Virginia (SCHEV). SCHEV uses these data in making recommendations regarding the need for additional classroom space in Virginia's public institutions of higher education. The classroom utilization rate is a composite measure that takes into account the frequency with which classrooms are used (*i.e.*, the number of hours per week they are scheduled) and the intensity with which they are used (*i.e.*, the number of seats within the classroom that are occupied when it is in use).

The threshold that SCHEV employs to determine whether an institution is using its classrooms to full capacity is 24, which implies that on average the institution schedules its classrooms for 40 hours per week and that they are filled to 60 percent capacity when in use. According to this measure, 10 of Virginia's 23 community colleges are already functioning at, or above, full capacity (*i.e.*, Blue Ridge Community College, located between Staunton and Harrisonburg; Germanna Community College, located in Fredericksburg; John Tyler Community College, located in southside Richmond; Lord Fairfax Community College, located outside of Winchester; New River Community College, located near Radford; Northern Virginia Community College, located in the northern Virginia suburbs of the District of Columbia; Piedmont Virginia Community College, located in Charlottesville; Thomas Nelson Community College, located in Newport News; Tidewater Community College, located in Norfolk; and Virginia Western Community College, located in Roanoke). It bears notice that these ten institutions primarily serve the urban centers of Northern Virginia, Central Virginia, Hampton Roads, the Valley Region, and Roanoke where, as demonstrated in the last section, the bulk of the demand for skilled trades workers takes place.

20 *Data Source*: State Council of Higher Education for Virginia.

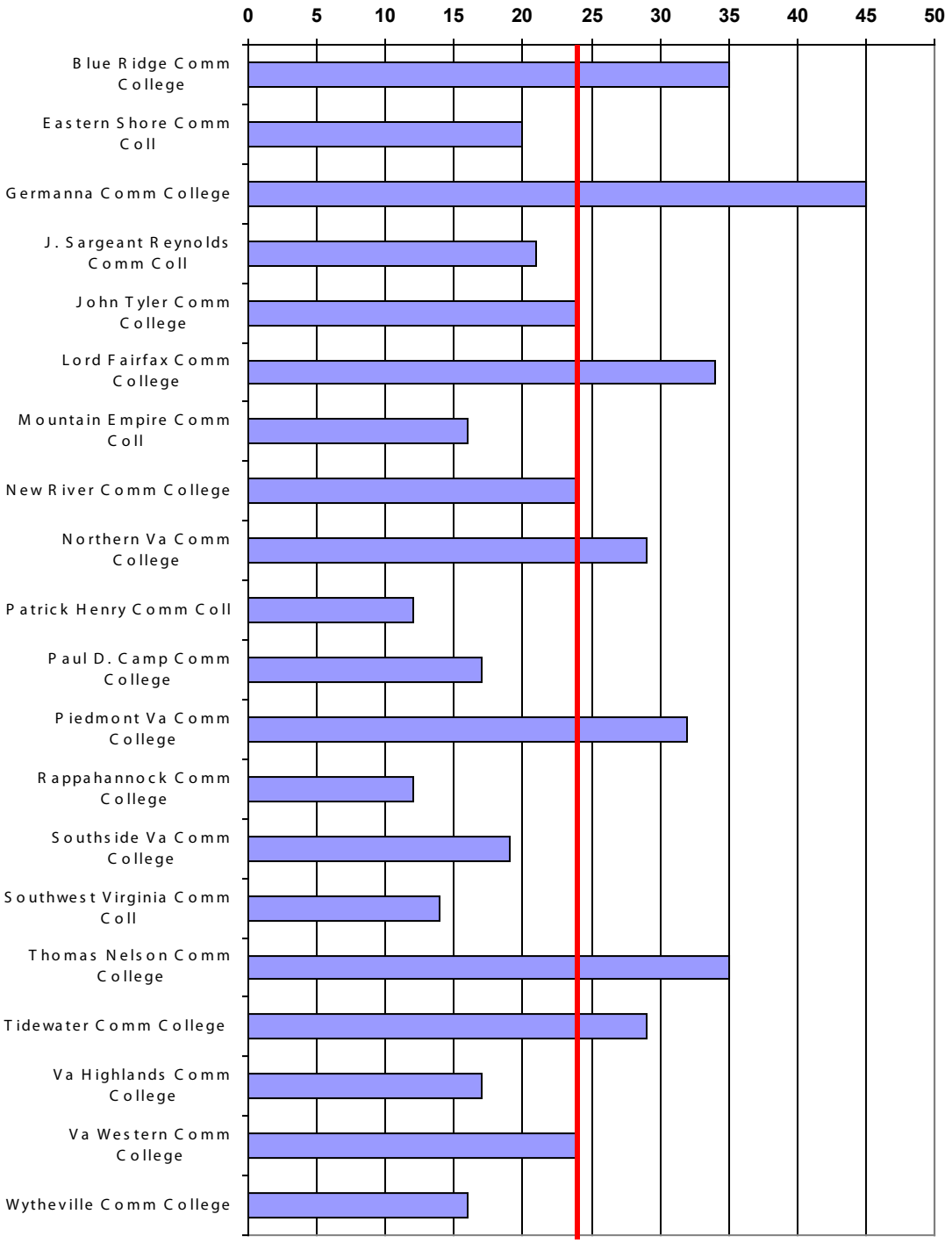


Figure 28: Community College Capacity - Fall 2005 Classroom Utilization

OCCUPATION DETAIL

In the pages that follow we provide additional detail on the educational pipeline serving each of the twelve skilled trades listed in Table 14.

Chemical Equipment Operators

The skilled trade Chemical Equipment Operators maps into two SOCs – 1) *Chemical Equipment Operators and Tenders* and 2) *Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders*. The education and training threshold for both of these SOCs is moderate-term on-the-job training. As shown in Table 15, in 2005 Virginia produced no graduates in the postsecondary educational programs serving these two SOCs.

Table 15: Chemical Equipment Operators - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Chemical Equipment Operators and Tenders	Moderate-term on-the-job training	0	0	0	0
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	Moderate-term on-the-job training	0	0	0	0

Figure 29: Chemical Equipment Operators - 2005 Educational Pipeline by WIA

Chemical Technicians

There is only one SOC associated with the skilled trade Chemical Technicians – *Chemical Technicians*. The education and training threshold for this SOC is a two-year Associates degree. As shown in Table 16, in 2005 Virginia produced no graduates in the postsecondary educational programs linked with this SOC.

Table 16: Chemical Technicians - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Chemical Technicians	Associates degree	0	0	0	0

Figure 30: Chemical Technicians - 2005 Educational Pipeline by WIA

Computer-Controlled Machine Tool Operators

The skilled trade Computer-Controlled Machine Tool Operators maps into two SOCs – 1) *Computer-Controlled Machine Tool Operator, Metal and Plastic* and 2) *Numerical Tool and Process Control Operators*.

The education and training threshold for *Computer-Controlled Machine Tool Operator, Metal and Plastic* is moderate-term on-the-job training. As shown in Table 17, in 2005 Virginia produced no graduates in the postsecondary educational programs serving this SOC.

The education and training threshold for *Numerical Tool and Process Control Operators* is long-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 80 graduates qualified to work in this SOC (*see* Table 17).

As shown in Figure 31, the largest supplier of graduates for this skilled trade was the two-year Career Colleges, accounting for 77 percent of the educational pipeline. Most of these graduates were concentrated in Central Virginia (*see* Figure 32).

Table 17: Computer-Controlled Machine Tool Operators - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Computer-Controlled Machine Tool Operator, Metal and Plastic	Moderate-term on-the-job training	0	0	0	0
Numerical Tool and Process Control Operators	Long-term on-the-job training	38	30	0	12

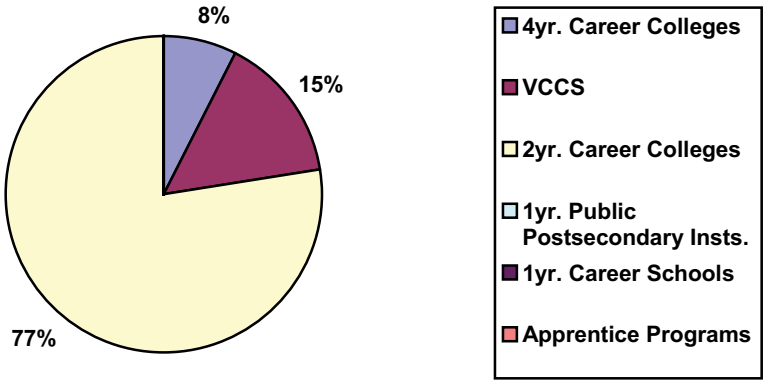


Figure 31: 2005 Total Qualified Supply of Computer-Controlled Machine Tool Operators by Type of Institution or Program

Figure 32: Computer-Controlled Machine Tool Operators - 2005 Educational Pipeline by WIA

Electricians and Electrical Technicians

The skilled trade Electricians and Electrical Technicians maps into three SOCs – 1) *Electrical and Electronic Engineering Technicians*, 2) *Electricians*, and 3) *Electrical and Electronic Repairers, Commercial and Industrial Equipment*.

The education and training threshold for *Electrical and Electronic Engineering Technicians* is a two-year Associates degree. As shown in Table 18, in 2005 Virginia postsecondary educational institutions produced 678 graduates qualified to work in this SOC.

The education and training threshold for *Electricians* is long-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 386 graduates qualified to work in this SOC (*see* Table 18).

The education and training threshold for *Electrical and Electronic Repairers, Commercial and Industrial Equipment* is a one-year or less postsecondary certificate. In 2005, Virginia postsecondary educational institutions produced 13 graduates qualified to work in this SOC (*see* Table 18).

As shown in Figure 33, the largest supplier of graduates for this skilled trade was the four-year Career Colleges, accounting for 46 percent of the educational pipeline (again, however, it is important to note that nearly all of these graduates came out of a single Associates degree program – *Computer Technology/Computer Systems Technology* – that is related to the *Electrical and Electronic Engineering Technicians* SOC, where 76 percent of workers are not employed within manufacturing). The second largest supplier of graduates were the registered Apprenticeship programs, supplying 36 percent of the educational pipeline. Most of the graduates associated with this skilled trade were concentrated in Hampton Roads (*see* Figure 34).

Table 18: Electricians and Electrical Technicians - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Electrical and Electronic Engineering Technicians	Associates degree	212	672	6	0
Electricians	Long-term on-the-job training	0	0	371	15
Electrical and Electronic Repairers, Commercial and Industrial Equipment	Certificate	5	0	7	1

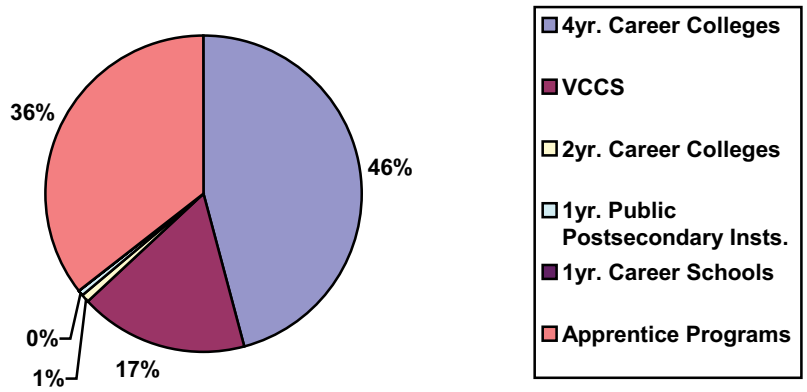


Figure 33: 2005 Total Qualified Supply of Electricians and Electrical Technicians by Type of Institution or Program

Figure 34: Electricians and Electrical Technicians - 2005 Educational Pipeline by WIA

Extruding and Drawing Machine Setters

There is only one SOC associated with the skilled trade Extruding and Drawing Machine Setters – *Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic*. The education and training threshold for this SOC is moderate-term on-the-job training. As shown in Table 19, in 2005 Virginia postsecondary education institutions produced 6 graduates in the programs supporting this SOC. All of these graduates came out of one-year public postsecondary schools (*see* Figure 35) in Southwest Virginia (*see* Figure 36).

Table 19: Extruding and Drawing Machine Setters - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	0	0

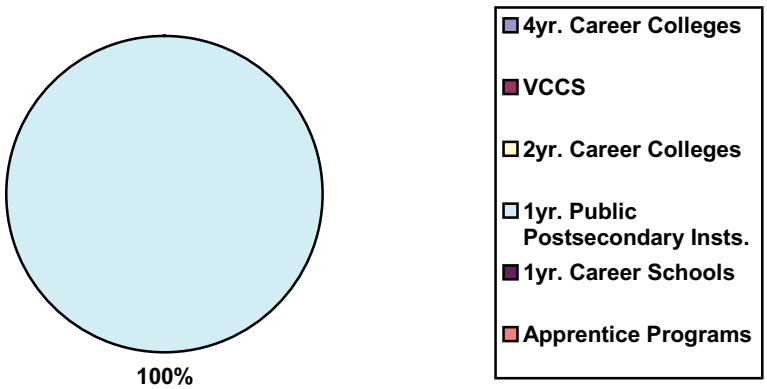


Figure 35: 2005 Total Qualified Supply of Extruding and Drawing Machine Setters by Type of Institution or Program

Figure 36: Extruding and Drawing Machine Setters - 2005 Educational Pipeline by WIA

Machine Maintenance Specialists

The skilled trade Machine Maintenance Specialists maps into three SOCs – 1) *Industrial Machinery Mechanics*, 2) *Machine and Repair Workers, General*, and 3) *Maintenance Workers, Machinery*.

The education and training threshold for *Industrial Machinery Mechanics* is long-term on-the-job training. As shown in Table 20, in 2005 Virginia postsecondary educational institutions produced 67 graduates qualified to work in this SOC.

The education and training threshold for *Machine and Repair Workers, General* is moderate-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 74 graduates qualified to work in this SOC (*see* Table 20).

The education and training threshold for *Maintenance Workers, Machinery* is short-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 66 graduates qualified to work in this SOC (*see* Table 20).

As shown in Figure 37, the largest supplier of graduates for this skilled trade was the Virginia Community College System, accounting for 88 percent of the educational pipeline. Most of the graduates associated with this skilled trade were concentrated in Central and Southside Virginia (*see* Figure 38)

Table 20: Machine Maintenance Specialists - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Industrial Machinery Mechanics	Long-term on-the-job training	0	0	1	66
Machine and Repair Workers, General	Moderate-term on-the-job training	0	0	8	66
Maintenance Workers, Machinery	Short-term on-the-job training	0	0	0	66

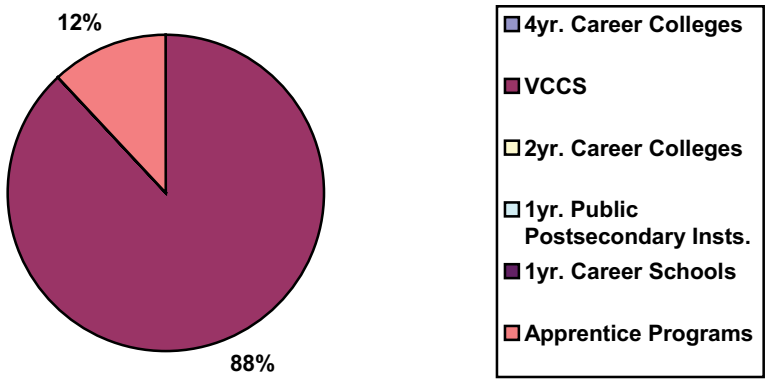


Figure 37: 2005 Total Qualified Supply of Machine Maintenance Specialists by Type of Institution or Program

Figure 38: Machine Maintenance Specialists - 2005 Educational Pipeline by WIA

Machinists

There is only one SOC associated with the skilled trade Machinists – *Machinists*. The education and training threshold for this SOC is long-term on-the-job training. As shown in Table 21, in 2005 Virginia postsecondary education institutions produced 94 graduates in the programs serving this SOC. The largest supplier of graduates for this skilled trade were the Registered Apprenticeship programs, accounting for 87 percent of the educational pipeline (*see* Figure 39). The largest concentrations of these graduates occurred in Hampton Roads, the Valley Region, and around Lynchburg (*see* Figure 40).

Table 21: Machinists - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Machinists	Long-term on-the-job training	6	0	81	7

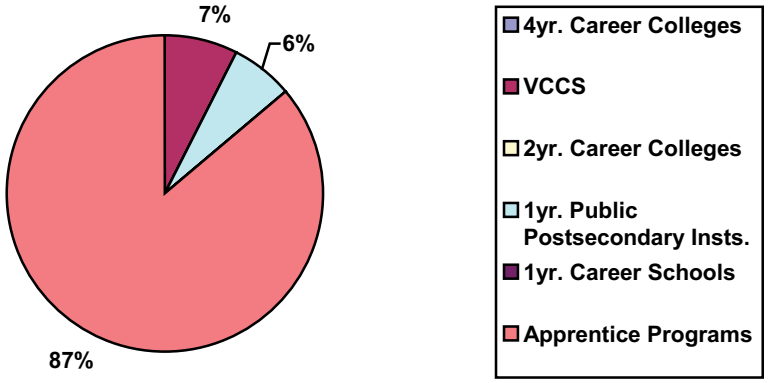


Figure 39: 2005 Total Qualified Supply of Machinists by Type of Institution or Program

Figure 40: Machinists - 2005 Educational Pipeline by WIA

Multiple Machine Tool Setters, Operators, and Tenders

The skilled trade Multiple Machine Tool Setters, Operator, and Tenders maps into five SOCs – 1) *Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic*, 2) *Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic*, 3) *Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic*, 4) *Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic*, and 5) *Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic*.

The education and training threshold for all of these SOCs is moderate-term on-the-job training. As shown in Table 22, in 2005 Virginia postsecondary education institutions produced 9 graduates in the programs serving: 1) *Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic*, 2) *Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic*, 3) *Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic*, and 4) *Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic*, and 21 graduates in the programs supporting *Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic*.

As shown in Figure 41, the largest supplier of graduates for this skilled trade were the Registered Apprenticeship programs, accounting for 57 percent of the educational pipeline. The largest concentrations of these graduates occurred in Southwest Virginia and Hampton Roads (*see* Figure 42).

Table 22: Multiple Machine Tool Setters, Operators, and Tenders – 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	0	3
Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	0	3
Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	0	3
Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	0	3
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Moderate-term on-the-job training	6	0	12	3

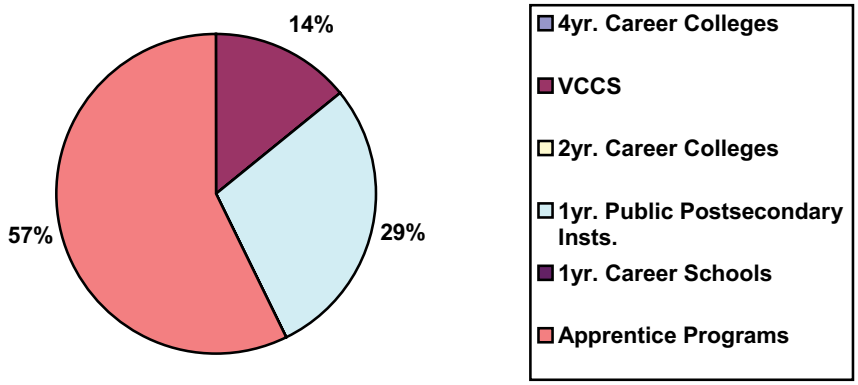


Figure 41: 2005 Total Qualified Supply of Multiple Machine Tool Setters, Operators, and Tenders by Type of Institution or Program

Figure 42: Multiple Machine Tool Setters, Operators, and Tenders – 2005 Educational Pipeline by WIA

Printing Machine Operators

The skilled trade Printing Machine Operators maps into three SOCs – 1) *Job Printers*, 2) *Prepress Technicians and Workers*, and 3) *Printing Machine Operators*.

The education and training threshold for *Job Printers* is long-term on-the-job training. As shown in Table 23, in 2005 Virginia postsecondary educational institutions produced 159 graduates qualified to work in this SOC.

The education and training threshold for *Prepress Technicians and Workers* is also long-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 195 graduates qualified to work in this SOC (*see* Table 23).

The education and training threshold for *Printing Machine Operators* is moderate-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 159 graduates qualified to work in this SOC (*see* Table 23).

As shown in Figure 43, the largest supplier of graduates for this skilled trade was the Virginia Community College System, accounting for 82 percent of the educational pipeline. Most of the graduates associated with this skilled trade were concentrated in Northern Virginia and Hampton Roads (*see* Figure 44)

Table 23: Printing Machine Operators - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Job Printers	Long-term on-the-job training	39	120	0	0
Prepress Technicians and Workers	Long-term on-the-job training	75	120	0	0
Printing Machine Operators	Moderate-term on-the-job training	39	120	0	0

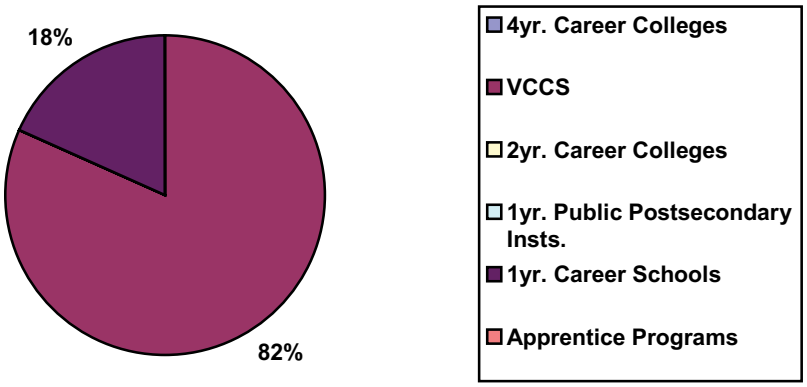


Figure 43: 2005 Total Qualified Supply of Printing Machine Operators by Type of Institution or Program

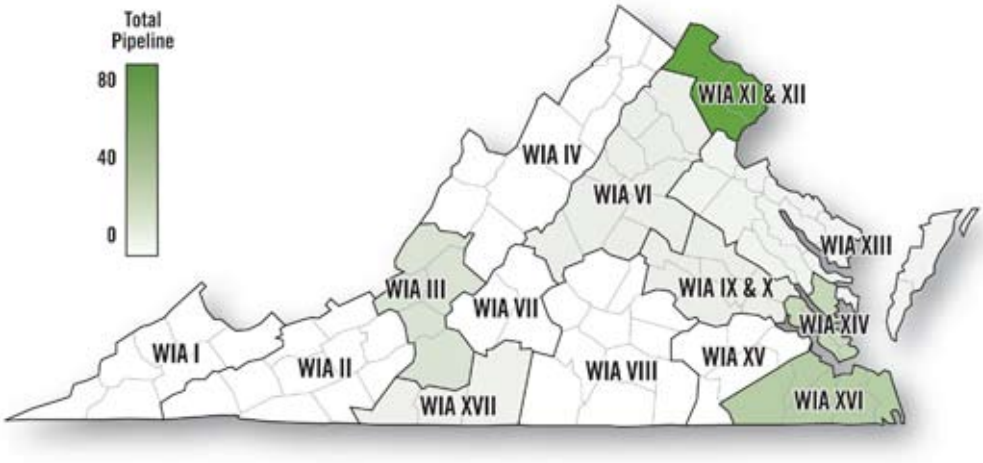


Figure 44: Printing Machine Operators - 2005 Educational Pipeline by WIA

Stationary Engineers and Boiler Operators

There is only one SOC associated with the skilled trade Stationary Engineers and Boiler Operators – *Stationary Engineers and Boiler Operators*. The education and training threshold for this SOC is long-term on-the-job training. As shown in Table 24, in 2005 Virginia postsecondary education institutions produced 3 graduates in the programs supporting this SOC. All of these graduates were from Registered Apprenticeship programs (*see* Figure 45) located in Central Virginia (*see* Figure 46).

Table 24: Stationary Engineers and Boiler Operators - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Stationary Engineers and Boiler Operators	Long-term on-the-job training	0	0	3	0

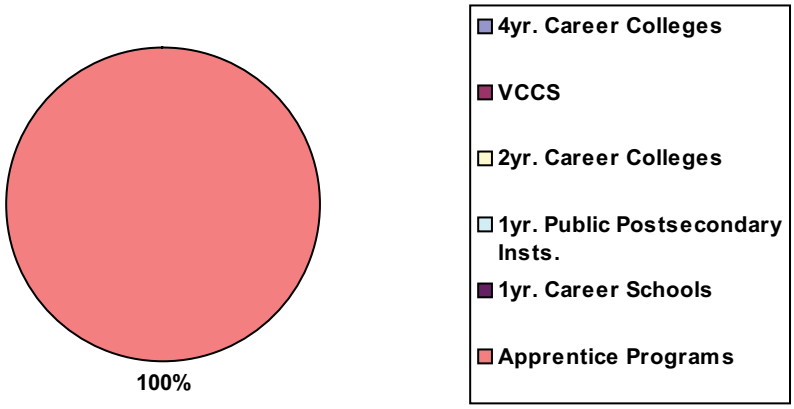


Figure 45: 2005 Total Qualified Supply of Stationary Engineers and Boiler Operators by Type of Institution or Program

Figure 46: Stationary Engineers and Boiler Operators - 2005 Educational Pipeline by WIA

Tool and Die Makers

There is only one SOC associated with the skilled trade Tool and Die Makers – *Tool and Die Makers*. The education and training threshold for this SOC is long-term on-the-job training. As shown in Table 25, in 2005 Virginia postsecondary education institutions produced 1 graduate in the programs serving this SOC. This graduate was out of the Virginia Community College System (*see* Figure 47).

Table 25: Tool and Die Makers - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Tool and Die Makers	Long-term on-the-job training	0	0	0	1

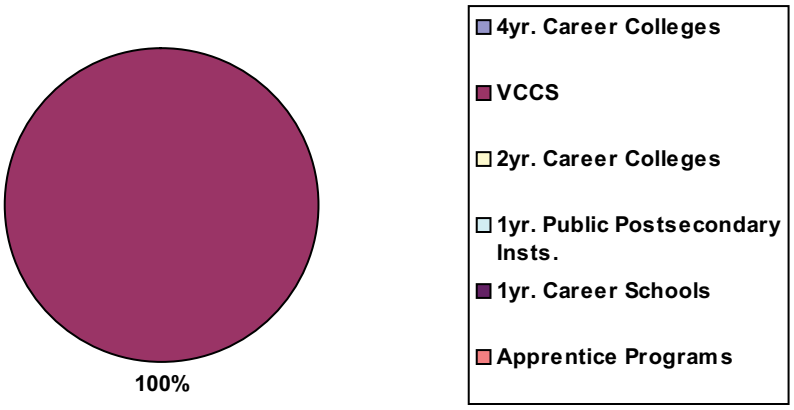


Figure 47: 2005 Total Qualified Supply of Tool and Die Makers by Type of Institution or Program

Figure 48: Tool and Die Makers - 2005 Educational Pipeline by WIA

Welders

The skilled trade Welders maps into two SOCs – 1) *Welders, Cutters, Solderers, and Brazers*, and 2) *Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders*.

The education and training threshold for *Welders, Cutters, Solderers, and Brazers* is long-term on-the-job training. As shown in Table 26, in 2005 Virginia postsecondary educational institutions produced 119 graduates qualified to work in this SOC (*see* Table 26).

The education and training threshold for *Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders* is moderate-term on-the-job training. In 2005, Virginia postsecondary educational institutions produced 56 graduates qualified to work in this SOC (*see* Table 26).

As shown in Figure 49, the largest supplier of graduates for this skilled trade were the Registered Apprenticeship programs, accounting for 53 percent of the educational pipeline. Most of the graduates associated with this skilled trade were concentrated in Southwest Virginia, Central Virginia, and Hampton Roads (*see* Figure 50)

Table 26: Welders - 2005 Statewide Educational Pipeline

SOC Title	Education and Training Level	Certificates	Associates	Apprentices	Career Studies
Welders, Cutters, Solderers, and Brazers	Long-term on-the-job training	27	0	63	29
Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders	Moderate-term on-the-job training	27	0	0	29

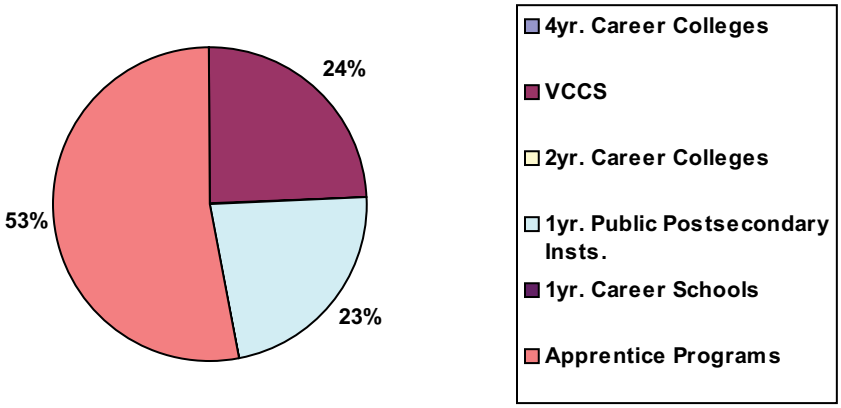


Figure 49: 2005 Total Qualified Supply of Welders by Type of Institution or Program

Figure 50: Welders - 2005 Educational Pipeline by WIA

Gap Analysis

In this section we compare the estimated demand for skilled trades workers with the estimated supply to identify potential gaps in the educational pipeline for skilled trades workers, both from a statewide perspective and regionally.

OVERVIEW

Table 27 compares the projected statewide average annual openings for each of the twelve skilled trades evaluated in Phase 1 of the VMA Skilled Trades Study with its 2005 pipeline of qualified graduates to identify: 1) the gap, or shortfall, in trained workers, and 2) the percentage of statewide need met. In reviewing these data, it is important to keep in mind that job vacancies can also be filled by qualified individuals who are not recent graduates, or who are recruited from out of state. As a result, the shortfalls detailed in Table 27 should be viewed as approximations of relative need, not a precise measure of need.

As these data show, in two of the twelve skilled trades (*i.e.*, 1) Chemical Equipment Operators and 2) Chemical Technicians) the percentage of statewide need met was zero. In six more (*i.e.*, 1) Extruding and Drawing Machine Setters, 2) Machine Maintenance Specialists, 3) Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic, 4) Stationary Engineers and Boiler Operators, 5) Tool and Die Makers, and 6) Welders) the percentage of statewide need met fell below 25 percent. And in one more (*i.e.*, Machinists) the percentage of statewide need met fell below 75 percent.

Only in three of the skilled trades evaluated (*i.e.*, 1) Computer-Controlled Machine Tool Operators, 2) Electrician and Electrical Technicians, and 3) Printing Machine Operators) was the percentage of statewide need met above 75 percent. Moreover, for one of these skilled trades, Electricians and Electrical Technicians, this finding is largely attributable to an artifact of the data where a large number of the graduates in that educational pipeline are actually not typically employed in manufacturing.

Overall, the annual gap in trained skilled trades workers is 2,197, with a cumulative gap between 2007 and 2012 of 12,894. Comparing these number to the pipeline of trained workers reveals that the total percentage of statewide need met across all twelve of the skilled trades evaluated in this portion of the study is only 44 percent.

Table 27: Statewide Gap in Skilled Trades Workers

Occupation	Projected Average Annual Openings: 2002-2012	Qualified Supply: 2005	Gap	% of Demand Met
Chemical Equipment Operators	49	0	49	0.0%
Chemical Technicians	35	0	35	0.0%
Computer-Controlled Machine Tool Operators	32	80	-48	100.0%
Electrician and Electrical Technicians	1,079	1,077	2	99.8%
Extruding and Drawing Machine Setters	99	6	93	6.1%
Machine Maintenance Specialists	1,422	75	1,347	5.3%
Machinists	151	94	57	62.3%
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	198	21	177	10.6%
Printing Machine Operators	238	195	43	81.9%
Stationary Engineers and Boiler Operators	17	3	14	17.6%
Tool and Die Makers	22	1	21	4.5%
Welders	478	119	359	24.9%
TOTAL				

OCCUPATION DETAIL

In the pages that follow we provide regional detail on the percentage of need met for each of the twelve skilled trades listed in Table 27.

Chemical Equipment Operators

Statewide, the cumulative shortfall in trained Chemical Equipment Operators between 2007 and 2012 is estimated to be 294. Also, as shown in Figure 51, the regional need met for this skilled trade was zero. This gap would have been most relevant in Central Virginia, where the bulk of the demand for this skilled trade takes place.

Figure 51: Chemical Equipment Operators – % of Need Met

Chemical Technicians

The cumulative statewide shortfall in trained Chemical Technicians between 2007 and 2012 is estimated to be 210. And, as with Chemical Equipment Operators, the regional need met for this skilled trade was zero across the breadth of the Commonwealth (*see* Figure 52). This gap would also have been most relevant in Central Virginia, where the bulk of the demand for this skilled trade takes place.

Figure 52: Chemical Technicians – % of Need Met

Computer Controlled Machine Tool Operators

The data reveal no cumulative shortfall in the supply of trained Computer Controlled Machine Tool Operators. However, as shown in Figure 53, there are likely regional imbalances in the demand and supply of this skilled trade. Recall from Figure 7 that the demand for Computer Controlled Machine Tool Operators tends to be concentrated in Southwest Virginia, with smaller concentrations in Hampton Roads, Central Virginia, and around Lynchburg. As shown in Figure 32, however, the supply of graduates associated with this skilled trade is concentrated in Central Virginia. This means that there are potential unmet needs in Southwest Virginia and Hampton Roads. Although the absolute magnitude of these needs is not large.

Figure 53: Computer-Controlled Machine Tool Operators – % of Need Met

Electricians and Electrical Technicians

The data reveal virtually no cumulative gap in the supply of trained Electricians and Electrical Technicians. Although, as shown in Figure 54, there once again do appear to be potential regional imbalances in demand and supply. Recall from Figure 9 that the demand for this skilled trade tends to be concentrated in Northern Virginia, Central Virginia, and Hampton Roads, with smaller concentrations distributed widely across the state. As demonstrated in Figure 54, however, although Central Virginia and Hampton Roads appear to be fully served, there may exist opportunities for enhancing the educational pipeline of these workers in Northern Virginia.

Figure 54: Electricians and Electrical Technicians – % of Need Met

Extruding and Drawing Machine Setters

Statewide, the cumulative shortfall in trained Extruding and Drawing Machine Setters between 2007 and 2012 is estimated to be 558. In addition, Figure 55 points to several regional imbalances in the demand and supply for this skilled trade. Recall from Figure 11 that the demand for Extruding and Drawing Machine Setters tends to be concentrated in Southwest Virginia, the Valley Region, and Central Virginia, with smaller concentrations in Hampton Roads and Northern Virginia, and around Roanoke, Lynchburg, and Danville/Martinsville. The data depicted in Figure 55 reveal that, whereas Southwest Virginia is well served, there may be opportunities for enhanced educational pipeline of these workers in the Valley Region and Central Virginia. The absolute magnitude of these regional gaps is not large however.

Figure 55: Extruding and Drawing Machine Setters – % of Need Met

Machine Maintenance Specialists

The estimated cumulative statewide shortfall between 2007 and 2012 in trained Machine Maintenance Specialists is the largest of the twelve skilled trades evaluated in this portion of the study – 8,082. Moreover, in this case as well, the data reveal potential regional imbalances between demand and supply. Recall from Figure 13 that the demand for this skilled trade tends to be concentrated in Northern Virginia, Central Virginia, and Hampton Roads, with smaller concentrations distributed widely across the state. Whereas, as shown in Figure 38, the supply tends to be concentrated in Central and Southside Virginia. As demonstrated in Figure 56, this means that there are likely opportunities for enhanced service in Northern Virginia and Hampton Roads. In addition, in this case the absolute size of the regional unmet needs appears to be non-trivial.

Figure 56: Machine Maintenance Specialists – % of Need Met

Machinists

Statewide, the cumulative shortfall in trained Machinists between 2007 and 2012 is estimated to be 342. As shown in Figure 57, however, there appear to be no significant regional imbalances in the demand and supply of this skilled trade.

Figure 57: Machinists – % of Need Met

Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic

The cumulative statewide shortfall in trained Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic between 2007 and 2012 is estimated to be 1,062. In addition, Figure 58 provides data that indicates there may also be regional imbalance in the demand and supply for this skilled trade. Recall from Figure 18 that the demand for Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic tends to be concentrated in Southwest Virginia, the Valley Region, and the Peninsula, with smaller concentrations distributed widely across the state. As Figure 58 demonstrates, whereas the needs of Southwest Virginia and the Peninsula appear to be adequately met, this appears not to be the case in the Valley Region.

Figure 58: Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic – % of Need Met

Printing Machine Operators

Statewide, the cumulative shortfall between 2007 and 2012 in trained Printing Machine Operators is estimated to be 258. Moreover, as shown in Figure 59, there also appear to be regional imbalances in demand and supply. Recall from Figure 20 that the demand for this skilled trade tends to be concentrated in the Valley Region, with smaller concentrations in Northern Virginia, Central Virginia, and Hampton Roads. As Figure 59 demonstrates, although demand in Northern Virginia, Central Virginia, and Hampton Roads is being fairly well met, there may again be unmet needs in the Valley Region.

Figure 59: Printing Machine Operators – % of Need Met

Stationary Engineers and Boiler Operators

The estimated cumulative statewide shortfall between 2007 and 2012 in trained Stationary Engineers and Boiler Makers is 84. Also, according to the data displayed in Figure 60, there may exist a regional imbalance in the demand and supply of this skilled trade. Recall from Figure 22 that the demand for Stationary Engineers and Boiler Makers tends to be concentrated in Northern Virginia and Central Virginia. As Figure 60 indicates, however, there may be opportunities for improving the educational pipeline of these workers in Northern Virginia. It is important to realize, however, that the absolute size of these unmet needs is, at best, relatively small.

Figure 60: Stationary Engineers and Boiler Operators – % of Need Met

Tool and Die Makers

Statewide, the cumulative shortfall in trained Tool and Die Makers between 2007 and 2012 is estimated to be 126. In addition, Figure 61 points to several regional imbalances in the demand and supply of this trade Recall from Figure 24 that the demand for Tool and Die Makers tends to be concentrated in the Southwest Virginia and Hampton Roads. As demonstrated by Figure 61, there may be opportunities for enhanced service delivery in both of these regions. Again, however, it is important to note that the absolute magnitude of the unmet needs is unlikely to be significant.

Figure 61: Tool and Die Makers – % of Need Met

Welders

The estimated cumulative statewide shortfall in trained Welders between 2007 and 2012 is the second largest of the twelve skilled trades evaluated in the Phase 1 portion of the study – 2,154. Moreover, as the data shown in Figure 62 demonstrate, there may also be regional imbalances in the demand and supply of this skilled trade, particularly in Hampton Roads. Recall from Figure 26 that the demand for Welders tends to be concentrated in Hampton Roads, with smaller concentrations in Northern Virginia and Southwest Virginia. Figure 62 reveals that there may be improvements possible in the percentage of need met in Hampton Roads.

Figure 62: Welders – % of Need Met

Summary of Phase 1 Findings

In this portion of the report we have presented the findings from Phase I of the VMA Skilled Trades Study. The purpose of this initial phase of the study was to: 1) provide a preliminary analysis of the scope and magnitude of the problems associated with meeting the demand for skilled trades workers in Virginia, and 2) better prepare us for Phase II of the study by illuminating areas where existing data may be inadequate to assess those problems.

The specific skilled trades evaluated in this portion of the VMA Skilled Trades Study were: 1) Chemical Equipment Operators, 2) Chemical Technicians, 3) Computer-Controlled Machine Tool Operators, 4) Electricians and Electrical Technicians, 5) Extruding and Drawing Machine Setters, 6) Machine Maintenance Specialists, 7) Machinists, 8) Multiple Machine Tool Setters, Operators, and Tenders, 9) Printing Machine Operators, 10) Stationary Engineers and Boiler Operators, 11) Tool and Die Makers, and 12) Welders.

Four key findings emerged from Phase 1:

1. There are several instances where the current statewide educational pipeline for skilled trades appears inadequate to meet future needs:
   - Overall, the average percentage of statewide need met across all twelve of the skilled trades evaluated in this portion of the study was only 44 percent.
   - The cumulative gap between 2007 and 2012 (the shortfall in needed skilled trades workers) is estimated to be 12,894 trained workers.
   - In two of the twelve skilled trades evaluated (*i.e.*, Chemical Equipment Operators and Chemical Technicians) the percentage of statewide need met was zero.
   - In six more (*i.e.*, Extruding and Drawing Machine Setters; Machine Maintenance Specialists; Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic; Stationary Engineers and Boiler Operators; Tool and Die Makers; and Welders) the percentage of statewide need met fell below 25 percent.
   - And in one more (*i.e.*, Machinists) the percentage of statewide need met fell below 75 percent.
   - Only in three of the skilled trades evaluated (*i.e.*, Computer-Controlled Machine Tool Operators; Electrician and Electrical Technicians; and Printing Machine Operators) was the percentage of statewide need met above 75 percent. Moreover, for one of these skilled trades, Electricians and Electrical Technicians, this finding is largely attributable to an artifact of the data where a large number of the graduates in that educational pipeline are actually not typically employed in manufacturing.
2. In addition, there appear to be several regional imbalances in the demand and supply for specific skilled trades:
   - *Chemical Equipment Operators and Chemical Technicians* – there appears to be a potential need for additional training programs in Central Virginia.
   - *Computer-Controlled Machine Tool Operators* – there appear to be potential unmet needs in Southwest Virginia and Hampton Roads.
   - *Machine Maintenance Specialists* – there appear to be opportunities for enhancing the educational pipeline for these workers in Northern Virginia and Hampton Roads.
   - *Multiple Machine Tool Setters, Operator, and Tenders, Metal and Plastic*, and *Printing Machine Operators* – there may exist unmet needs in the Valley Region.
   - *Welders* – there appear to be opportunities for enhancing the educational pipeline for these workers in Hampton Roads.
3. Analysis of institutional capacity within the Virginia Community College System, one of the major providers of trained skilled trades workers, indicates that 10 of the system's 23 colleges are already operating at, or above, capacity. This constraint likely inhibits their ability to add to the skilled trades educational pipeline with existing resources. Moreover, it bears notice that these ten institutions primarily serve the urban centers of Northern Virginia, Central Virginia, Hampton Roads, the Valley Region, and Roanoke, where the bulk of the demand for skilled trades workers takes place.
4. Several factors were revealed in this portion of the study that point to the need for a survey of Virginia manufacturers to obtain primary data on skilled trades employment.
   - In certain skilled trades occupations (*e.g.*, Electricians and Electrical Technicians) it is difficult to accurately assess the manufacturing-specific demand and supply of the skilled trade workers from existing data. There are three reasons for this. First, on the demand side, industry-specific occupation data are often imputed using the average proportion of industry employment comprised of that occupation, not direct measurements. This raises questions of accuracy, particularly at the regional level. Second, on the supply side, existing crosswalks between occupations and related training programs are insufficient to identify the proportion of graduates from specific training programs that go into specific occupations. As a result, it is difficult to gauge the true educational pipeline of trained workers for specific skilled trades. Third, the outsourcing by manufacturers of certain skilled trade functions to other industries (*e.g.*, construction) also makes it difficult to quantify the manufacturing-specific demand and supply of the skilled trade workers, because those numbers are credited to the other industry in existing data.
   - The Virginia Employment Commission (VEC) does not forecast occupational employment directly. Instead, the occupational forecast is derived from the VEC's forecast of industry employment. Any errors associated with this derivation are likely to be exacerbated in "small numbers" situations where a specific occupation comprises a small proportion of the overall employment in a given industry – a characteristic exhibited by many of the skilled trades.

Phase 2: Survey of Virginia Manufacturers

This portion of the report presents the findings from Phase 2 of VMA's Skilled Trades Study – a survey of Virginia manufacturers. Phase 2 was conducted by Alan Newman Research, Inc. The purpose of the Phase 2 manufacturing survey was to obtain primary data on skilled trades employment, evaluate potential refinements of the occupational categories used to define skilled trades, and compile information on certain hiring and training issues.

Based on the findings from Phase 1, the Skilled Trades Workforce Development Committee incorporated several changes in the process used to conduct Phase 2. First and foremost, they introduced a new job category – *Manufacturing Technician* – that is not represented in the Bureau of Labor Statistic's Standard Occupation Classification (SOC) taxonomy.

The reason for introducing this new job category was to better reflect the reality of modern manufacturing, where production machinery often means sophisticated multi-million dollar equipment involving the use of robotics and complex numerical controls, as opposed to the comparatively simple mechanical devices of the past. Because of this change, the traditional job classification *Machine Operator*, and the skill set associated with that job classification, no longer accurately captures a large portion of the modern skilled trades workforce. To account for this, the Skilled Trades Workforce Development Committee developed a new job classification – *Manufacturing Technician* – which refers to individuals who's job skills must exceed those of a traditional Machine Operator, but are less than those required of a Programmer or Engineer.

In addition to adding the *Manufacturing Technician* job classification, the Skilled Trades Workforce Development Committee also chose to delete four of the skilled trades employed in Phase 1 of the analysis because of their apparent limited relevance. These were: 1) Chemical Equipment Operators, 2) Extruding and Drawing Machine Setters, 3) Stationary Engineers and Boiler Operators, and 4) Tool and Die Makers. The Committee further elected to split the skilled trade category Electricians and Electrical Technicians that was employed in Phase 1 into two separate classifications, and combine the skilled trades categories Computer-Controlled Machine Tool Operators and Multiple Machine Tool Setters, Operators, and Tenders into a single classification.

Based on these changes, a total of nine skilled trades were included in the survey of Virginia manufacturers: 1) Manufacturing Technicians, 2) Chemical Technicians, 3) Electronics Technicians and Repairers, 4) (Industrial) Electricians, 5) Machine Maintenance Specialists, 6) (CNC and Conventional) Machine Tool Operators, 7) (CNC and Conventional) Machinists, 8) Printing Machine Operators, and 9) Welders. Full detail on the job descriptions associated with each of these skilled trades classifications is provided in section A5 of the Appendix to this report.

Finally, another change incorporated by the Skilled Trades Workforce Development Committee was to include in the survey questions related to issues pertaining to the hiring of skilled trades workers, and questions pertaining to the training of skilled trades workers.

The remainder of this portion of the report is divided into four sections: 1) a description of data and methods, 2) results for each of the skilled trades included in the Phase 2, 3) hiring and training issues, and 4) a summary of the most salient findings derived from Phase 2 of the VMA Skilled Trades Study.

Data and Methods

THE SURVEY

Data was collected through a web survey (for a copy of the full survey instrument *see* section A7 of the Appendix). To create a comprehensive list of manufacturers in Virginia, we used data purchased from Manufacturers' News, Inc. and augmented those data with VMA membership records. Based on these sources, a list of 5,863 Virginia manufacturers was compiled. Survey invitations, including a cover letter from Governor Kaine (*see* section A6 of the Appendix), were mailed to all manufacturers on that list, along with instructions for accessing the web survey. In addition, email invitations were sent to the approximately 2,900 manufacturers on the list for which an email address was available. Later, two sets of follow-up postcards were sent to manufacturers who had not responded, with additional instructions for obtaining a paper version of the survey, should that option be necessary.

The initial deadline for the survey was set for July 12, 2007 and was later extended to July 27, 2007 in an attempt to encourage a greater number of responses. The final number of completed surveys received was 456. Face-to-face interviews were employed to verify the data received for ten randomly selected survey responses (for a tabulation of the responses from these validation interviews, *see* section A8 of the Appendix).

EXTRAPOLATION TO THE STATEWIDE LEVEL

Projecting the information received from the survey to the statewide level involved two statistical operations. First, because the distribution of survey responses was more heavily weighted toward larger manufacturers than is typical of the broader distribution of manufacturers within the state (*i.e.*, larger firms were more likely to respond to the survey than smaller firms), it was necessary to adjust the survey sample to bring it into alignment with the statewide norm. This required stratifying the survey responses according to firm size and re-weighting the findings from each stratum to bring them into alignment with the proportion of statewide employment accounted for by manufacturers within that size category.[21] Second, the results

21 The survey sample was stratified according to nine standard firm size categories. To account for differences in the distribution of different size firms between the sample and the population of manufacturers within the state as a whole, weights were applied to the survey results obtained for each of the nine stratum. These weights forced the sum of the number of employees estimated in each sample stratum to that of the statewide population of manufacturers within that firm size category (based on Virginia Employment Commission 4th quarter 2006 data on industry employment). Whereas more typical weighting schemes would adjust the sample strata to match the statewide proportion of firms in each firm size category (as opposed to the number of employees), this approach proved untenable because the weighted estimate was found to be biased. The source of that bias proved to be the largest stratum (firms with over 1,000 employees), where the sampling units included outliers that biased the sample for that stratum relative to the statewide population of manufacturers.

obtained from the survey were projected to the statewide level and standard errors were calculated around each of those statewide estimates.[22]

Skilled Trades Employment

In this section, we review the employment data obtained from the survey for each of the nine skilled trades included in the Phase 2 analysis.

OVERVIEW

Table 28 lists the nine skilled trades evaluated in Phase 2. The numbers presented in this table are estimated statewide projections based on the sample data obtained from the survey. For each skilled trade, Table 28 provides data on: 1) 2007 employment, 2) 2010 employment, 3) the annual percentage employment increase between 2007 and 2010, 4) cumulative retirements for 2007 through 2010, 5) cumulative openings for 2007 through 2010, and 6) retirements as a percentage of overall openings.

What these data show is that, total employment in these skilled trades is expected to climb by about 4.1 percent per year between 2007 and 2010, for a total increase of 12.8 percent. To put this growth rate in perspective, the Virginia Employment Commission currently projects that, over the same period, statewide growth across all occupations in Virginia will only be 1.6 percent per year. In addition, it is important to note that out of the nine skilled trades listed in Table 28, seven are expected to experience annual employment growth rates that are substantially above the statewide average. The highest of these is *Manufacturing Technicians*, with a 5.2 percent estimated annual growth in employment.

Table 28: Occupational Findings – Statewide Employment and Openings

Skilled Trade	Estimated 2007 Employment	Projected 2010 Employment	Estimated Annual Employment Increase: 2007 to 2010	Projected Cumulative Retirements: 2007 through 2010	Projected Cumulative Openings: 2007 through 2010	Retirements as a percentage of Total Openings
Manufacturing Technicians	41,226	48,023	5.2%	5,769	22,606	25.5%
Chemical Technicians	2,398	2,683	3.8%	211	1,023	20.6%
Electronics Technicians and Repairers	6,610	7,528	4.4%	853	3,036	28.1%
(Industrial) Electricians	2,513	2,813	3.8%	441	1,324	33.3%
Machine Maintenance Specialists	7,642	7,934	1.3%	890	2,533	35.1%
(CNC and Conventional) Machine Tool Operators	13,740	15,699	4.5%	867	6,290	13.8%
(CNC and Conventional) Machinists	6,222	6,647	2.2%	535	3,366	15.9%
Printing Machine Operators	5,855	5,801	-0.3%	364	2,041	17.8%
Welders	11,291	12,843	4.4%	908	4,651	19.5%
TOTAL	**97,496**	**109,971**	**4.1%**	**10,837**	**46,870**	**23.1%**

As shown in table 28, the cumulative number of skilled trades openings from 2007 through 2010 is estimated to be 46,870, with 10,837 of these openings, or 23.1 percent, driven by retirements. Once again, *Manufacturing Technicians* have the largest impact, accounting for almost half (22,606 out of 46,870) of the total cumulative openings. It is expected that retirements will have their greatest impact on *Machine Maintenance Specialists* (where they drive 35.1 percent of openings) and *Electricians* (where they drive 33.3 percent of openings).

Table 29 revisits the Phase 1 gap analysis detailed in Table 27 by comparing the projected statewide average annual openings for each of the nine skilled trades evaluated in Phase 2 with the earlier estimates derived in Phase 1. Because of differences in the way these data were developed, the reader is again cautioned to view these results as relative approximations, rather than precise measurements. With that caution in mind, what these data show is that according to the survey data the magnitude of the gap, or shortfall, in trained workers may be much greater than was revealed in Phase 1 of this study, where the analysis was based on existing labor data.

Specifically, where the Phase 1 analysis showed an annual gap in trained workers of approximately 2,441[23], data from the survey indicate that this number may be as high as 11,751. Similarly, where the Phase 1 analysis indicated that the cumulative gap between 2007 and 2012 was around

22 The "survey" library for the statistical package R2.4.1 was employed to estimate the standard errors of the total and mean estimates. This software was developed by Thomas Lumley at the University of Washington. The Jackknife method of replication was used and each replicate was pos-stratified to produce the standard errors (*see* Valiant, Richard, "Post-stratification and Conditional Variance Estimation," *Journal of the American Statistical Association*, pp.88:89-96, 1993, for a detailed description of the benefits associated with using this method to address situations of this nature). The results were verified by hand.

23 This number has been adjusted to reflect differences in the skilled trades evaluated in Phase 1 and Phase 2.

14,646[24], data from the survey indicate that this number could be as high as 70,506 (although, it is important to note that in both of these instances much of the increase is attributable to the introduction of the new job category *Manufacturing Technician* in the Phase 2 analysis – a job category for which no corresponding educational pipeline data is available). Comparing these numbers to the pipeline of trained workers reveals that, where the percentage of the statewide need for trained skilled trades workers accommodated by the current educational pipeline was 33 percent according to the findings from the Phase 1 analysis, according to the survey data this number could be as low as 12 percent.

With respect to individual skilled trades, out of the nine skilled trades evaluated in the Phase 2 analysis, only two – *Electronics Technicians and Repairers* and *(Industrial) Electricians* – exhibited a percentage of need met above 75 percent. In the remaining seven, percentage of need met was 33 percent or less. The lowest percentage of need met was in *Manufacturing Technicians* (where no corresponding educational pipeline data are available) and *Chemical Technicians*. In both cases the percentage of the statewide need for trained skilled trades workers accommodated by the current educational pipeline was zero percent.

Table 29: Occupational Findings - Gap Analysis 2007-2012

Skilled Trade	Avg. Annual Openings: Phase 1	Avg. Annual Openings: Phase 21	Educational Pipeline	Gap: Phase 1	% of Need Met: Phase 1	Gap: Phase 2	% of Need Met: Phase 2
Manufacturing Technicians	N/A	6,459	N/A[2]	N/A	N/A	6,459	0.0%
Chemical Technicians	35	292	0	35	0.0%	292	0.0%
Electronics Technicians and Repairers	237	867	685	0	100.0%	182	76.8%[3]
(Industrial) Electricians	842	378	371	471	44.1%	7	98.1%
Machine Maintenance Specialists	1,422	724	75	1,347	5.3%	649	10.4%
(CNC and Conventional) Machine Tool Operators	230	1,797	101	129	43.9%	1,696	5.6%
(CNC and Conventional) Machinists	151	962	94	57	62.3%	868	9.8%
Printing Machine Operators	238	583	195	43	81.9%	388	33.4%
Welders	478	1,329	119	359	24.9%	1,210	9.0%
TOTAL	**3,633**	**13,391**	**1,640**	**2,441**	**32.8%**	**11,751**	**12.2%**

Manufacturing Technicians

Because *Manufacturing Technicians* was a newly introduced job category, additional questions were included in the survey to evaluate how well it reflected the changing reality of modern manufacturing. What these questions revealed was that the overwhelming majority of manufacturers who responded to the survey thought that *Manufacturing Technicians* captured a class of manufacturing jobs that is not well represented in the current Bureau of Labor Statistics' (BLS) system for classifying occupations. In addition, a majority of the manufacturers who responded to the survey were supportive of adding *Manufacturing Technicians* to the official BLS occupational taxonomy. Figures 63 through 65 provide detail on the survey results for these questions.

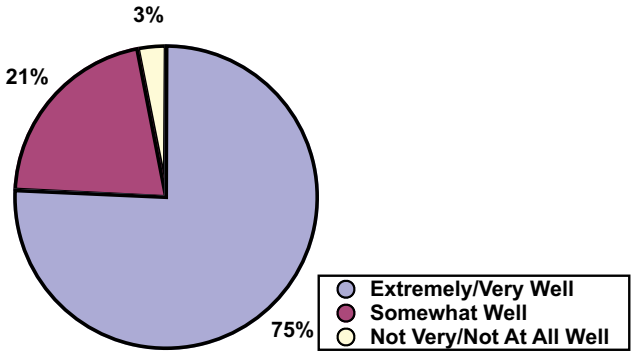


Figure 63: "How well does this new category capture jobs that are not adequately represented in the traditional definition of skilled trades occupations?"[25]

24 *Ibid.*

25 Percentages may not sum due to rounding.

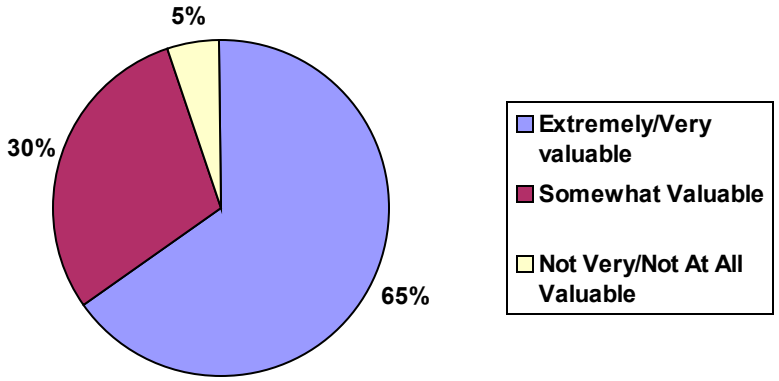


Figure 64: "In your opinion, how valuable is this definition in terms of its ability to capture jobs that are important to today's manufacturing enterprise?"

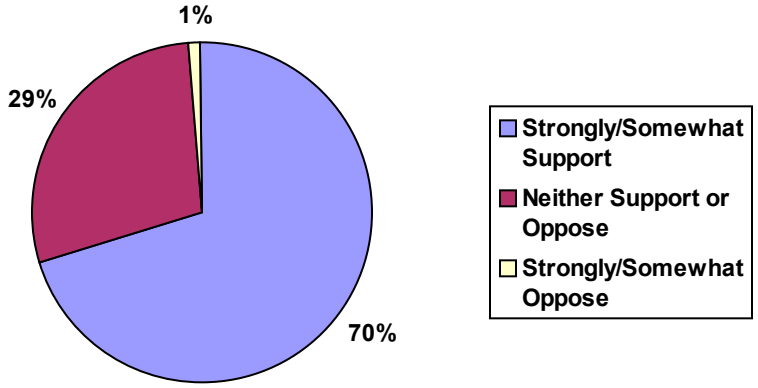


Figure 65: "How strongly would you support or oppose the Bureau of Labor Statistics adding the occupational category, manufacturing technician, to the list of occupational categories included under the definition of skilled trades occupations?"

Hiring and Training Issues

In addition to data on trends in skilled trades employment, the Phase 2 survey of manufacturers was also used to compile information on certain hiring and training issues. With regard to hiring issues, questions were included in the survey that assessed the skills of recent entry-level workers in three areas: 1) soft skills (*e.g.*, work ethic, punctuality, and teamwork), 2) measurable skills preparation (*e.g.*, reading for information, math, and locating information), and 3) basic manufacturing principles (*e.g.*, lean manufacturing, process controls, quality management, and problem solving).

The responses to these questions are summarized in Figures 66 through 68. As these graphs show, nearly half of the manufacturers who responded to the survey rated the soft skills and measurable skills preparation of recent entry-level hires as fair to very poor. Moreover, nearly seven out of ten respondents rated recent entry-level hires' knowledge of basic manufacturing principles as fair to very poor.

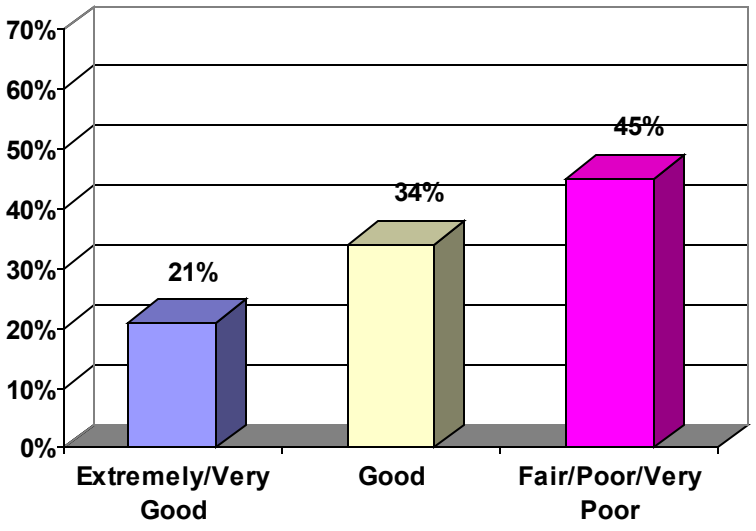


Figure 66: "Please rate the entry-level workers your company has hired over the past three years with regards to each of the following areas - *soft skills*."

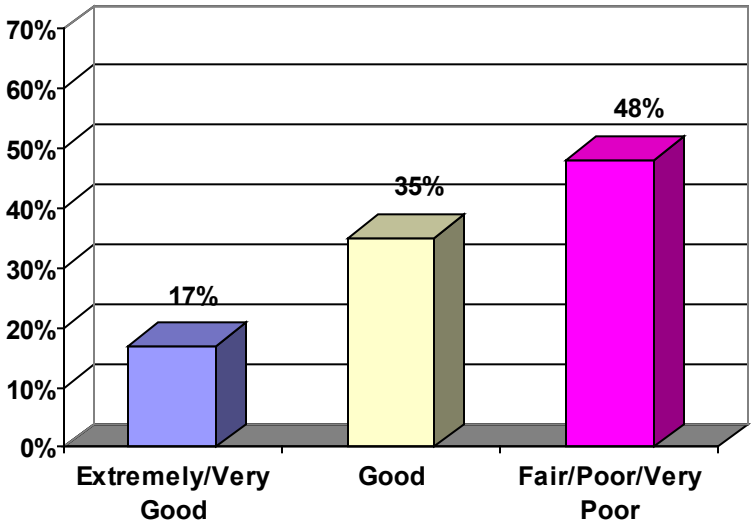


Figure 67: "Please rate the entry-level workers your company has hired over the past three years with regards to each of the following areas - *measurable skills preparation*."

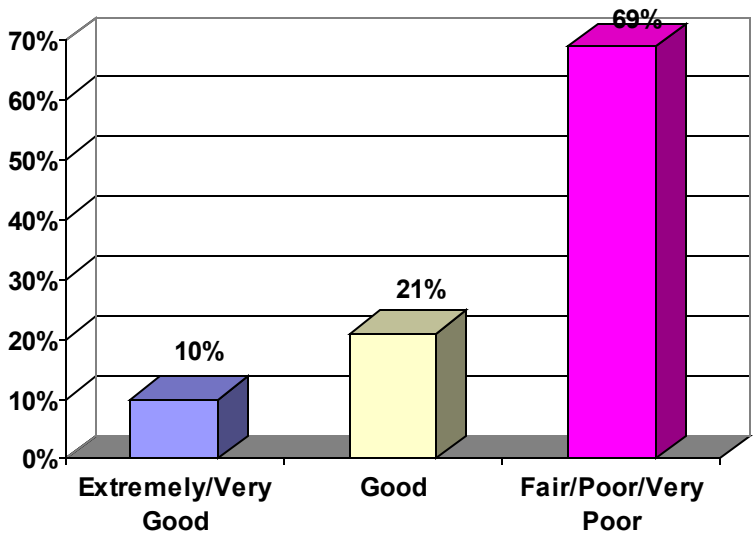


Figure 68: "Please rate the entry-level workers your company has hired over the past three years with regards to each of the following areas - *basic manufacturing principles*."

With regard to training issues, additional questions were included in the survey that were used to compile information on current training expenditures by manufacturers, and their opinions on how the state could assist in the hiring process by providing better manufacturing-related credentialing. The responses to these questions are summarized in Figures 69 through 71.

As shown in Figure 69, most of the manufacturers who responded to the survey spend between $1,000 and $4,999 to train new employees during their first year on the job. The larger the firm, however, the more likely they are to invest $5,000 or more in first year employee training.

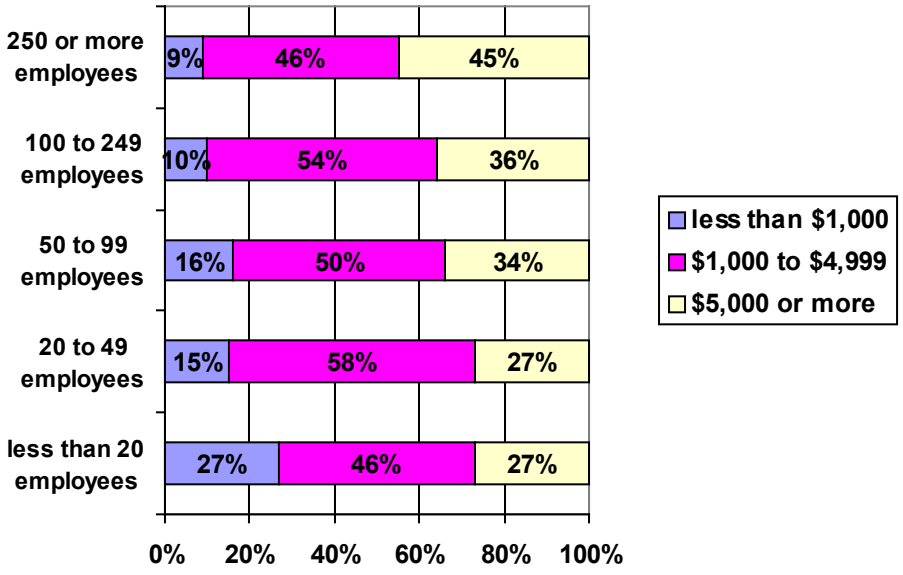


Figure 69: "For all the occupations described in this survey, how much would you estimate you spend in training, on average, per new employee during their first year on the job?"

Figures 70 and 71 summarize the survey respondents' opinions on how the state could assist in the hiring process by providing better manufacturing-related credentialing. As shown in Figure 70, fully 83 percent of the manufacturers who responded to the survey agreed that there should be additional requirements for career and technical education in Virginia's K-12 education system. Further, as depicted in Figure 71, 66 percent of respondents agreed that Virginia should institute a standardized manufacturing skills credential system that would certify the competencies of entry-level and advanced manufacturing workers.

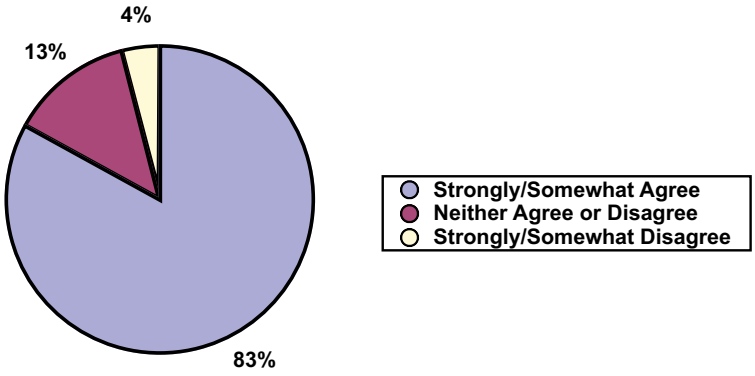


Figure 70: "There should be additional requirements for career and technical education in Virginia's K-12 education system."

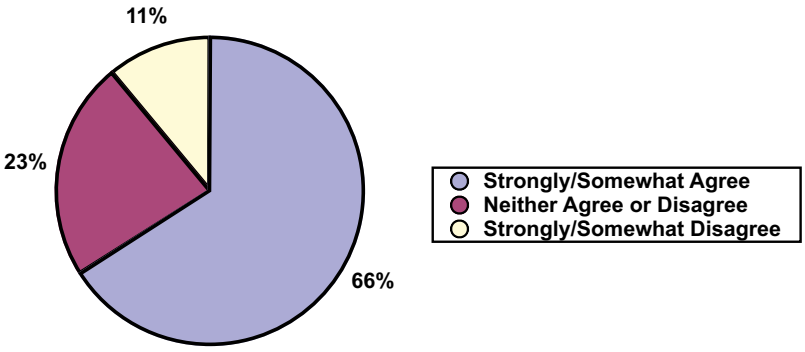


Figure 71: "Virginia should have a standardized manufacturing skills credential system, similar to that in the medical profession, that certifies workers for competencies at the entry-level and continues up through the college level."

Summary of Phase 2 Findings

In this portion of the report we have presented the findings from Phase 2 of VMA's Skilled Trades Study – a survey of Virginia manufacturers. The purpose of this survey was to obtain primary data on skilled trades employment, evaluate potential refinements of the occupational categories used to define skilled trades, and compile information on certain hiring and training issues.

Based on the findings from the Phase 1 analysis, several changes were made to the list of skilled trades evaluated in Phase 2 of the VMA Skilled Trades Study. Most notable among these was the inclusion of a new job category – *Manufacturing Technician* – that is not represented in the Bureau of Labor Statistic's Standard Occupation Classification (SOC) taxonomy. This new job category was included in the survey to better reflect the reality of modern manufacturing, where production machinery often means sophisticated multi-million dollar equipment involving the use of robotics and complex numerical controls, as opposed to the comparatively simple mechanical devices of the past.

In addition to adding the *Manufacturing Technician* job classification, eight other skilled trades were evaluated in the Phase 2 survey. These were: 1) Chemical Technicians, 2) Electronics Technicians and Repairers, 3) (Industrial) Electricians, 4) Machine Maintenance Specialists, 5) (CNC and Conventional) Machine Tool Operators, 6) (CNC and Conventional) Machinists, 7) Printing Machine Operators, and 8) Welders.

Six key findings emerged from Phase 2:

1. Growth in skilled trades employment is likely to far outstrip employment growth in most other occupations:
   - Total employment in the nine skilled trades evaluated in Phase 2 is expected to climb by about 4.1 percent per year between 2007 and 2010, for a total increase of 12.8 percent. To put this growth rate in perspective, the Virginia Employment Commission currently projects that, over the same period, statewide growth across all occupations in Virginia will only be 1.6 percent per year.
   - In seven out of the nine skilled trades evaluated, annual employment growth is expected to be substantially above the statewide average.
   - *Manufacturing Technicians* are expected to experience the largest growth in employment, at 5.2 percent per year.
2. The cumulative number of skilled trades openings from 2007 through 2010 is estimated to be 46,870:
   - 23.1 percent of these openings will be driven by retirements.
   - *Manufacturing Technicians* are expected to experience the largest number of openings, accounting for 22,606 of the 46,870.
3. The magnitude of the gap, or shortfall, in trained skilled trades workers may be much greater than was revealed in Phase 1 of this study, where the analysis was based on existing labor data:
   - Where the Phase 1 analysis showed an annual gap in trained workers of approximately 2,441, data from the survey indicate that this number may be as high as 11,751 (although, it is important to note that much of this increase is attributable to the introduction of the new job category *Manufacturing Technician* – a job category for which no corresponding educational pipeline data are available).
   - Where the Phase 1 analysis showed that the cumulative gap between 2007 and 2012 was around 14,646, data from the survey indicate that this number could be as high as 70,506 (although, again, it is important to note that much of this increase is attributable to the introduction of the new job category *Manufacturing Technician*).
   - Where the percentage of the statewide need for trained skilled trades workers accommodated by the current educational pipeline was 33 percent according to the findings from the Phase 1 analysis (refers only to the skilled trades evaluated in Phase 2), data from the survey indicate that this number could be as low as 12 percent.
4. An overwhelming majority of manufacturers approved of the proposed *Manufacturing Technician* job category.
   - 96 percent of manufacturers who responded to the survey thought that *Manufacturing Technicians* captured a class of manufacturing jobs that are not adequately represented in the traditional definition of skilled trades occupations.
   - 70 percent of the manufacturers who responded to the survey were supportive of adding *Manufacturing Technicians* to the official BLS occupational taxonomy.
5. Entry-level workers suffer from low skills:
   - Nearly half of the manufacturers who responded to the survey rated the soft skills and measurable skills preparation of recent entry-level hires as fair to very poor.
   - Seven out of ten rated recent entry-level hires' knowledge of basic manufacturing principles as fair to very poor.
6. Statewide credentialing could greatly improve the hiring process:
   - 83 percent of the manufacturers who responded to the survey agreed that there should be additional requirements for career and technical education in Virginia's K-12 education system.
   - 66 percent of respondents agreed that Virginia should institute a standardized manufacturing skills credential system that would certify the competencies of entry-level and advanced manufacturing workers.
   - 65 percent of the respondents agreed that the public image of manufacturing occupations is a major contributing factor to the problems employers experience in recruiting skilled workers.

Conclusions

In this report we have presented findings from the VMA Skilled Trades Study. This study was conducted in two phases. Phase 1 involved using existing labor and education databases to provide a preliminary analysis of the scope and magnitude of the problems associated with meeting the demand for skilled trades workers in Virginia. Phase 2 involved surveying Virginia manufacturers to obtain primary data on skilled trades employment, evaluate potential refinements in the occupational categories used to define skilled trades, and compile information on various hiring and training issues.

The adequacy of the skilled trades pipeline has become an issue of increasing importance to manufacturers because a general slowdown in the growth of the U.S. labor force, coupled with a large pending wave of retirements and the increasingly high-tech nature of manufacturing, are making it increasingly difficult to find adequate numbers of skilled trades workers. Absent proactive policy solutions, this combination of events is very likely to create crippling bottlenecks that have the potential to forestall economic growth.

What this study has shown is that job growth in skilled trades is expected to far outstrip employment growth in most other occupations. Moreover, when we compare the estimated number of annual openings in skilled trades with the estimated number of workers graduating from associated training programs, we find that the cumulative shortfall in trained workers between 2007 and 2012 may be as high 11,751 workers. In addition, these training gaps are in some instances further exacerbated by apparent regional imbalances between the demand for trained skilled trades workers and the location of existing training programs.

This study has also demonstrated that the current system used by the Bureau of Labor Statistics for classifying occupations may not accurately reflect the realities of modern manufacturing employment. This is particularly true with respect to the traditional classification *Machine Operator*. In a modern manufacturing facility, production machinery often means sophisticated multi-million dollar equipment involving the use of robotics and complex numerical controls, as opposed to the comparatively simple mechanical devices of the past. To account for this change, a new occupation classification was put forward in this study – *Manufacturing Technician* – that refers to individuals who's job skills must exceed those of a traditional *Machine Operator*, but are still below those required of a *Programmer* or *Engineer*. Results from this study indicate that inclusion of this new occupation classification is overwhelmingly supported by Virginia manufacturers.

This study found that entry-level workers in manufacturing often lack critical skills, including soft skills, measurable skills, and knowledge of basic manufacturing principles. To reduce the problems associated with identifying and addressing these deficits, manufacturers strongly support additional requirements for career and technical education in Virginia's K-12 education system, and the creation of a statewide credentialing program for manufacturing. Another finding was that the public image of manufacturing occupations significantly contributes to the problems employers experience in recruiting skilled workers.

In closing, the health of the manufacturing industry and its supply chain substantially impacts the economic performance of the Commonwealth. Occupations in the manufacturing industry pay significantly higher wages in many regions of the Commonwealth. These occupations also require substantial skills and the current pipeline of skilled worker training, education and certification is not keeping pace with employer demand. Further, survey responses from Virginia manufacturers indicate that the cumulative gap in trained skilled trades workers for 2007-2012 may be almost five times greater than was previously estimated using available Bureau of Labor Statistics data. According to these survey data, as many as 70,506 additional trained skilled trades workers may be needed by 2012.

Disclosure Statement

The Virginia Manufacturers Association does not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, age, disability, or any other basis prohibited by state law relating to discrimination in employment.

A1: Skilled Trades Occupations Evaluated in Phase 1 and Associated Bureau of Labor Statistics (BLS) Standard Occupational Classifications (SOC)

Occupation	BLS Standard Occupation (SOC) Code	BLS Standard Occupation (SOC) Title
Chemical Equipment Operators	519011	Chemical Equipment Operators and Tenders
Chemical Equipment Operators	519012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders
Chemical Technicians	194031	Chemical Technicians
Computer-Controlled Machine Tool Operators	514011	Computer-Controlled Machine Tool Operator, Metal and Plastic
Computer-Controlled Machine Tool Operators	514012	Numerical Tool and Process Control Operators
Electricians and Electrical Technicians	173023	Electrical and Electronic Engineering Technicians
Electricians and Electrical Technicians	472111	Electricians
Electricians and Electrical Technicians	492094	Electrical and Electronic Repairers, Commercial and Industrial Equipment
Extruding and Drawing Machine Setters	514021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic
Machine Maintenance Specialists	499041	Industrial Machinery Mechanics
Machine Maintenance Specialists	499042	Machine and Repair Workers, General
Machine Maintenance Specialists	499043	Maintenance Workers, Machinery
Machinists	514041	Machinists
Multiple Machine Tool Setters, Operators, and Tenders	514031	Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic
Multiple Machine Tool Setters, Operators, and Tenders	514032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic
Multiple Machine Tool Setters, Operators, and Tenders	514033	Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic
Multiple Machine Tool Setters, Operators, and Tenders	514034	Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic
Multiple Machine Tool Setters, Operators, and Tenders	514081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic
Printing Machine Operators	515021	Job Printers
Printing Machine Operators	515022	Prepress Technicians and Workers
Printing Machine Operators	515023	Printing Machine Operators
Stationary Engineers and Boiler Operators	518021	Stationary Engineers and Boiler Operators
Tool and Die Makers	514111	Tool and Die Makers
Welders	514121	Welders, Cutters, Solderers, and Brazers
Welders	514122	Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders

A2: Skilled Trades Occupations Evaluated in Phase 1 and Associated Postsecondary Education Programs

Occupation	SOC Code	SOC Title	Education & Training Level	Classification of Instructional Program (CIP) Code	Classification of Instructional Program (CIP) Title
Chemical Equipment Operators	519012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	Moderate-term OJT	N/A	N/A
Chemical Equipment Operators	519011	Chemical Equipment Operators and Tenders	Moderate-term OJT	410301	Chemical Technology/ Technician
Chemical Technicians	194031	Chemical Technicians	Associate degree	011001	Food Science
Chemical Technicians	194031	Chemical Technicians	Associate degree	410301	Chemical Technology/ Technician
Computer-Controlled Machine Tool Operators	514012	Numerical Tool and Process Control Operators	Long-term OJT	110201	Computer Programming/ Programmer, General
Computer-Controlled Machine Tool Operators	514012	Numerical Tool and Process Control Operators	Long-term OJT	110301	Data Processing and Data Processing Technology/ Technician
Electricians and Electrical Technicians	173023	Electrical and Electronic Engineering Technicians	Associate degree	150303	Electrical, Electronic and Communications Engineering Technology/ Technician
Electricians and Electrical Technicians	173023	Electrical and Electronic Engineering Technicians	Associate degree	150305	Telecommunications Technology/Technician (NEW)
Electricians and Electrical Technicians	173023	Electrical and Electronic Engineering Technicians	Associate degree	150399	Electrical and Electronic Engineering Technologies/ Technicians, Other
Electricians and Electrical Technicians	173023	Electrical and Electronic Engineering Technicians	Associate degree	151201	Computer Engineering Technology/Technician
Electricians and Electrical Technicians	173023	Electrical and Electronic Engineering Technicians	Associate degree	151202	Computer Technology/ Computer Systems Technology (NEW)
Electricians and Electrical Technicians	472111	Electricians	Long-term OJT	460302	Electrician
Electricians and Electrical Technicians	492094	Electrical and Electronic Repairers, Commercial and Industrial Equipment	Postsecondary vocational award	470104	Computer Installation and Repair Technology/ Technician
Electricians and Electrical Technicians	492094	Electrical and Electronic Repairers, Commercial and Industrial Equipment	Postsecondary vocational award	470105	Industrial Electronics Technology/Technician
Extruding and Drawing Machine Setters	514021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480501	Machine Tool Technology/ Machinist
Machine Maintenance Specialists	499041	Industrial Machinery Mechanics	Long-term OJT	470303	Industrial Mechanics and Maintenance Technology
Machine Maintenance Specialists	499041	Industrial Machinery Mechanics	Long-term OJT	470399	Heavy/Industrial Equipment Maintenance Technologies, Other
Machine Maintenance Specialists	499042	Machine and Repair Workers, General	Moderate-term OJT	460412	Building/Construction Site Management/Manager (NEW)

Occupation	SOC Code	SOC Title	Education & Training Level	Classification of Instructional Program (CIP) Code	Classification of Instructional Program (CIP) Title
Machine Maintenance Specialists	499043	Maintenance Workers, Machinery	Short-term OJT	470303	Industrial Mechanics and Maintenance Technology
Machine Maintenance Specialists	499043	Maintenance Workers, Machinery	Short-term OJT	470399	Heavy/Industrial Equipment Maintenance Technologies, Other
Machinists	514011	Computer-Controlled Machine Tool Operator, Metal and Plastic	Moderate-term OJT	480503	Machine Shop Technology/ Assistant
Machinists	514041	Machinists	Long-term OJT	480501	Machine Tool Technology/ Machinist
Machinists	514041	Machinists	Long-term OJT	480503	Machine Shop Technology/ Assistant
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514031	Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480501	Machine Tool Technology/ Machinist
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514031	Cutting, Punching, and Press Machine, Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480506	Sheet Metal Technology/ Sheetworking
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480501	Machine Tool Technology/ Machinist
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514033	Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480501	Machine Tool Technology/ Machinist
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514033	Grinding, Lapping, Polishing, and Buffing Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480503	Machine Shop Technology/ Assistant
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514034	Lathe and Turning Machine Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480501	Machine Tool Technology/ Machinist
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480501	Machine Tool Technology/ Machinist
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	514081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Moderate-term OJT	480503	Machine Shop Technology/ Assistant
Printing Machine Operators	515021	Job Printers	Long-term OJT	100302	Printing Management (NEW)
Printing Machine Operators	515021	Job Printers	Long-term OJT	100305	Graphic and Printing Equipment Operator, General Production
Printing Machine Operators	515022	Prepress Technicians and Workers	Long-term OJT	100302	Printing Management (NEW)
Printing Machine Operators	515022	Prepress Technicians and Workers	Long-term OJT	100303	Prepress/Desktop Publishing and Digital Imaging Design
Printing Machine Operators	515022	Prepress Technicians and Workers	Long-term OJT	100305	Graphic and Printing Equipment Operator, General Production
Printing Machine Operators	515022	Prepress Technicians and Workers	Long-term OJT	100306	Platemaker/Imager
Printing Machine Operators	515022	Prepress Technicians and Workers	Long-term OJT	100399	Graphic Communications, Other (NEW)

Occupation	SOC Code	SOC Title	Education & Training Level	Classification of Instructional Program (CIP) Code	Classification of Instructional Program (CIP) Title
Printing Machine Operators	515022	Prepress Technicians and Workers	Long-term OJT	500409	Graphic Design (NEW)
Printing Machine Operators	515023	Printing Machine Operators	Moderate-term OJT	100302	Printing Management (NEW)
Printing Machine Operators	515023	Printing Machine Operators	Moderate-term OJT	100305	Graphic and Printing Equipment Operator, General Production
Printing Machine Operators	515023	Printing Machine Operators	Moderate-term OJT	100307	Printing Press Operator
Printing Machine Operators	515023	Printing Machine Operators	Moderate-term OJT	100399	Graphic Communications, Other (NEW)
Stationary Engineers and Boiler Operators	518021	Stationary Engineers and Boiler Operators	Long-term OJT	N/A	N/A
Tool and Die Makers	514111	Tool and Die Makers	Long-term OJT	480507	Tool and Die Technology/ Technician
Welders	514121	Welders, Cutters, Solderers, and Brazers	Long-term OJT	480508	Welding Technology/Welder
Welders	514122	Welding, Sodering, and Brazing Machine Setters, Operators, and Tenders	Moderate-term OJT	480508	Welding Technology/Welder

A3: Graduate Pipeline Detail for Skilled Trades Occupations Evaluated in Phase 1 - 2004-05 Associates Degrees

WIA	Postsecondary Institution	Associates Degrees						
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing and Data Tech. (110301)	Elec. and Commun. Eng. Tech. (150303)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)
1	Appalachian School of Law	0	0	0	0	0	0	0
1	Bluefield College	0	0	0	0	0	0	0
1	Mt Empire CC	0	0	0	0	11	0	0
1	Southwest VA CC	0	0	0	0	21	0	0
1	UVA Wise	0	0	0	0	0	0	0
2	Emory and Henry College	0	0	0	0	0	0	0
2	New River CC	0	0	0	0	27	0	0
2	Radford University	0	0	0	0	0	0	0
2	Virginia Highlands CC	0	0	0	0	7	0	0
2	Virginia Intermont College	0	0	0	0	0	0	0
2	Virginia Tech	0	0	0	0	0	0	0
2	Washington County Adult Skill Center	0	0	0	0	0	0	0
2	Wytheville CC	0	0	0	0	8	0	0
3	Bar Palma Beauty Careers Academy	0	0	0	0	0	0	0
3	DS Lancaster CC	0	0	0	0	0	0	0
3	ECPI Technical College Roanoke	0	0	0	0	0	0	43

WIA	Postsecondary Institution	Associates Degrees						
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing and Data Tech. (110301)	Elec. and Commun. Eng. Tech. (150303)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)
3	Ferrum College	0	0	0	0	0	0	0
3	Hollins University	0	0	0	0	0	0	0
3	Jefferson College of Health Sciences	0	0	0	0	0	0	0
3	Natl College of Business & Technology - Salem	0	0	0	0	0	6	63
3	Roanoke College	0	0	0	0	0	0	0
3	Tap This Valley Works CET	0	0	0	0	0	0	0
3	Virginia Western CC	19	0	0	0	7	0	0
4	Blue Ridge CC	0	0	0	0	9	0	0
4	Bridgewater College	0	0	0	0	0	0	0
4	DS Lancaster CC	0	0	0	0	0	0	0
4	Eastern Menonite University	0	0	0	0	0	0	0
4	James Madison	0	0	0	0	0	0	0
4	Lord Fairfax CC	0	0	0	0	0	0	0
4	Lord Fairfax CC	0	0	0	0	0	0	0
4	Mary Baldwin College	0	0	0	0	0	0	0
4	Shenandoah University	0	0	0	0	0	0	0
4	Southern Virginia University	0	0	0	0	0	0	0
4	Staunton School of Cosmetology	0	0	0	0	0	0	0
4	Virginia Military Institute	0	0	0	0	0	0	0
4	Washington and Lee University	0	0	0	0	0	0	0
4	Woodrow Wilson Rehabilitation Center	0	0	0	0	0	0	0
6	Germanna CC	0	0	0	0	2	0	0
6	International Beauty School	0	0	0	0	0	0	0
6	J Sargent Reynolds CC	0	0	0	0	10	0	0
6	Lord Fairfax CC	0	0	0	0	0	0	0
6	Piedmont VA CC	0	0	0	0	11	0	0
6	University of Virginia	0	0	0	0	0	0	0
6	Virginia School of Massage	0	0	0	0	0	0	0
7	Central Virginia CC	5	0	0	0	5	0	0
7	Legends Institute	0	0	0	0	0	0	0
7	Liberty University	0	0	0	0	0	0	0
7	Lynchburg College	0	0	0	0	0	0	0
7	Lynchburg General Hospital School of Nursing	0	0	0	0	0	0	0
7	Miller-Motte Technical College	0	0	0	0	0	0	0
7	Randolph Macon Womens	0	0	0	0	0	0	0
7	Sweet Briar College	0	0	0	0	0	0	0

WIA	Postsecondary Institution	Associates Degrees						
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing and Data Tech. (110301)	Elec. and Commun. Eng. Tech. (150303)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)
8	Danville CC	0	0	0	0	0	0	0
8	Hampden-Sydney College	0	0	0	0	0	0	0
8	John Tyler CC	0	0	0	0	2	0	0
8	Longwood University	0	0	0	0	0	0	0
8	Piedmont VA CC	0	0	0	0	11	0	0
8	Southside CC	0	0	0	0	6	0	0
8	St Paul's College	0	0	0	0	0	0	0
9&10	Baptist Theological Seminary at Richmond	0	0	0	0	0	0	0
9&10	Beta Tech	0	0	0	0	0	0	0
9&10	Bon Secours Memorial School of Nursing	0	0	0	0	0	0	0
9&10	Braxton School of Business	0	0	0	0	0	0	0
9&10	Bryant and Stratton College Richmond	0	0	0	0	0	0	0
9&10	ECPI Technical College Richmond	0	0	0	0	0	0	48
9&10	Empire Beauty School -- Midlothian	0	0	0	0	0	0	0
9&10	ITT Technical Institute Richmond	0	0	0	0	0	0	0
9&10	J Sargent Reynolds CC	0	0	0	0	10	0	0
9&10	John Tyler CC	0	0	0	0	2	0	0
9&10	Randolph Macon	0	0	0	0	0	0	0
9&10	Rappahannock CC	0	0	0	0	0	0	0
9&10	Richmond School of Health and Technology	0	0	0	0	0	0	0
9&10	St Mary's School of Nursing Henrico County	0	0	0	0	0	0	0
9&10	Union Theological Seminary and Presbyterian School	0	0	0	0	0	0	0
9&10	University of Richmond	0	0	0	0	0	0	0
9&10	Virginia Commonwealth	0	0	0	0	0	0	0
9&10	Virginia School of Technology - Richmond	0	0	0	0	0	0	0
9&10	Virginia Union University	0	0	0	0	0	0	0
11&12	ACT College	0	0	0	0	0	0	0
11&12	Alexandria CET	0	0	0	0	0	0	0
11&12	Argosy University - Washington DC Campus	0	0	0	0	0	0	0
11&12	Devry University - Virginia	0	0	0	30	0	0	0
11&12	George Mason University	0	0	0	0	0	0	0
11&12	Gibbs College	0	0	0	0	0	0	0
11&12	Graham Webb International Academy of Hair	0	0	0	0	0	0	0
11&12	Heritage Institute	0	0	0	0	0	0	0
11&12	Heritage Institute Manassas	0	0	0	0	0	0	0
11&12	ITT Technical Institute - Springfield	0	0	0	0	0	0	0

WIA	Postsecondary Institution	Associates Degrees						
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing and Data Tech. (110301)	Elec. and Commun. Eng. Tech. (150303)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)
11&12	Marymount University	0	0	0	0	0	0	0
11&12	Northern VA CC	43	0	0	0	2	0	0
11&12	Parks College	0	0	0	0	0	0	0
11&12	Potomac College	0	0	0	0	0	0	0
11&12	Springfield Beauty Academy	0	0	0	0	0	0	0
11&12	Stratford University	0	2	0	0	0	0	35
11&12	TESST College of Technology - Alexandria	0	0	0	0	0	0	0
11&12	The Art Institute of Washington	0	0	0	0	0	0	0
11&12	The Chubb Institute - Arlington	0	0	0	0	0	0	0
11&12	University of Northern Virginia	0	0	0	0	0	0	0
11&12	University of Phoenix - Northern Virginia Campus	0	0	0	0	0	0	0
13	Career Training Solutions	0	0	0	0	0	0	0
13	Eastern Shore CC	0	0	0	0	4	0	0
13	Germanna CC	0	0	0	0	2	0	0
13	Rappahannock CC	0	0	0	0	0	0	0
13	University of Mary Washington	0	0	0	0	0	0	0
14	Christopher Newport	0	0	0	0	0	0	0
14	College of William & Mary	0	0	0	0	0	0	0
14	Hampton Roads School of Technology	0	0	0	0	0	0	0
14	Hampton University	0	0	0	0	0	0	0
14	Kee Business College	0	0	0	0	0	0	0
14	Kee Business College Chesapeake	0	0	0	0	0	0	0
14	Medical Careers Institute	0	0	0	0	0	0	0
14	New Horizons Regional Educ Center Nursing	0	0	0	0	0	0	0
14	NNPS RRMC School of Practical Nursing	0	0	0	0	0	0	0
14	NNPS RRMC School of Radiologic Technology	0	0	0	0	0	0	0
14	Rappahannock CC	0	0	0	0	0	0	0
14	Riverside Regional Medical Center School of Nursin	0	0	0	0	0	0	0
14	Thomas Nelson CC	22	0	0	0	7	0	0
14	Tidewater Tech Chesapeake	0	0	8	0	0	0	0
14	Tidewater Tech Newport News	0	0	0	0	0	0	0
14	Virginia School of Hair Design	0	0	0	0	0	0	0
15	Colonial Heights Beauty Academy	0	0	0	0	0	0	0
15	John Tyler CC	0	0	0	0	2	0	0
15	Richard Bland College	0	0	0	0	0	0	0
15	Southside CC	0	0	0	0	6	0	0

WIA	Postsecondary Institution	Associates Degrees						
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing and Data Tech. (110301)	Elec. and Commun. Eng. Tech. (150303)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)
15	Southside Regional Medical Center	0	0	0	0	0	0	0
15	Virginia State University	0	0	0	0	0	0	0
16	Advanced Technology Institute	0	0	0	0	0	0	0
16	Aviation Institute of Maintenance - Virginia Beach	0	0	0	0	0	0	0
16	Bryant and Stratton College Virginia Beach	0	0	0	0	0	0	0
16	Eastern Virginia Medical School	0	0	0	0	0	0	0
16	ECPI College of Technology	0	0	0	0	0	0	269
16	ESI Technology Training Center	0	0	0	0	0	0	0
16	Hicks Academy of Beauty Culture	0	0	0	0	0	0	0
16	ITT Technical Institute Norfolk	0	0	0	0	0	0	0
16	Johnson & Wales University Norfolk	0	0	0	0	0	0	0
16	Norfolk Public Schools Skills Center	0	0	0	0	0	0	0
16	Norfolk State	0	0	0	0	0	0	0
16	Old Dominion	0	0	0	0	0	0	0
16	Patrick Henry CC	0	0	0	0	22	0	0
16	Paul D Camp CC	0	0	0	0	0	0	0
16	Regent University	0	0	0	0	0	0	0
16	Rudy & Kelly Academy of Hair and Nails	0	0	0	0	0	0	0
16	Sentara School of Health Professions	0	0	0	0	0	0	0
16	Suffolk Beauty Academy	0	0	0	0	0	0	0
16	Tidewater CC	31	0	0	0	9	0	0
16	Tidewater Tech	0	0	20	0	8	0	0
16	Tidewater Tech Norfolk	0	0	0	0	0	0	0
16	Virginia Beach City Public Schools Nursing	0	0	0	0	0	0	0
16	Virginia School of Technology Virginia Beach	0	0	0	0	0	0	0
16	Virginia Wesleyan College	0	0	0	0	0	0	0
16	Wards Corner Beauty Academy Norfolk	0	0	0	0	0	0	0
16	Wards Corner Beauty Academy Virginia Beach	0	0	0	0	0	0	0
17	Averett University	0	0	0	0	0	0	0
17	Danville CC	0	0	0	0	0	0	0
17	Danville Regional Medical Center School of Nursing	0	0	0	0	0	0	0
17	Patrick Henry CC	0	0	0	0	22	0	0

A4: Graduate Pipeline Detail for Skilled Trades Occupations Evaluated in Phase 1 – 2004-05 Certificates

WIA	Postsecondary Institutions	Postsecondary Certificates									
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing & Data Tech. (110301)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)	Comp. Inst. & Rep. Tech. (47104)	Machine Tool Tech. (480501)	Welding Tech. (480508)	Graphic Design (500409)
1	Appalachian School of Law	0	0	0	0	0	0	0	0	0	0
1	Bluefield College	0	0	0	0	0	0	0	0	0	0
1	Mt Empire CC	0	0	0	0	0	0	0	0	0	0
1	Southwest VA CC	4	0	0	2	0	0	0	0	0	0
1	UVA Wise	0	0	0	0	0	0	0	0	0	0
2	Emory and Henry College	0	0	0	0	0	0	0	0	0	0
2	New River CC	0	0	0	0	0	0	0	0	0	0
2	Radford University	0	0	0	0	0	0	0	0	0	0
2	Virginia Highlands CC	0	0	0	14	0	0	0	0	0	0
2	Virginia Intermont College	0	0	0	0	0	0	0	0	0	0
2	Virginia Tech	0	0	0	0	0	0	0	0	0	0
2	Washington County Adult Skill Center	0	0	0	0	0	0	0	6	27	0
2	Wytheville CC	0	0	0	0	0	0	0	0	0	0
3	Bar Palma Beauty Careers Academy	0	0	0	0	0	0	0	0	0	0
3	DS Lancaster CC	0	0	0	0	0	0	0	0	0	0
3	ECPI Technical College Roanoke	0	0	0	0	0	0	0	0	0	0
3	Ferrum College	0	0	0	0	0	0	0	0	0	0
3	Hollins University	0	0	0	0	0	0	0	0	0	0
3	Jefferson College of Health Sciences	0	0	0	0	0	0	0	0	0	0
3	Natl College of Business & Technology - Salem	0	0	0	0	2	20	0	0	0	0
3	Roanoke College	0	0	0	0	0	0	0	0	0	0
3	Tap This Valley Works CET	0	0	0	0	0	0	0	0	0	0
3	Virginia Western CC	0	0	0	0	0	0	0	0	0	0
4	Blue Ridge CC	4	0	0	0	0	0	0	0	0	0
4	Bridgewater College	0	0	0	0	0	0	0	0	0	0
4	DS Lancaster CC	0	0	0	0	0	0	0	0	0	0
4	Eastern Menonite University	0	0	0	0	0	0	0	0	0	0
4	James Madison	0	0	0	0	0	0	0	0	0	0
4	Lord Fairfax CC	1	0	0	0	0	0	0	0	0	0
4	Lord Fairfax CC	1	0	0	0	0	0	0	0	0	0

WIA	Postsecondary Institutions	Postsecondary Certificates									
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing & Data Tech. (110301)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)	Comp. Inst. & Rep. Tech. (47104)	Machine Tool Tech. (480501)	Welding Tech. (480508)	Graphic Design (500409)
4	Mary Baldwin College	0	0	0	0	0	0	0	0	0	0
4	Shenandoah University	0	0	0	0	0	0	0	0	0	0
4	Southern Virginia University	0	0	0	0	0	0	0	0	0	0
4	Staunton School of Cosmetology	0	0	0	0	0	0	0	0	0	0
4	Virginia Military Institute	0	0	0	0	0	0	0	0	0	0
4	Washington and Lee University	0	0	0	0	0	0	0	0	0	0
4	Woodrow Wilson Rehabilitation Center	0	0	0	0	0	0	5	0	0	0
6	Germanna CC	7	0	0	0	0	0	0	0	0	0
6	International Beauty School	0	0	0	0	0	0	0	0	0	0
6	J Sargent Reynolds CC	0	0	0	0	0	0	0	0	0	0
6	Lord Fairfax CC	1	0	0	0	0	0	0	0	0	0
6	Piedmont VA CC	0	0	0	0	0	0	0	0	0	0
6	University of Virginia	0	0	0	0	0	0	0	0	0	0
6	Virginia School of Massage	0	0	0	0	0	0	0	0	0	0
7	Central Virginia CC	0	0	0	3	0	0	0	0	0	0
7	Legends Institute	0	0	0	0	0	0	0	0	0	0
7	Liberty University	0	0	0	0	0	0	0	0	0	0
7	Lynchburg College	0	0	0	0	0	0	0	0	0	0
7	Lynchburg General Hospital School of Nursing	0	0	0	0	0	0	0	0	0	0
7	Miller-Motte Technical College	0	0	0	0	0	0	0	0	0	0
7	Randolph Macon Womens	0	0	0	0	0	0	0	0	0	0
7	Sweet Briar College	0	0	0	0	0	0	0	0	0	0
8	Danville CC	6	0	0	54	0	0	0	0	0	0
8	Hampden-Sydney College	0	0	0	0	0	0	0	0	0	0
8	John Tyler CC	8	0	0	0	0	0	0	0	0	0
8	Longwood University	0	0	0	0	0	0	0	0	0	0
8	Piedmont VA CC	0	0	0	0	0	0	0	0	0	0
8	Southside CC	0	0	0	6	0	0	0	0	0	0
8	St Paul's College	0	0	0	0	0	0	0	0	0	0
9 & 10	Baptist Theological Seminary at Richmond	0	0	0	0	0	0	0	0	0	0

WIA	Postsecondary Institutions	Postsecondary Certificates									
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing & Data Tech. (110301)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)	Comp. Inst. & Rep. Tech. (47104)	Machine Tool Tech. (480501)	Welding Tech. (480508)	Graphic Design (500409)
9 & 10	Beta Tech	0	0	0	0	0	0	0	0	0	0
9 & 10	Bon Secours Memorial School of Nursing	0	0	0	0	0	0	0	0	0	0
9 & 10	Braxton School of Business	0	0	0	0	0	0	0	0	0	0
9 & 10	Bryant and Stratton College Richmond	0	0	0	0	0	0	0	0	0	0
9 & 10	ECPI Technical College Richmond	0	0	0	0	0	6	0	0	0	0
9 & 10	Empire Beauty School -- Midlothian	0	0	0	0	0	0	0	0	0	0
9 & 10	ITT Technical Institute Richmond	0	0	0	0	0	0	0	0	0	0
9 & 10	J Sargent Reynolds CC	0	0	0	0	0	0	0	0	0	0
9 & 10	John Tyler CC	8	0	0	0	0	0	0	0	0	0
9 & 10	Randolph Macon	0	0	0	0	0	0	0	0	0	0
9 & 10	Rappahannock CC	0	0	0	0	0	0	0	0	0	0
9 & 10	Richmond School of Health and Technology	0	0	0	0	0	0	0	0	0	0
9 & 10	St Mary's School of Nursing Henrico County	0	0	0	0	0	0	0	0	0	0
9 & 10	Union Theological Seminary and Presbyterian School	0	0	0	0	0	0	0	0	0	0
9 & 10	University of Richmond	0	0	0	0	0	0	0	0	0	0
9 & 10	Virginia Commonwealth	0	0	0	0	0	0	0	0	0	0
9 & 10	Virginia School of Technology - Richmond	0	0	0	0	0	0	0	0	0	0
9 & 10	Virginia Union University	0	0	0	0	0	0	0	0	0	0
11 & 12	ACT College	0	0	0	0	0	0	0	0	0	0
11 & 12	Alexandria CET	0	0	0	0	0	0	0	0	0	0
11 & 12	Argosy University - Washington DC Campus	0	0	0	0	0	0	0	0	0	0
11 & 12	Devry University - Virginia	0	0	0	0	0	0	0	0	0	0
11 & 12	George Mason University	0	0	0	0	0	0	0	0	0	0
11 & 12	Gibbs College	0	0	0	0	1	0	0	0	0	0
11 & 12	Graham Webb International Academy of Hair	0	0	0	0	0	0	0	0	0	0
11 & 12	Heritage Institute	0	0	0	0	0	0	0	0	0	0
11 & 12	Heritage Institute Manassas	0	0	0	0	0	0	0	0	0	0
11 & 12	ITT Technical Institute - Springfield	0	0	0	0	0	0	0	0	0	0

WIA	Postsecondary Institutions	Postsecondary Certificates									
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing & Data Tech. (110301)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)	Comp. Inst. & Rep. Tech. (47104)	Machine Tool Tech. (480501)	Welding Tech. (480508)	Graphic Design (500409)
11 & 12	Marymount University	0	0	0	0	0	0	0	0	0	0
11 & 12	Northern VA CC	0	0	0	4	0	0	0	0	0	0
11 & 12	Parks College	0	0	0	0	0	0	0	0	0	0
11 & 12	Potomac College	0	0	0	0	0	0	0	0	0	0
11 & 12	Springfield Beauty Academy	0	0	0	0	0	0	0	0	0	0
11 & 12	Stratford University	0	0	0	0	0	1	0	0	0	0
11 & 12	TESST College of Technology - Alexandria	0	0	0	0	0	0	0	0	0	0
11 & 12	The Art Institute of Washington	0	0	0	0	0	0	0	0	0	0
11 & 12	The Chubb Institute - Arlington	0	0	0	0	0	0	0	0	0	36
11 & 12	University of Northern Virginia	0	0	0	0	0	0	0	0	0	0
11 & 12	University of Phoenix - Northern Virginia Campus	0	0	0	0	0	0	0	0	0	0
13	Career Training Solutions	0	0	0	0	0	0	0	0	0	0
13	Eastern Shore CC	0	0	0	1	0	0	0	0	0	0
13	Germanna CC	7	0	0	0	0	0	0	0	0	0
13	Rappahannock CC	0	0	0	0	0	0	0	0	0	0
13	University of Mary Washington	0	0	0	0	0	0	0	0	0	0
14	Christopher Newport	0	0	0	0	0	0	0	0	0	0
14	College of William & Mary	0	0	0	0	0	0	0	0	0	0
14	Hampton Roads School of Technology	0	0	0	0	0	0	0	0	0	0
14	Hampton University	0	0	0	0	0	0	0	0	0	0
14	Kee Business College	0	0	0	0	0	0	0	0	0	0
14	Kee Business College Chesapeake	0	0	0	0	0	0	0	0	0	0
14	Medical Careers Institute	0	0	0	0	0	0	0	0	0	0
14	New Horizons Regional Educ Center Nursing	0	0	0	0	0	0	0	0	0	0
14	NNPS RRMC School of Practical Nursing	0	0	0	0	0	0	0	0	0	0
14	NNPS RRMC School of Radiologic Technology	0	0	0	0	0	0	0	0	0	0
14	Rappahannock CC	0	0	0	0	0	0	0	0	0	0
14	Riverside Regional Medical Center School of Nursin	0	0	0	0	0	0	0	0	0	0

WIA	Postsecondary Institutions	Postsecondary Certificates									
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing & Data Tech. (110301)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)	Comp. Inst. & Rep. Tech. (47104)	Machine Tool Tech. (480501)	Welding Tech. (480508)	Graphic Design (500409)
14	Thomas Nelson CC	6	0	0	0	0	0	0	0	0	0
14	Tidewater Tech Chesapeake	0	0	27	0	0	0	0	0	0	0
14	Tidewater Tech Newport News	0	0	0	0	0	0	0	0	0	0
14	Virginia School of Hair Design	0	0	0	0	0	0	0	0	0	0
15	Colonial Heights Beauty Academy	0	0	0	0	0	0	0	0	0	0
15	John Tyler CC	8	0	0	0	0	0	0	0	0	0
15	Richard Bland College	0	0	0	0	0	0	0	0	0	0
15	Southside CC	0	0	0	6	0	0	0	0	0	0
15	Southside Regional Medical Center	0	0	0	0	0	0	0	0	0	0
15	Virginia State University	0	0	0	0	0	0	0	0	0	0
16	Advanced Technology Institute	0	0	0	0	0	0	0	0	0	0
16	Aviation Institute of Maintenance - Virginia Beach	0	0	0	0	0	0	0	0	0	0
16	Bryant and Stratton College Virginia Beach	0	0	0	0	0	0	0	0	0	0
16	Eastern Virginia Medical School	0	0	0	0	0	0	0	0	0	0
16	ECPI College of Technology	0	4	0	0	0	86	0	0	0	0
16	ESI Technology Training Center	0	0	0	0	0	0	0	0	0	0
16	Hicks Academy of Beauty Culture	0	0	0	0	0	0	0	0	0	0
16	ITT Technical Institute Norfolk	0	0	0	0	0	0	0	0	0	0
16	Johnson & Wales University Norfolk	0	0	0	0	0	0	0	0	0	0
16	Norfolk Public Schools Skills Center	0	0	0	0	0	0	0	0	0	0
16	Norfolk State	0	0	0	0	0	0	0	0	0	0
16	Old Dominion	0	0	0	0	0	0	0	0	0	0
16	Patrick Henry CC	3	0	0	0	0	0	0	0	0	0
16	Paul D Camp CC	0	0	0	2	0	0	0	0	0	0
16	Regent University	0	0	0	0	0	0	0	0	0	0
16	Rudy & Kelly Academy of Hair and Nails	0	0	0	0	0	0	0	0	0	0

WIA	Postsecondary Institutions	Postsecondary Certificates									
		Graphic & Printing Equip. Operator, Gen. Production (100305)	Computer Programming, Gen (110201)	Data Processing & Data Tech. (110301)	Elec. Eng. Tech. (150399)	Comp. Eng. Tech. (151201)	Comp. Tech. (151202)	Comp. Inst. & Rep. Tech. (47104)	Machine Tool Tech. (480501)	Welding Tech. (480508)	Graphic Design (500409)
16	Sentara School of Health Professions	0	0	0	0	0	0	0	0	0	0
16	Suffolk Beauty Academy	0	0	0	0	0	0	0	0	0	0
16	Tidewater CC	0	0	0	5	0	0	0	0	0	0
16	Tidewater Tech	0	0	7	5	0	0	0	0	0	0
16	Tidewater Tech Norfolk	0	0	0	0	0	0	0	0	0	0
16	Virginia Beach City Public Schools Nursing	0	0	0	0	0	0	0	0	0	0
16	Virginia School of Technology Virginia Beach	0	0	0	0	0	0	0	0	0	0
16	Virginia Wesleyan College	0	0	0	0	0	0	0	0	0	0
16	Wards Corner Beauty Academy Norfolk	0	0	0	0	0	0	0	0	0	0
16	Wards Corner Beauty Academy Virginia Beach	0	0	0	0	0	0	0	0	0	0
17	Averett University	0	0	0	0	0	0	0	0	0	0
17	Danville CC	6	0	0	54	0	0	0	0	0	0
17	Danville Regional Medical Center School of Nursing	0	0	0	0	0	0	0	0	0	0
17	Patrick Henry CC	3	0	0	0	0	0	0	0	0	0

A5: Skilled Trades Occupations Evaluated in Phase 2 and Associated Job Descriptions and Sample Job Titles

Occupation	Job Description	Sample Job Titles
Chemical Technicians	Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for purposes such as research and development of new products or processes, quality control, maintenance of environmental standards, and other work involving experimental, theoretical, or practical application of chemistry and related sciences. Jobs are in industrial laboratory environments.	Chemical Technician, Formulation Technician, Lab Analyst, Lab Tech, Lab Tester, Research Associate, Research and Development Technician, and Research Technician.
Electronics Technicians and Repairers	Troubleshoot, diagnose and repair electronic machine control equipment; Test and modify electrical machinery, electrical-control equipment, and circuitry in industrial plants and laboratories. Repair, test, adjust, and install electronic equipment, such as industrial controls, transmitters and antennas.	Control Technician, Electrical Design Technician, Electronics Technician, Electronics Maintenance, Electronics Mechanic, Electronics Technician, Engineering Assistant, Engineering Technician, Equipment Engineering Technician, Industrial Electrician, Instrument and Electrical Technician, Machine Control Technician, and Test Technician.
(Industrial) Electricians	Install, maintain, and repair electrical wiring, equipment, and fixtures in a manufacturing plant. Ensure work is in accordance with relevant codes. May install electrical control systems.	Electrician, Industrial Electrician, Journeyman Electrician, and Maintenance Electrician.
Machine Maintenance Specialists	Repair, install, adjust, lubricate and maintain industrial production and processing machinery or refinery and pipeline distribution systems. Diagnose machine performance problems.	Building Maintenance Mechanic, Engineering Technician, Equipment Engineering Technician, Industrial Electrician, Industrial Machinery Mechanic, Industrial Maintenance Millwright, Machine Repairer, Maintenance Mechanic, Maintenance Technician, Master Mechanic, Mechanic, and Overhauler.
(CNC and Conventional) Machine Tool Operators	After machines are programmed or setup by others, operate, or tend machines to cut, drill, bore, grind, mill, plane, polish, ream, saw, sharpen, thread, or turn metal or plastic. Operate computer-controlled machine tools or robots. Perform quality checks to insure conformance to specifications.	Bore Mill Operator, Cell Operator, Cell Technician, Centerless Grinder Operator, Die Maintenance Technician, Die Repairman, Drill Operator, Drill Press Operator, Drill Setup Operator, Grinder, Grinder Operator, Lathe Operator, Machine Technician, Radial Drill Operator, Saw Operator, Screw Machine Operator, CNC Drilling Operator, CNC Lathe Operator, CNC Machine Operator, CNC Machinist, CNC Mill Operator, CNC Operator, Machine Operator, and Production Machinist.
(CNC and Conventional) Machinists	In addition to the work performed by "Machine Tool Operators" (Repair, install, adjust, lubricate and maintain industrial production and processing machinery or refinery and pipeline distribution systems & diagnose machine performance problems), Machinists in this classification setup and/or operate a variety of machine tools to produce precision parts. Edit CNC programs to optimize performance; change and adjust machine parameters and tooling as needed to meet dimensional and output requirements. Problem-solve machining issues when performance is not satisfactory.	CNC Machinist, Machinist, Machinist - Tool and Die, CNC Technician, and Setup Machinist.
Manufacturing Technicians	Operate precision machinery, systems and processes. Typical skills expected in these positions might include: CAD skills, computer controlled machine programming, precision measurement, process and machine trouble-shooting, problem-solving, machine maintenance, use diagnostic and statistical tools. These positions generally describe someone who has enough broad-based knowledge about a multi-step process to successfully trouble-shoot and cure problems beyond the scope of typical "machine operators." These positions may also describe someone charged with developing/ refining prototype fabrication methods for new products.	Operator, Production Operator, Production Technician, Technician, Chemical Equipment Operator, Chemical Operator, Fixers, CNC Technician, Manufacturing Technician, and Production Manufacturing Specialist.
Printing Machine Operators	Setup or operate various types of printing machines. Setup and prepare material for printing presses.	Desktop Operator, Electronic Prepress Operator, Electronic Prepress Technician, Lithographic Press Operator, Offset Press Operator, Offset Pressman, Plate Maker, Plate Mounter, Prepress Operator, Prepress Proofer, Prepress Stripper, Prepress Technician, Press Operator, Press Technician, Pressman, Printer, Printing Press Operator, Production Manager, Printing Pressman, and Typesetter.
Welders	Use programmed, automatic hand-held or flame equipment to weld or join metal components or to fill holes, indentations, or seams of fabricated metal products. Setup, operate, or tend welding, flame-cutting, plasma cutting, or brazing machines or robots. Braze components to assemble fabricated metal parts.	Brazer, Connector, Fabricator, Maintenance Welder, Mig Welder, Sheet Metal Mechanic, Sub Arc Operator, Welder, and Welder-Fitter.

A6: Governor Kaine's Cover Letter for Phase 2 Survey

COMMONWEALTH of VIRGINIA

Office of the Governor

Timothy M. Kaine
Governor

May 29, 2007

Dear Virginia Manufacturer:

Workforce development is a top priority of my administration. We recently completed a strategic plan for workforce development in the Commonwealth which clearly outlines the workforce needs and challenges of the manufacturing sector. To develop solutions, I am asking you to participate in the Virginia Skilled Trades Gap Analysis project.

Just like you, I need a strong business case to create solutions. The business case in this matter will be clearly defining the gap between the supply and demand of skilled trades workers and manufacturing technicians by region within the next three years. I am aware that manufacturing has the highest concentration of workers over 55 years old and we must prepare our future workforce to fill those valuable jobs.

In the next few weeks, you will receive another letter from the Chairman of the Virginia Manufacturers Association (VMA), President and CEO of the VMA and Chairman of the Manufacturing Advisory Council asking for your hiring and training needs for thirteen key skilled trades occupations. Your information will remain confidential and only reported in aggregate format by the VMA.

I am eager to see this final report and I hope that you are as well. I anticipate receiving the draft report at the Governor's Summit on Manufacturing on July 24, 2007. This information will provide a better understanding of the specific workforce needs of the manufacturing sector and how best to enhance our statewide workforce development network to meet these needs.

Patrick Henry Building • 1111 East Broad Street • Richmond, Virginia 23219
(804) 786-2211 • TTY (800) 828-1120
www.governor.virginia.gov

Virginia Manufacturer
May 29, 2007
Page 2

I thank you for participating in the Virginia Skilled Trades Gap Analysis project and helping to move Virginia forward.

Sincerely,

Timothy M. Kaine

TMK:kd

c: Daniel LeBlanc, Senior Advisor for Workforce
Patrick Gottschalk, Secretary of Commerce and Trade
Brett Vassey, President, Virginia Manufacturers Association

A7: Phase 2 Survey Instrument

VMA Skilled Trades Occupational Survey

Welcome to the Skilled Trades Occupational Survey of Manufacturers

Thank you for your willingness to participate in *the first-ever census* of the manufacturing sector in Virginia. This project is entirely driven by manufacturers. *Your responses*, combined with those of other manufactures, *will provide extremely valuable information* for Virginia's Governor and the Legislature to consider in developing solutions to the workforce crisis our industry may experience due to a shortage of qualified workers. Needless to say, your participation is very valuable.

Please be assured that *ALL of your responses will remain private and confidential*. Results will ONLY be reported in the aggregate. You and your company will NOT be identified in any way. This survey is for research purposes only.

We recognize your time is very important, and so we truly appreciate your sharing your opinions and experience with us. We expect that this survey will take *approximately 15-20 minutes* to complete.

Before getting any further, please enter your six digit/character password in the space below (you can find this password in the invitation letter you received from Brett Vassey).

Password: ___ ___ ___ ___ ___ ___

Please answer all of the questions on the following pages as accurately as you can. Since this information will be used to paint a picture of the laborforce needs of the manufacturing sector in Virginia, it is vital that the information we receive be as accurate as possible.

Once you have answered all the questions, finished, please return ALL pages of this document (including this cover page) to the following address:

Alan Newman Research
ATTN: VMA Survey
1025 Boulders Parkway
Suite 401
Richmond, Virginia 23225

If you have any questions about this project, feel free to contact Brett Vassey, VMA President & CEO, at thefuture@vamanufacturers.com or by telephone at 804.643.7489, ext. 25, or Forrest Peters, Project Coordinator, at thefuture@vamanufacturers.com or by telephone at 804.643.7489, ext. 13.

Alan Newman Research

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

SECTION 1. The first series of questions will provide VMA with a general understanding of the employment needs of your company. As with all questions in this survey, please be as accurate as possible.

Q1. How many total persons does your company currently employ full-time? _____

Q2. How many total persons does your company project it will employ full-time in 2010? _____

Q3. How many of your company's current, full-time employees will be eligible to retire by 2010? _____

Q4. How many total persons does your company currently employ part-time? _____

For the next group of questions, please place an 'X' in the box next to your answer.

Q5a. Does your company use outside contractors on an ongoing basis (i.e. Maintenance support, etc.)? NOTE: For the purposes of this survey, a contractor is an individual or group of individuals who are contracted to perform a particular service and/or produce an agreed upon outcome, where there is no provision for controlling or directing the manner in which the job is done.

- ☐ Yes (1)
- ☐ No (2)

Q5b. What is the predominant reason your company uses outside contractors? NOTE: For the purposes of this survey, a contractor is an individual or group of individuals who are contracted to perform a particular service and/or produce an agreed upon outcome, where there is no provision for controlling or directing the manner in which the job is done.

- ☐ Cost Savings (1)
- ☐ Lack of Skilled Workers Available to Perform Work (2)
- ☐ Some Other Reason [Please Specify:_____] (3)

Q5c. Has the number of contractors your company uses increased, decreased, or stayed about the same over the last five years?

- ☐ Increased (1)
- ☐ Stayed about the same (2)
- ☐ Decreased (3)

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

SECTION 2. The next set of questions focus on your current and future workforce needs in several specific occupational categories. For each occupational category, you will be presented with a job description as well as some example job titles of positions that would fall into this occupational category. Please read each description carefully to ensure the information you provide for each category is as accurate as possible.

This is the longest of the five sections in the survey. However, it contains some of the most vital information for developing a compelling business case. The business case needed by Virginia's Governor and the Legislature will be clearly defining the gap between the supply and demand of skilled trades workers and manufacturing technicians by region within the next three years.

Please note that for this survey, we would like you to report information ONLY for your facility; that is only for the facility at which you were contacted for this survey.

Manufacturing Technicians

Job Description: Operate precision machinery, systems and processes. Typical skills expected in these positions MIGHT include: CAD skills, computer controlled machine programming, precision measurement, process and machine trouble-shooting, problem-solving, machine maintenance, use diagnostic and statistical tools. These positions generally describe someone who has enough broad-based knowledge about a multi-step process to successfully trouble-shoot and cure problems beyond the scope of typical "machine operators." These positions may also describe someone charged with developing/refining prototype fabrication methods for new products.

Sample Job Titles: Operator, Production Operator, Production Technician, Technician, Chemical Equipment Operator, Chemical Operator, Fixers, CNC Technician, Manufacturing Technician, and Production Manufacturing Specialist.

Special Note: This is a newly defined position intended to be applicable to those jobs where a broader, more general skill set is required than is the case with the other specifically identified conventional skilled trades. These are multi-craft and multi-skilled positions that reflect the transformation of the less-skilled "operator" jobs of yesterday. The intent is for this description to capture jobs that do not meet the generally accepted traditional definition of "skilled trades" (and associated transferable apprenticeship), but are equally valuable to the enterprise, require education and training beyond the high school level, at least six (6) months of training, and therefore meet the definition of "skilled trades." These are NOT basic operator positions charged with "tending" a production line, machine or process.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q6a. How many total Manufacturing Technicians does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for Manufacturing Technicians, but rather how many people your company currently has employed as Manufacturing Technicians. _____

Q6b. How many total Manufacturing Technicians did your company employ in 2006? _____

Q6c. How many openings (unfilled positions) does your company currently have for Manufacturing Technicians? _____

Q6d. How many total Manufacturing Technicians do you anticipate your company will need to employ in 2010? _____

Q6e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of Manufacturing Technicians needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q6f. How many of the Manufacturing Technicians your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

Before moving forward, please take a moment to review the above information for the Manufacturing Technicians occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Chemical Technicians

Job Description: Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for purposes such as research and development of new products or processes, quality control, maintenance of environmental standards, and other work involving experimental, theoretical, or practical application of chemistry and related sciences. Jobs are in industrial laboratory environments.

Sample of Job Titles: Chemical Technician, Formulation Technician, Lab Analyst, Lab Tech, Lab Tester, Research Associate, Research and Development Technician, and Research Technician.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q7a. How many total Chemical Technicians does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for Chemical Technicians, but rather how many people your company currently has employed as Chemical Technicians. _____

Q7b. How many total Chemical Technicians did your company employ in 2006? _____

Q7c. How many openings (unfilled positions) does your company currently have for Chemical Technicians? _____

Q7d. How many total Chemical Technicians do you anticipate your company will need to employ in 2010? _____

Q7e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of Chemical Technicians needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q7f. How many of the Chemical Technicians your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the Chemical Technicians occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Electronics Technicians and Repairers

Job Description: Troubleshoot, diagnose and repair electronic machine control equipment; Test and modify electrical machinery, electrical-control equipment, and circuitry in industrial plants and laboratories. Repair, test, adjust, and install electronic equipment, such as industrial controls, transmitters and antennas.

Sample of Job Titles: Control Technician, Electrical Design Technician, Electronics Technician, Electronics Maintenance, Electronics Mechanic, Electronics Technician, Engineering Assistant, Engineering Technician, Equipment Engineering Technician, Industrial Electrician, Instrument and Electrical Technician, Machine Control Technician, and Test Technician.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q8a. How many total Electronics Technicians and Repairers does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for Electronics Technicians and Repairers, but rather how many people your company currently has employed as Electronics Technicians and Repairers. _____

Q8b. How many total Electronics Technicians and Repairers did your company employ in 2006? _____

Q8c. How many openings (unfilled positions) does your company currently have for Electronics Technicians and Repairers? _____

Q8d. How many total Electronics Technicians and Repairers do you anticipate your company will need to employ in 2010? _____

Q8e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of Electronics Technicians and Repairers needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q8f. How many of the Electronics Technicians and Repairers your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the Electronics Technicians and Repairers occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

(Industrial) Electricians

Job Description: Install, maintain, and repair electrical wiring, equipment, and fixtures in a manufacturing plant. Ensure work is in accordance with relevant codes. May install electrical control systems.

Sample of Job Titles: Electrician, Industrial Electrician, Journeyman Electrician, and Maintenance Electrician.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q9a. How many total (Industrial) Electricians does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for (Industrial) Electricians, but rather how many people your company currently has employed as (Industrial) Electricians. _____

Q9b. How many total (Industrial) Electricians did your company employ in 2006? _____

Q9c. How many openings (unfilled positions) does your company currently have for (Industrial) Electricians? _____

Q9d. How many total (Industrial) Electricians do you anticipate your company will need to employ in 2010? _____

Q9e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of (Industrial) Electricians needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q9f. How many of the (Industrial) Electricians your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the (Industrial) Electricians occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Machine Maintenance Specialists

Job Description: Repair, install, adjust, lubricate and maintain industrial production and processing machinery or refinery and pipeline distribution systems. Diagnose machine performance problems.

Sample of Job Titles: Building Maintenance Mechanic, Engineering Technician, Equipment Engineering Technician, Industrial Electrician, Industrial Machinery Mechanic, Industrial Maintenance Millwright, Machine Repairer, Maintenance Mechanic, Maintenance Technician, Master Mechanic, Mechanic, and Overhauler.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q10a. How many total Machine Maintenance Specialists does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for Machine Maintenance Specialists, but rather how many people your company currently has employed as Machine Maintenance Specialists. _____

Q10b. How many total Machine Maintenance Specialists did your company employ in 2006? _____

Q10c. How many openings (unfilled positions) does your company currently have for Machine Maintenance Specialists? _____

Q10d. How many total Machine Maintenance Specialists do you anticipate your company will need to employ in 2010? _____

Q10e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of Machine Maintenance Specialists needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q10f. How many of the Machine Maintenance Specialists your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the Machine Maintenance Specialists occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

(CNC & Conventional) Machine Tool Operators

Job Description: After machines are programmed or setup by others, operate, or tend machines to cut, drill, bore, grind, mill, plane, polish, ream, saw, sharpen, thread, or turn metal or plastic. Operate computer-controlled machine tools or robots. Perform quality checks to insure conformance to specifications.

Sample of Job Titles: Bore Mill Operator, Cell Operator, Cell Technician, Centerless Grinder Operator, Die Maintenance Technician, Die Repairman, Drill Operator, Drill Press Operator, Drill Setup Operator, Grinder, Grinder Operator, Lathe Operator, Machine Technician, Radial Drill Operator, Saw Operator, Screw Machine Operator, CNC Drilling Operator, CNC Lathe Operator, CNC Machine Operator, CNC Machinist, CNC Mill Operator, CNC Operator, Machine Operator, and Production Machinist

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q11a. How many total (CNC & Conventional) Machine Tool Operators does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for (CNC & Conventional) Machine Tool Operators, but rather how many people your company currently has employed as (CNC & Conventional) Machine Tool Operators. _____

Q11b. How many total (CNC & Conventional) Machine Tool Operators did your company employ in 2006? _____

Q11c. How many openings (unfilled positions) does your company currently have for (CNC & Conventional) Machine Tool Operators? _____

Q11d. How many total (CNC & Conventional) Machine Tool Operators do you anticipate your company will need to employ in 2010? _____

Q11e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of (CNC & Conventional) Machine Tool Operators needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q11f. How many of the (CNC & Conventional) Machine Tool Operators your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the (CNC & Conventional) Machine Tool Operators occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

(CNC & Conventional) Machinists

Job Description: In addition to the work performed by "Machine Tool Operators" (Repair, install, adjust, lubricate and maintain industrial production and processing machinery or refinery and pipeline distribution systems & diagnose machine performance problems), Machinists in this classification setup and/or operate a variety of machine tools to produce precision parts. Edit CNC programs to optimize performance; change and adjust machine parameters and tooling as needed to meet dimensional and output requirements. Problem-solve machining issues when performance is not satisfactory.

Sample of Job Titles: CNC Machinist, Machinist, Machinist - Tool and Die, CNC Technician, and Setup Machinist.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q12a. How many total (CNC & Conventional) Machinists does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for (CNC & Conventional) Machinists, but rather how many people your company currently has employed as (CNC & Conventional) Machinists. _____

Q12b. How many total (CNC & Conventional) Machinists did your company employ in 2006? _____

Q12c. How many openings (unfilled positions) does your company currently have for (CNC & Conventional) Machinists? _____

Q12d. How many total (CNC & Conventional) Machinists do you anticipate your company will need to employ in 2010? _____

Q12e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of (CNC & Conventional) Machinists needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q12f. How many of the (CNC & Conventional) Machinists your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the (CNC & Conventional) Machinists occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Printing Machine Operators

Job Description: Setup or operate various types of printing machines. Setup and prepare material for printing presses.

Sample of Job Titles: Desktop Operator, Electronic Prepress Operator, Electronic Prepress Technician, Lithographic Press Operator, Offset Press Operator, Offset Pressman, Plate Maker, Plate Mounter, Prepress Operator, Prepress Proofer, Prepress Stripper, Prepress Technician, Press Operator, Press Technician, Pressman, Printer, Printing Press Operator, Production Manager, Printing Pressman, and Typesetter.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q13a. How many total Printing Machine Operators does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for Printing Machine Operators, but rather how many people your company currently has employed as Printing Machine Operators. _____

Q13b. How many total Printing Machine Operators did your company employ in 2006? _____

Q13c. How many openings (unfilled positions) does your company currently have for Printing Machine Operators? _____

Q13d. How many total Printing Machine Operators do you anticipate your company will need to employ in 2010? _____

Q13e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of Printing Machine Operators needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q13f. How many of the Printing Machine Operators your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the Printing Machine Operators occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Welders

Job Description: Use programmed, automatic hand-held or flame equipment to weld or join metal components or to fill holes, indentations, or seams of fabricated metal products. Setup, operate, or tend welding, flame-cutting, plasma cutting, or brazing machines or robots. Braze components to assemble fabricated metal parts.

Sample of Job Titles: Brazer, Connector, Fabricator, Maintenance Welder, Mig Welder, Sheet Metal Mechanic, Sub Arc Operator, Welder, and Welder-Fitter.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q14a. How many total Welders does your company currently employ? Please note this is NOT how many positions you have available (either filled or unfilled) for Welders, but rather how many people your company currently has employed as Welders. _____

Q14b. How many total Welders did your company employ in 2006? _____

Q14c. How many openings (unfilled positions) does your company currently have for Welders? _____

Q14d. How many total Welders do you anticipate your company will need to employ in 2010? _____

Q14e. How many new hires do you anticipate your company will need to make between now and 2010 in order to reach the total number of Welders needed in 2010? Please include retirements, expansions, and attrition in this figure. _____

Q14f. How many of the Welders your company currently employs do you expect will retire over the next three years? Please indicate the total number you expect will retire in each year for the next three years.

2008: _____

2009: _____

2010: _____

BEFORE MOVING FORWARD, please take a moment to review the above information for the Welders occupational category and verify that it is correct.

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

SECTION 3. The next series of questions has to do with the hiring process, including the pool of applicants available to your company.

Q15. In the past three years, when your company has recruited for skilled workers, approximately what percentage of applicants actually qualified for an interview? _____%

For the next question, please place an 'X' in the box next to your answer.

Q16. What is the leading reason applicants for skilled worker positions do not qualify for an interview?

- ☐ Failed Drug Test (1)
- ☐ Insufficient Education (2)
- ☐ Inadequate Skills (3)
- ☐ Other [Please Specify:_____] (4)

Q17. In the past three years, when your company has recruited for unskilled workers, approximately what percentage of applicants qualified for an interview? _____ %

For the next question, please place an 'X' in the box next to your answer.

Q18. What is the leading reason applicants for unskilled worker positions do not qualify for an interview?

- ☐ Failed Drug Test (1)
- ☐ Insufficient Education (2)
- ☐ Inadequate Skills (3)
- ☐ Other [Please Specify:_____] (4)

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

For the next group of questions, please place an 'X' in the box below your rating for that item.

Q19. Please rate the entry-level workers your company has hired over the past three years with regards to each of the following areas.

	Excellent	Very Good	Good	Fair	Poor	Very Poor
"Soft Skills" – such as work ethic, punctuality, and teamwork.						
Measurable Skills Preparation – such as reading for information, math, and locating information.						
Basic Manufacturing Principles – such as lean manufacturing, process controls, quality management, and problem solving.						

Q20. How valuable are each of the following methods/resources to your company when recruiting new workers?

	Extremely Valuable	Very valuable	Somewhat Valuable	Not Very Valuable	Not Valuable At All
Military Resources					
Virginia Employment Commission					
Newspapers					
Internet Employment Sites or Other Internet Resources					
Referrals					
Other Sources (Please Specify: _____)					

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

SECTION 4. Earlier in the survey you were introduced to a new occupational category: manufacturing technician. The next few questions ask you to evaluate this definition.

For the next question, please place an 'X' in the box next to your answer.

Q21. The traditional definition of skilled trades occupations can be summarized as follows:

"Skilled trades occupations require a high school diploma and may require additional vocational training, degree, certification, and/or job-related course work. Skilled trades occupations prepare individuals with occupational skills, specialized skills, knowledge, attitudes, and work habits necessary to become employed and make satisfactory progress in the trade and industrial field as skilled or semi-skilled workers. These occupations include:

- Chemical Equipment Operators
- Chemical Technicians
- Computer-Controlled Machine Tool Operators
- Electricians and Electrical Technicians
- Extruding and Drawing Machine Setters
- Machine Maintenance Specialists
- Machinists
- Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic
- Printing Machine Operators
- Stationary Engineers and Boiler Operators
- Tool and Die Makers
- Welders"

In your opinion, how comprehensive is this definition in terms of its ability to adequately capture those jobs/positions that comprise today's manufacturing enterprise?

- ☐ Completely Comprehensive (1)
- ☐ Very Comprehensive (2)
- ☐ Somewhat Comprehensive (3)
- ☐ Not Very Comprehensive (4)
- ☐ Not Comprehensive At All (5)

Q22. What are some of the reasons you perceive the traditional definition of skilled trades occupations to be less than completely comprehensive? Please be as detailed as possible.

_____

_____

_____

_____

_____

_____

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q23. It is clear that in today's manufacturing environment, some occupational categories, such as "machine operator," do not adequately capture the level of skill and expertise necessary for controlling multi-million dollar computer-driven machinery that may involve robotics, complex controls, several integrated production processes, or other highly advanced mechanical technology. Therefore, a new occupational category is being proposed.

Manufacturing Technicians

Job Description: Operate precision machinery, systems and processes. Typical skills expected in these positions MIGHT include: CAD skills, computer controlled machine programming, precision measurement, process and machine trouble-shooting, problem-solving, machine maintenance, use diagnostic and statistical tools. These positions generally describe someone who has enough broad-based knowledge about a multi-step process to successfully trouble-shoot and cure problems beyond the scope of typical "machine operators." These positions may also describe someone charged with developing/refining prototype fabrication methods for new products.

Sample Job Titles: Operator, Production Operator, Production Technician, Technician, Chemical Equipment Operator, Chemical Operator, Fixers, CNC Technician, Manufacturing Technician, and Production Manufacturing Specialist.

For the next group of questions, please place an 'X' in the box next to your answer.

How well does this new category (manufacturing technicians) capture jobs that are not adequately represented in the traditional definition of skilled trades occupations??

- ☐ Extremely Well (1)
- ☐ Very Well (2)
- ☐ Somewhat Well (3)
- ☐ Not Very Well (4)
- ☐ Not Well At All (5)

Q24. In your opinion, how valuable is this definition in terms of its ability to capture jobs that are valuable to today's manufacturing enterprise?

- ☐ Extremely Valuable (1)
- ☐ Very Valuable (2)
- ☐ Somewhat Valuable (3)
- ☐ Not Very Valuable (4)
- ☐ Not Valuable At All (5)

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q25. How strongly would you support or oppose the Bureau of Labor Statistics adding the occupational category, manufacturing technician, as defined in this survey, to the list of occupational categories included under the definition of skilled trades occupations?

- ☐ Strongly Support (1)
- ☐ Somewhat Support (2)
- ☐ Neither Support nor Oppose (3)
- ☐ Somewhat Oppose (4)
- ☐ Strongly Oppose (5)

Q26. In as much detail as possible, please explain why you would support or oppose the Bureau of Labor Statistics adding the occupational category, manufacturing technician, to the definition of skilled trades occupations.

_____

_____

_____

_____

_____

_____

_____

_____

For the next question, please place an 'X' in the box next to your answer.

Q27. How likely is it that your company will collapse traditional skilled trades occupations into "hybrid" jobs due to retirement and changing skills demands?

- ☐ Extremely Likely (1)
- ☐ Very Likely (2)
- ☐ Somewhat Likely (3)
- ☐ Not Very Likely (4)
- ☐ Not Likely At All (5)

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

SECTION 5. This last series of questions are concerned with training for skilled trades positions.

For the next group of questions, please place an 'X' in the box below your rating for that item.

Q28. Please read each of the following statements and indicate how strongly you either agree or disagree with that statement. [RANDOMIZE ORDER OF STATEMENTS]

	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree
There should be additional requirements for career and technical education in Virginia's K-12 education system.					
The public image of manufacturing occupations is a major contributing factor to the problems employers experience in recruiting skilled workers.					
Virginia should have a standardized manufacturing skills credential system, similar to that in the medical profession that certifies workers for competencies at the entry-level and continues up through the college level.					

For the next group of questions, please place an 'X' in the box next to your answer.

Q29. In your opinion, which of the following should be responsible for training individuals to fill the demand for skilled positions in manufacturing? Please select all that apply.

- ☐ Community Colleges (1)
- ☐ Private Industry (2)
- ☐ State Government (3)
- ☐ Other [Please Specify: _____] (4)

PLEASE CONTINUE SURVEY ON NEXT PAGE

VMA SKILLED TRADES OCCUPATIONAL SURVEY OF MANUFACTURERS

Q30. ***For the occupations described in this survey,*** how much would you estimate you spend in training, on average, per new employee during their first year on the job?

- ☐ Less than $1,000 (1)
- ☐ $1,000 - $4,999 (2)
- ☐ $5,000 - $7,499 (3)
- ☐ $7,500 - $9,999 (4)
- ☐ $10,000 or more (5)

That was the last question. Thank you for taking the time to participate. The information you provided, combined with those from other manufacturers in Virginia, will provide extremely valuable information to Virginia's Governor and the Legislature as they develop solutions to the workforce crisis the industry may experience in the near future.

Please review this questionnaire and be sure you have answered all of the questions as accurate as possible. Also, be sure you have entered your password on the front page of this questionnaire.

When you have completed this survey, please return ALL pages of this document (including the cover page) to the following address:

Alan Newman Research
ATTN: VMA Survey
1025 Boulders Parkway
Suite 401
Richmond, Virginia 23225

Once again, thank you for your willingness to participate in this important research effort.

A8: Validation Interviews Summary

Interview Objectives:

- Conduct interviews among selected respondents to the *Skilled Trades Occupational Survey* to assure the accuracy of their answers
- Assess the ease/difficulty of completing the survey and identify areas for improvement
- Provide greater depth of understanding of the responses of selected firms
- Understand the workforce needs of these firms.
- Explore response to new occupational category *Manufacturing Technician*.
- Understand participants' skilled trades workforce needs over the next three years.

Method:

- Data verification was completed via face-to-face interviews with 11 selected manufacturers who completed the survey. (*Note: One participant retired between the date of the original survey and the validation survey. The employee hired in his place participated in the validation interview and verified the data collected in the original survey.)*
- Participants were recruited from a list generated because they had agreed at the end of the survey to be contacted for a follow-up interview.
- Participants re-answered a number of questions from the survey verbally to verify the accuracy of their original responses.
- Participants also discussed the following:
  - Ease of completing the survey and any areas of difficulty
  - Current workforce needs, projected workforce needs in the next three years, and the proposed occupational category *Manufacturing Technician*
  - Ways of addressing the issue of training workers for skilled trade positions
- Participants with the following job titles were represented in the research: President, Vice President, General Manager, Owner, Co-owner, Finance Manager and CFO
- Participants from the following labor workforce areas participated in the research: printers, paper packaging, metal fabricator, cabinet making, MRI automation, circuit board manufacturing, and large machinery parts.
- Companies ranged in size from two to 200 full-time employees.

Data Verification:

- About half said they had no difficulty reporting the information requested by the survey; the others said they had to estimate on a few of the questions:
  - The estimates cited were as follows: projections for growth and needs, the percentage of skilled and unskilled labor (Q. 15,17), and job descriptions ("because of overlap" in some position descriptions)
- Nearly all of survey responses were validated by participants with the exception of one or two questions; specific inconsistencies were as follows:
  - One participant assigned more than one occupational category to the same person ("because I didn't realize there was a printing category");
  - Another participant said she did not understand the difference between Q.11a (referring to *Machine Tool Operator*) and Q.12a (referring to *Machinist*) until she read further into the survey and determined the differences between occupational categories

Completing the Survey:

- Participants all said the survey was "not at all difficult" or "somewhat difficult;" no one indicated the survey was "very difficult":
  - Seven reported no difficulty participating in the survey.
  - Four reported having some difficulty answering the questions:
    - One or two had difficulty assigning a occupational category that appropriately fit their employees—particularly in smaller organizations, which had one or two people doing the jobs described in four or five different categories.
    - Another participant indicated the survey would have been easier if the occupational categories were listed at the beginning of the survey so they could determine in advance the category which best fit the duties of their employees.

- All participants said they would be "very likely" or "somewhat likely" to participate in a similar survey next year; no one said they would be "not at all likely" to participate:
  - Those who said they would be "somewhat likely" said they would likely participate as long as the survey was not longer or more complicated.

Workforce Hiring Experience:

- Nearly all indicated that less than 50% of applicants actually qualified for the skilled and unskilled positions they were seeking; more than half said that 15% or less of applicants qualified for skilled labor positions:
  - The few who indicated having less difficulty finding applicants with adequate skills were highly specialized organizations that interviewed and hired more formally educated professionals (e.g., engineers).
  - Specific skilled worker inadequacies mentioned included the following:
    - Machinist skills ("Title is too broad and the skills don't match my needs").
    - Journeyman machinists ("These people are very hard to find").
    - No printing background—no machine experience, insufficient math skills ("some can't even read a ruler").
    - Past job experience is often not transferable to a different industry (e.g., "a navy [trained] machinist is different from the actual needs of my jobs").
  - Participants said that unskilled workers generally had inadequate educations; specific inadequacies mentioned included:
    - Language skills.
    - Math skills.
    - Basic computer skills.
    - Communications skills ("I need someone who can produce as well as clearly communicate with professional clientele").
- All participants said they would be "very likely" or "somewhat likely" to participate in a similar survey next year; no one said they would be "not at all likely" to participate:
- In spite of the low percentage of qualified applicants, most said the skilled workers hired in the past three years have been "good" or "fair":
  - One or two said their workers were "very good" or "excellent."
  - Only one or two said "very poor."
- While participants said it was difficult finding the right workers, they also said they are selective in choosing new employees.
- Most said they recruited workers from referrals from other businesses, from the community colleges, and, to a lesser extent, from the military; almost no one used the newspaper.

Evaluation of the Skilled Workforce:

- Participants varied in their rating of their skilled work force in various areas:
  - *Soft skills*. Most rated the soft skills of their workers as adequate; However, a few commented that "employees lack a strong work ethic."
  - *Measurable skills*. Most rated the measurable skills preparation as adequate; some specific inadequacies cited included reading skills, math skills, and communication skills.
  - *Basic manufacturing principles*. About half rated their workforce as fair or poor; Inadequacies cited included knowledge of lean manufacturing principles, no problem solving skills, general lack of manufacturing experience, lack of an understanding of business.

Manufacturing Technician:

- Slightly more than half said the definition of *Manufacturing Technician* was "somewhat comprehensive" and slightly less than half said the definition was "very comprehensive;" Only one said the definition was "not very comprehensive."
- All but one said the new occupational category captured jobs "very well" that are not adequately represented in the traditional definition of skilled trades occupations:
  - A few indicated the definition may be too broad; one participant noted that the definition did not have any soft skill requirements.
- About half said they would support adding the new occupational category "strongly" or "somewhat;" the remainder said they would "neither oppose or support" it because the category did not directly effect their organization.

Manufacturing Education:

- Most participants indicated there is a need for additional need for technical education:
  - Specific suggestions included more vocational classes in high school and junior college, more emphasis on teaching basic math and reading skills high school students not going to college, and additional "hands-on" training for high school students.
- Participants also said that the image of manufacturing jobs needs to be improved:
  - One participant suggested emphasizing the benefits/pay of skilled trade jobs ("if you're willing to get a little dirty").

Standardized Skills Credentials:

- Participants were split on whether Virginia should have a standardized manufacturing skills credential system:
  - Four said they "strongly agree" or "somewhat agree."
- They strongly believed it would improve the quality of workers:
  - Four said they "somewhat disagree."
- Some were skeptical whether it would actually improve the quality of workers; one participant said, "it might eliminate someone with the talent to be trained on the job;" another said "it comes down to the motivation of the individual":
  - Three said they "neither agree nor disagree."
- One participant said their company currently has a certification process that has been unsuccessful because it is based on working a certain number of hours, not achieving a level of skill.

Skilled Trades Worker Training:

- Participants made the following suggestions for improving training:
  - "Create a partnership between education and industry."
  - "Change the negative image of manufacturing—start in middle school."
  - "Improve the technical education at the high school level"
  - "Develop an apprenticeship program."
  - "Promote the many types of jobs available in the industry."
  - "Provide summer internships for high school students."
  - "Create a means to identify reasoning and comprehension skills, in addition to work ethic."
  - "Encourage bright students to go into manufacturing—I need the top 50% of the class."
  - "Teach soft skills to students in high school."
  - "Involve local companies to participate in internships."
  - "Create specific programs in community colleges."
  - "Help small shops to provide employees with health insurance and benefits to attract valuable workers."

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1 These figures are derived by taking the projected 2007 through 2010 cumulative openings detailed in Table 28 and dividing them by 3.5 (accounts for the fact that the survey was administered in the middle of 2007).

2 Because *Manufacturing Technicians* is a job classification that was created for the purpose of the survey, no crosswalk currently exists for identifying the training programs associated with this occupation.

3 This figure differs slightly from the data presented in this table because it accounts for the fact that *Electronics Technicians and Repairers* is a composite of two Bureau of Labor Statistic's defined occupations – *Electrical and Electronic Engineering Technicians* and *Electrical and Electronic Repairers, Commercial and Industrial Equipment.* According to VEC's 2002 to 2012 occupational projection, the anticipated number of average annual openings for *Electrical and Electronic Engineering Technicians* was 175. Whereas, the educational pipeline for this occupation, according to U.S. Department of Education IPEDS data was approximately 678 per year. Indicating 100.0 percent of need met. The comparable data for *Electrical and Electronic Repairers, Commercial and Industrial Equipment* were 62 average annual openings and 7 qualified graduates, indicating 11.3 percent of need met. The 76.8 percent figure in Table 29 is a composite of these two percentages.