

Manufacturing in the Tri-County Workplace: *A Report on Workforce and Industry Trends and Opportunities, and Career Pathways / Skill Standards*

*Prepared by the Center for Individual & Organizational Effectiveness (C4IOE.com)
for the Tri-County Workforce Investment Board – Butler, Pennsylvania
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This Report accompanies a Graphic Model and a Descriptive Model of Manufacturing Career Pathways & Skill Standards, which are all available on the Tri-County Workforce Investment Board website



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Cover photo: *Image by WVXU – Women training for skilled manufacturing jobs*

Purpose of Project and Report

This report was developed as the culmination of a research and development project sponsored by the Butler, Pennsylvania-based Tri-County Workforce Investment Board, who contracted with Pittsburgh-based consulting firm Center for Individual & Organizational Effectiveness, to address key research questions around demographics of the region, Manufacturing industry trends and occupational trends on a national, state, regional, and local level, career pathways, training needs, and skill standards (including credentialing) for key Manufacturing occupations.

Objectives of the project included: (1) develop industry surveys for the TCWIB to use annually with the industry partnerships regarding their workforce training needs, hiring needs, and occupational and industry trends, (2) research and develop Manufacturing career pathways (career models for occupational groups/options) and skill standards (education/training and credentials required for the occupations), (3) research workforce, occupational, and industry trends specifically related to the Manufacturing occupations identified and the training required for those roles, and (4) provide some recommendations related to workforce development/training and career paths for the identified key occupations in the Manufacturing industry.

Executive Summary

Meta trends: There are a confluence of disruptive trends affecting the U.S. workforce in general, and the manufacturing workforce in particular. The largest is a demographic shift – baby boomers are retiring at an estimated 10,000 workers per day while the labor rate for those 16-24 years of age will decrease over time, exacerbating an already existing labor shortage.

How automation and technology innovation will affect the industry and workforce is generating uncertainty within the industry, and some see the labor shortage for manufacturing accelerating the adoption of automation in the near term. 3D printing is increasing in quality and decreasing in cost - spurring increasing demand for these skills - and may start to challenge some traditional manufacturing models.

Other workforce trends reflect the growing disparities and inequalities in the country: capital and talent largely gravitate to a few major coastal metros, with less business creation and skilled talent in smaller metros and rural areas; the increasing prevalence of flexible and task-based work benefits some but not others; and numerous social and health issues are detrimentally affecting the workforce, particularly middle-aged white men.

U.S. manufacturing: Manufacturing in the U.S. has evolved, with fewer jobs on an assembly line and more running computers or machines. After years of decline and off-shoring of jobs, manufacturing is once again a viable American industry. This, however, is not so much a return to the past as much as a reboot, with many manufacturing jobs requiring higher level skills and BA degrees, STEM knowledge, and experience.

While manufacturing is growing as a portion of national Gross Domestic Product, the number of manufacturing jobs is shrinking due to the adoption of technologies that allow greater productivity. Even with the number of jobs declining, the National Association of Manufacturers projects nearly 3.5 million manufacturing jobs will be needed over the next decade, and 2 million positions are expected to go unfilled due to a persisting skills gap.

State and regional manufacturing: Pennsylvania, and southwestern Pennsylvania in particular, have an aging and shrinking population, adding to a decreasing talent pool for manufacturing jobs. While the Pittsburgh area produces a high number of graduates of two and four year colleges (though notably less among the African American and Hispanic populations), talent retention is among the lowest of major cities in the country.

Manufacturing is the third largest regional industry in terms of regional Gross Domestic Product (\$137 billion in 2015) and fifth largest in terms of jobs, employing 7.8% of workers. Measured by workforce numbers, the largest types of manufacturing industries in the region are: fabricated metal production manufacturing (16,740 employees), primary metal manufacturing (12,472), machinery manufacturing (10,942), and computer and electronic product manufacturing (8,359). Regional manufacturing occupations with the greatest number of workers employed: are First-Line Supervisors of Production and Operating Workers, Machinists, and Welders Cutters Solderers and Brazers; and regional high-demand occupations include: Machinists, Welders, Industrial Maintenance

Technicians, and Mechanical Engineers. Occupations projected to grow significantly within the region by 2024 include: Industrial Machinery Mechanics (20%), CNC Machine Tool Programmers (19%), Computer-controlled Machine Tool Operators (16%), and Machinist (11%).

While the number of production workers is projected to slightly decline (-1% over the next 10 years), an aging workforce means employers will need to fill nearly 7,000 roles per year due to reach replacement. According to the 2016 Allegheny Conference / Burning Glass's Inflection Point Report, "looking more narrowly at welders, machinists, and other roles, which typically utilize post-secondary programs, there are over 1,000 projected annual openings, against only 472 completions in 2015."

The regional trend for fewer manufacturing jobs with higher skills mirrors the national trend, with local employers pointing to a growing need for skills such as automation controls, mechanical engineers, robotics expertise and 3D printing. Increasingly, workers are needed to not only operate, but program, maintain and manage advanced computer-controlled equipment.

The Inflection Point Report found that the top ten baseline skills in demand in the regional manufacturing workforce are, respectively: communication skills, troubleshooting, organizational skills, preventative maintenance, computer skills, writing, problem solving, customer service, detail-orientation, and Microsoft Office. The same report identified the top ten in-demand specialized skills as, respectively: repair, inspection, hand tools, welding, machining, HVAC, power tools, machinery, blueprint reading, and mathematics.

In the Tri-County region, Butler County is home to significantly more manufacturing firms than its neighbors, but both Armstrong and Butler have more manufacturing firms, and a greater percentage of residents in manufacturing, than the state average.

Tri-County employers and educators survey: In a recent TCWIB / C4IOE survey, local manufacturing employers expressed concern over the skills gap – which they felt would continue to grow – and a weak labor pool for some positions, as well as a lack of soft skills and basic computer and math skills among new and potential hires. A negative perception of manufacturing as a career path hinders recruitment, and a number of respondents felt coordination between industry and educators could be improved. At the same time, both employers and educators identified constraints or challenges to training, such as not being able to take time off of work to attend, lack of employee motivation, and lack up-to-date training tools.

Career pathways: C4IOE identified six key manufacturing occupational clusters in demand or projected to be in demand in the Tri-County area or region. The top occupation clusters in current demand are: Machining, Welding, and Production. Clusters projected to grow in the region include: 3D Printing / Additive Manufacturing, Quality, and Logistics.

A wide variety of career paths exist within these clusters, as well as a variety of entry points to those paths. Career progressions can branch into multiple job opportunities, such as a skilled machinist or production worker moving into quality control, installation and repair, or safety occupations, as well as management roles. In addition, more jobs

are emerging at the intersection of technology and manufacturing, requiring hybrid-skills or a broader base of skills.

Recommendations: C4IOE identified seven recommendations to help address workforce needs and training in the Tri-County area:

1. Focus on High Priority Occupations and other occupations showing high growth potential
2. Proactively seek and attract talent
3. Upskill workers
4. Prepare now for an aging workforce
5. Strengthen connections to regional resources that support manufacturing
6. Explore non-traditional education and new training approaches
7. Play an active role in rebranding manufacturing

Multiple changes and trends are converging on today's manufacturing ecosystem, creating a significant level of uncertainty about what and who to invest in, and how to best prepare and engage the workforce. In response, many educators and employers agree that the best skill for workers to cultivate, is the mindset of a life-long learner. It is not just about skill acquisition, but a perspective that accommodates and even embraces a continually evolving work environment.

I. Current Landscape: Workforce and Manufacturing Trends and Developments

A. Overarching Workforce Trends

The shifts and disruptions underway in the employment and labor markets have prompted a number of recent in-depth reports and articles on the future of work, many published just in the last 12 months. Following is a look at the top broad trends that are affecting the U.S. workforce.

*The Workforce is Aging:*¹ According to the Bureau of Labor Statistics (BLS), by 2024 nearly 25% of the workforce is expected to be 55 years old or older – double the percentage in 1994 (BLS, 2015). The oldest of the country’s estimated 77 million baby boomers began turning age 65, the traditional retirement age, in 2011. Now this generation, born between 1946-1964, has begun to reach retirement age in staggering numbers: approximately 10,000 a day (Heimlich, 2010). As those workers exit the work place, so goes decades of experience and institutional knowledge, some of which cannot be replaced. According to *U.S. News & World Report*, “the U.S. economy will experience a shortfall of 5 million workers with the necessary education and training to fill expected job openings by 2020” (Bidwell, 2013).

The fastest-growing segment of the workforce is, and will continue to be, older workers, as the middle to end of the baby boom generation still has over a decade before many will reach retirement age. Even then, many people are working longer (out of both need and choice) than in the past. This is reflected in BLS projections that the number of workers over age 65 will continue to increase from 18.6% in 2014 to 21.7% in 2024; and the labor rate for those 16-24 years of age will decrease, from 13.7% in 2014 to 11.3 in 2024.

Education Gap: By 2020, 65% of an estimated 165 million jobs in the U.S. economy will require some postsecondary education or training beyond high school. (Coulombe, 2016). While nationally there has been a long-term trend of an increasing percentage of the population attending 2 and 4-year colleges, this breaks down unevenly across regions. There is a significant amount of polarization – even at the micro level of city neighborhoods, with some areas increasingly sending children to college and other areas remaining flat or even declining. Metro areas are disproportionately college educated, and white residents still far outpace minorities in college completion rates, though there has been a steady uptick in the number of disadvantaged students attending colleges. Even with areas of progress, it is widely expected that companies will face a persistent skills shortage among highly specialized technical workers and senior managers and executives.

Disappearing Soft Skills: There is also what some call a crisis in the lack of soft skills, especially communication skills, among new hires, regardless of educational background. One oft-cited reason for this is the increased use of technological means of communication, rather than face to face conversations. These and other trends have prompted educators and employers to question if traditional education paths are

¹ Of note is that many emerging economies have the opposite demographic shift – their workforces are youth heavy and will remain so.

preparing young people well enough for workforce needs. Similarly, there is doubt that traditional classroom-style education and training can keep pace with changes in the workplace.

Geographic Polarization: Another long-term trend that has accelerated is that wealthy zip codes are getting wealthier and poorer zip codes poorer. More college educated populations live in cities, especially coastal cities. There are growing opportunity and income gaps across the country caused, in part, by growing gaps in average incomes across regional labor markets, with rural areas faring the worst.

Capital and Talent Concentration: The wealthier and globally connected cities are increasingly nationally and internationally networked and offer more varied and better employment opportunities than the rest of metro areas. This serves a strong pull factor for brain drain to top cities. Movement from more rural to more urban opportunities has been happening for a long time. What is different is that the competition among metro areas for the best and brightest is shaking out to favor a few super-cities that are particularly attracting the millennial generation. This exacerbates issues with regional income equality and access to opportunities.

Declining Business Creation and Employee Mobility: Among economists and researchers there is no agreement for why there has been a decline over 20 years in the number of people starting businesses, changing jobs or moving for a new job, but it is clear that this trend has increased since the recession of 2007. It is widely felt that a less dynamic economy will make adaptation to changes like automation more difficult.

Technology Innovation: Disruption due to technology innovation is not new; but what is different about this current period of innovation is the unprecedented pace and scope of the changes being wrought by digital technology and automation. This is forcing a structural shift in thinking about work itself, the economy and how we use our resources – all foundational building blocks of our society. Additionally, the difficulty in finding workers for manufacturing jobs is pushing the adoption of automation, especially among larger manufacturers.

A widely reported 2013 study from Oxford University estimated 47% of total U.S. employment is at risk of being automated over the next decade or two. The University of Redlands School of Business did a follow-up study published in May 2017, finding nearly all large U.S. metro areas could lose over 55% of their current jobs due to automation. According to the analysis the Pittsburgh area's share of jobs facing automation by 2035 is between 58 and 61%.

New Training Opportunities: Advances in Virtual Reality and Augmented Reality offer a new platform for learning / training. A number of educators point to these technologies, plus online learning in general, as ways to make training more accessible and affordable to more people.

Social / Health Crises: A convergence of social and health issues are detrimentally affecting the workforce, such as high incidents of obesity, diabetes, suicide, prescription drug / opioid abuse, and depression/ anxiety. One of the most startling social developments is the falling life expectancy for middle-aged working class white American males since the 1990s. Nowhere else in the developed world is a group of people losing years off of their life expectancy (Boddy, 2017).

Research by Princeton University's Anne Case and Angus Deaton points to distress from globalization and technological change as the probable cause for the phenomenon. They cite the cycle of despair experienced by many in this group as "rooted in the massive shifts in the labor market" that left many in the working class unable to find sustaining employment, though many aspects of life feed into the problem (Boddy, 2017).

Employment and Income Structures: There has been a half century trend away from how much of an individual's earnings are made from a job, versus how much is made through other means, such as financial and real estate investments, task-based work and government programs like Medicaid and social security. According to recent data from the U.S. Bureau of Economic Analysis (BEA), employees earned two-thirds of their income through wages and salaries in the 1960s, and today earn only one-half this way (BEA, 2017).

Uncertainty About the Future of the Job Market: Educators and technologists agree that automation will cause some jobs to disappear permanently – particularly any job that entails repetitive motion or binary decision-making. But other jobs will be created, for example in designing, operating, maintaining and programming the technology. What is also clear is that this shift in job types, particularly in manufacturing, is continuing to move upward in skill level.

Another unknown is whether work and careers will remain concentrated in full time occupations for most workers, or continue to trend towards tasks, projects and "the gig economy" (typically contract employment) where workers often have less security but more flexibility. The percentage of workers in flexible, task-based employment rose from 10% in 2005 to almost 16% in 2015 (Katz and Krueger, 2016).

Maker Movement: The national maker movement continues to expand in the U.S., with some experts suggesting it could be a revolution in manufacturing. The maker movement offers technologies and tools that enable cutting-edge manufacturing at low volume – something that commercial manufacturing traditionally can only accommodate at a high cost. The proliferation of TechShops, like the one in Pittsburgh's East End, and maker spaces as training centers, like the University of Pittsburgh's Manufacturing Assistance Center, continues and often with support of federal dollars. This allows people to use advanced machinery at low cost, supports experiential learning, and offers a new set of facilities for training workers of all ages and education levels.

Whether the maker model has the potential to scale enough to impact commercial manufacturing is unclear. However, a recent *Atlantic Monthly* article made a case that it does, comparing the growing accessibility of cutting edge production tools to how word processing and digital desktop tools changed the capital intensive printing and publishing industries (Fallows, 2017).

One such tool to watch is 3D printing, or additive manufacturing, which enables an entirely different manufacturing model. The costs of the technology are dropping while the quality of the product continues to improve – spurring increasing demand for these skills. According to the latest Allegheny Conference Pittsburgh Region Scorecard, "this [3D printing] disruption is already being felt in products that are polymer based and will occur in the coming 5-7 years in metal-based products" (Catalyst Connection, 2016).

B. National and State Manufacturing Trends and Developments

Current Situation

The nature of manufacturing jobs in the U.S. has evolved, with fewer jobs on an assembly line and more jobs running computers or machines. After years of off-shoring, a number of manufacturers are moving production back to the U.S., as costs of labor, shipping, packaging, and higher risks associated with manufacturing at a great distance have offset labor savings. Following decades of decline, manufacturing is once again a viable American industry.

In 2016 manufacturing contributed \$2.18 trillion to the U.S. economy, up from \$1.7 trillion in the second quarter of 2009, and accounted for 11.7% of GDP. According to the National Association of Manufacturers (NAM), “for every \$1.00 spent in manufacturing, another \$1.81 is added to the economy – the highest multiplier effect of any sector.” Citing new research by the Manufacturers Alliance for Productivity and Innovation, NAM notes others believe the multiplier is higher, even \$3.60 for each \$1.00.

There are over a quarter of a million manufacturing firms in the U.S. but most employ under 500 workers, and many under 20 workers (BLS, 2017). In 2015 there were 12.3 million Americans in manufacturing jobs (nearly 10% of the workforce) earning, on average, \$81,289 (including pay and benefits) for the year and \$26 per hour (NAM, 2017).

U.S. manufacturers perform more than three-quarters of all private-sector research and development (R&D) in the nation, driving more innovation than any other sector. R&D in the sector has risen from \$126.2 billion in 2000 to \$229.9 billion in 2014 (BEA, 2016).

Future Projections

While manufacturing is growing as a portion of national Gross Domestic Product (GDP), the number of manufacturing jobs is shrinking due to the adoption of technologies that allow greater productivity. Even with the number of jobs declining, NAM projects nearly 3.5 million manufacturing jobs will be needed over the next decade, and 2 million positions are expected to go unfilled due to a persisting skills gap. Moreover, 80% of manufacturers report a moderate or serious shortage of qualified applicants for skilled and highly skilled production positions (Deloitte / Manufacturing Institute, 2011).

Manufacturing growth has been outpacing and continues to outpace skill development. Between 2014 and 2024, the BLS estimates a loss of 550,000 jobs, or 3.1% of all manufacturing positions. Of the 77 industries identified with manufacturing, only 19 are projected to add jobs.

This is due to the confluence of a number of trends, the most relevant being the speed at which the baby boomer generation is retiring – 10,000 people a day according to the Pew Research Center; and subsequent generations did not view manufacturing as a career option, and hence are not in the industry talent pipeline.

In response, state and federal governments have developed programs like Manufacturing USA and others to encourage STEM, robotics, and digital technologies

education; colleges and universities are growing their STEM programs, and some employers are bringing training and apprenticeship programs into the workplace to encourage upskilling of existing employees.

Even with the aforementioned efforts, it will be a challenge for U.S. manufacturers to maintain talent in an increasingly competitive environment; maintain continuity with the loss of decades of institutional knowledge due to the aging workforce; and manage an increasingly multigenerational and diverse workforce (Coulombe, 2016).

Growing and Shrinking Manufacturing Occupations

BLS projects national overall manufacturing employment to decline between 2014 and 2024 at a 0.7% rate annually (from 12,188,300 in 2014 to 11,374,200 in 2024), a more moderate decline than the 1.6% rate experienced in the prior decade (BLS Employment Projections 2014-24, 2016). The BLS Employment Projections Program identified manufacturing occupations projected to grow or decline over the ten-year period 2014-24. Of the occupations highlighted in the table below – which reflect the type of manufacturing jobs commonly found in southwestern PA – the top growing occupations are²: Computer-controlled Machine Tool Operators, metal and plastic, and Computer Numerically Controlled Machine Tool Programmers, metal and plastic. The top shrinking occupations are: All types of Machine Setters, Operators, and Tenders, metal and plastic; Miscellaneous Metal Workers and Plastics Workers, all; Tool and Die Makers; and Machinists.

Occupation	Employment 2014	Employment 2024	% change	Education needed for entry
1. Industrial Production Manager	173.4	167.0	-3.7	BA + 5 years' experience
2. First-line supervisors of production and operating workers	606.9	588.2	-3.1	HS diploma / equiv. + less than 5 yrs experience
3. Assemblers and fabricators, all types	1,834.0	1,824.3	-0.5	HS diploma / equiv.
4. Structural metal fabricators and fitters	79.2	80.8	2.0	HS diploma / equiv.
5. Computer-controlled machine tool operators, metal and plastic	148.8	174.8	17.5	HS diploma / equiv. + moderate OJT
6. Computer numerically controlled machine tool programmers, metal and plastic	25.1	29.9	18.9	HS diploma / equiv. + long term OJT
7. Forming machine setters, operators, and tenders, metal and plastic, all	128.8	101.7	-21.0	HS diploma / equiv. + moderate OJT

² Based on % of change over the 2014-2024 period.

8. Machine tool cutting setters, operators, and tenders, metal and plastic, all	346.7	274.6	-20.8	HS diploma / equiv. + moderate OJT
9. Machinists	31.0	27.4	-11.7	HS diploma / equiv. + moderate OJT
10. Molders and molding machine setters, operators, and tenders, metal and plastic	141.5	105.8	-25.2	HS diploma / equiv. + moderate OJT
11. Multiple machine tool setters, operators, and tenders, -metal and plastic	99.8	97.3	-2.5	HS diploma / equiv. + moderate OJT
12. Tool and die makers	77.8	67.7	-13.0	HS diploma / equiv. + long OJT
13. Welding, -soldering, and brazing workers, all	457.5	461.2	0.8	HS diploma / equiv. + moderate OJT
14. Miscellaneous metal workers and plastic workers, all (i.e. tool grinders, metal workers, heat treating and coating machines workers)	104.7	85.4	-18.4	HS diploma / equiv. + moderate OJT
15. Production planning & expedition clerks	304.6	310.9	2.1	HS diploma / equiv. + moderate OJT
16. Helpers - Production	419.2	403.2	-3.8	Short-term OJT
17. Production workers, all other	236.2	244.0	3.3	HS diploma / equiv. + moderate OJT

Source: U.S. Bureau of Labor Statistics, *Employment Projections program, 2014*

Pennsylvania Demographics

Pennsylvania has one of the largest populations of older people in the nation, ranking sixth in number of people over 65. It also has one of the lowest in-migration rates of immigrants, particularly in the western half of the state. Combined, these trends lead to an aging and shrinking population.

PA Demographic Snapshot	
Population estimate, 2016	12,784,227
Population estimate, 2015	12,802,503
PA Population by Age Groups (2015 estimate)	
Under 5	5.6%
Under 18	21%
18-64	62%
65+	17%

PA Educational Attainment (age 25 years and over)	
Not a HS graduate	10.3%
High school graduate (includes equivalency)	35.7%
Some college, no degree	16%
Associate's degree	8.3%
Bachelor's degree	18.1%
Graduate or professional degree	11.6%
Percent high school graduate or higher	89.7%
Percent bachelor's degree or higher	29.7%

Source: US Census Bureau, 2016

Pennsylvania Labor Employment

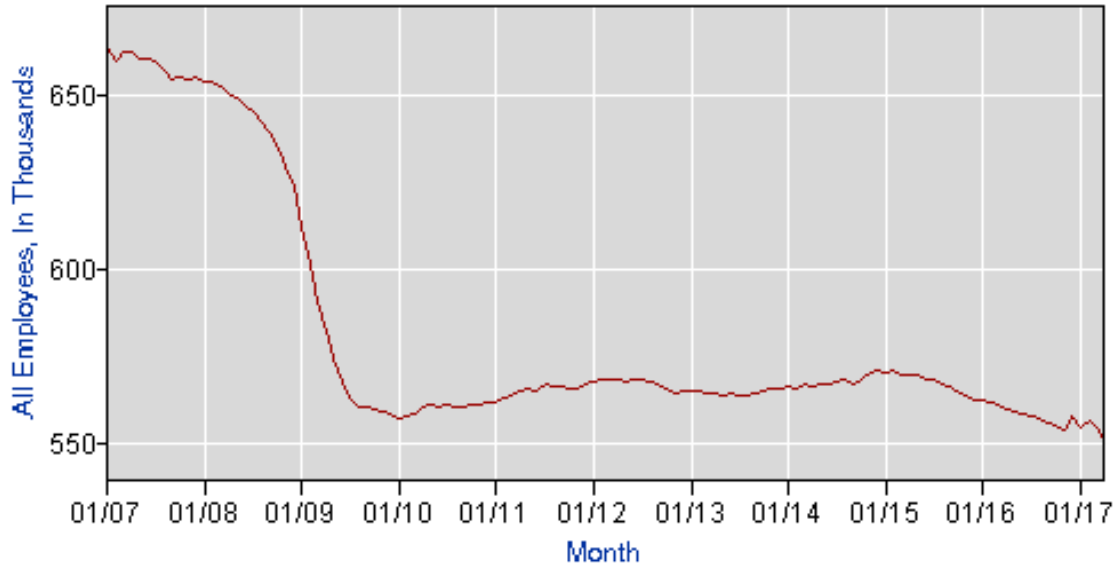
Pennsylvania has a total working age population of 6,443,000. The unemployment rate as of March 2017 was 4.8% (311,000 unemployed), slightly higher than the national average of 4.5%. Unemployment is highest among the 16-19 age group (15.3%), and lowest among the group 55+ (4.1%). Unemployment is more than double for black residents (11.2%) than white residents (4.8%) (Workstats, April 2017).

Pennsylvania Manufacturing Industry Trends

Manufacturing accounts for 12.35% of the total output in the state, employing 9.6% of the workforce. Total output from manufacturing was \$85.13 billion in 2015. In addition, there were 566,000 manufacturing employees in Pennsylvania in 2016, with an average annual compensation of \$72,500 in 2015 (Center for Manufacturing Research, 2017). Nationally, manufacturing GDP increased between 2014 and 2015 by 3.3% while manufacturing in Pennsylvania grew by 1.8% (Catalyst Connections, 2016).

As of 2014, there were 12,506 manufacturing firms in the state (BEA, 2017). The largest industry sectors, ranked by earnings, are chemicals products – significantly larger than the number two sector, food/ beverage/ tobacco products, followed by fabricated metal products, primary metals, and machinery.

Over the last ten years the number of manufacturing jobs in Pennsylvania has declined from 662,400 in April 2007 to 550,800 in April 2017, with a sharp downturn occurring in 2008-09, after the Recession of 2007-08. While a portion of those jobs were re-gained, the last few years show a trend of a small but steady loss of manufacturing jobs on an almost monthly basis (BLS, 2017). This reflects a trend in technology gains that enable manufacturers to maintain or increase productivity with, respectively, fewer or the same number of workers.



Source: BLS, PA manufacturing all employees, 2017

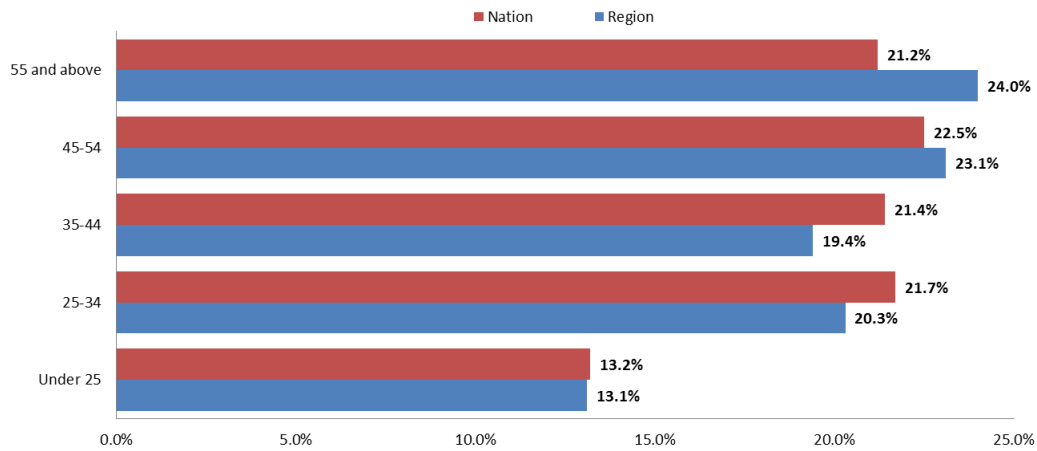
C. Southwestern Pennsylvania Manufacturing Trends and Developments

Southwestern Pennsylvania Demographics

The southwest Pennsylvania workforce, encompassing a 10-county area³, is an important part of the larger economic engine for the state. According to the 2017 Southwest Planning Region Transitional Regional Plan (Southwest Planning Committee), the Southwestern Pennsylvania region is home to nearly 2,500,000 residents, which represents, about 20% of the state's population. The labor force continues to grow in the region and has, like Pennsylvania, experienced a decrease in unemployment. Mirroring the larger state and national trends, the regional workforce is aging.

³ Note: When discussing the southwestern Pennsylvania region, most data in this section uses the aggregated 10-county model consisting of Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Washington and Westmoreland counties as its regional catchment area. This is commonly used by local economic development entities like the Allegheny Conference on Community Development and Pittsburgh Today's benchmarking data. In a few places, where noted, data was only available for the Pittsburgh MSA, which is comprised of seven counties: Allegheny, Armstrong, Beaver, Butler, Fayette, Washington and Westmoreland.

Population by Age



Population Trends - 1990-2015

An affiliate of the Allegheny Conference

Area	2015	2010	2000	1990	Comp. Annual % Change '10-'15	Comp. Annual % Change '00-'10	Comp. Annual % Change '90-'00
Pennsylvania	12,802,503	12,702,379	12,281,054	11,881,643	0.2%	0.3%	0.3%
10-County Region	2,565,612	2,574,959	2,656,007	2,694,079	-0.1%	-0.3%	-0.1%
Pittsburgh MSA*	2,353,045	2,356,285	2,431,087	2,468,289	0.0%	-0.3%	-0.2%
Allegheny County	1,230,459	1,223,348	1,281,666	1,336,449	0.1%	-0.5%	-0.4%
Armstrong County	67,052	68,941	72,392	73,478	-0.6%	-0.5%	-0.1%
Beaver County	168,871	170,539	181,412	186,093	-0.2%	-0.6%	-0.3%
Butler County	186,818	183,862	174,083	152,013	0.3%	0.5%	1.4%
Fayette County	133,628	136,606	148,644	145,351	-0.4%	-0.8%	0.2%
Greene County	37,519	38,686	40,672	39,550	-0.6%	-0.5%	0.3%
Indiana County	86,966	88,880	89,605	89,994	-0.4%	-0.1%	0.0%
Lawrence County	88,082	91,108	94,643	96,246	-0.7%	-0.4%	-0.2%
Washington County	208,261	207,820	202,897	204,584	0.0%	0.2%	-0.1%
Westmoreland County	357,956	365,169	369,993	370,321	-0.4%	-0.1%	0.0%
City of Pittsburgh	304,391	305,704	334,563	369,879	-0.1%	-0.9%	-1.0%

* MSA (Metropolitan Statistical Area includes these counties: Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, and Westmoreland.)

Source: U.S. Census Bureau, Decennial Census, Population Estimates
Last Updated: 07.25.2016

Southwestern Pennsylvania Educational Attainment

High school graduation rates for the Pittsburgh 7-county MSA have been increasing, but the rates of 26 area districts still fall well below the national average. The 2010-11 regional high school graduation rate was 86% and in 2013-14 it has increased to 90%. While the Pittsburgh area produces a high number of graduates of two and four year colleges, talent retention is among the lowest of major cities in the country (Florida, 2016). The Pittsburgh area has a 33% retention rate of bachelor's degree graduates, a much lower percentage than sub-baccalaureate graduates with a 79% retention rate. One factor relative to low retention is that many of the most commonly awarded degrees do not align directly with regional demand (Burning Glass, 2016).

Large disparities in educational attainment exist when viewed across regional racial and ethnic lines, with African Americans and Hispanics having much lower completion rates

than white residents (Sustainable Pittsburgh, 2016). For example, The Pittsburgh Regional Quality of Life Survey reports that 18% of African Americans have a Bachelor's degree or higher degree compared to 41% of white residents (UCSUR, 2016).

SWPA Educational Attainment (18 years or older)	
Less than HS degree	6.7%
HS degree or equivalent	30.5%
Some college or Associates degree	25.9%
Bachelor's degree or higher	36.9%

Source: US Census Bureau, 2014 data

Southwestern Pennsylvania Wages

According to the Southwest Planning Committee's research, the region's jobs are concentrated in occupations that pay between \$8.50 and \$15 an hour. About 40% pay below \$15, while 9% pay over \$35 an hour. Nearly 30% of all jobs pay \$15.01-\$25 an hour and are in high growth industries: HealthCare, Construction, Energy, and Information Technology.

Benchmarking southwestern Pennsylvania wages against 14 other benchmark regions⁴ finds that manufacturing wages are low or close to average for represented manufacturing jobs. According to BLS average annual wage data for 2016, Machinists in the region earn \$40,500, the second lowest wage for this job among the benchmark areas, which spans a high of \$52,800 in Seattle and a low of \$40,370 in Cleveland. Industrial Production Managers in southwestern Pennsylvania fare better, earning \$108,670, just below the benchmark average of \$112,612 but more than the U.S. average of \$107,060.

Southwestern Pennsylvania Industries

According to the Southwest Planning Committee's planning research, the core industries offering the highest rate of employment throughout the region are:

- Health Care (196,444 jobs, 16.9% of jobs)
- Retail Trade (134,275 jobs; 11.5% of jobs)
- Government (123,051 jobs, 10.6% of jobs)
- Accommodation and Food Services (101,721 jobs, 8.7% of jobs)
- Manufacturing (90,779 jobs, 7.8% of jobs)

⁴ The 15 benchmark metro regions are: Boston, Charlotte, Cincinnati, Cleveland, Denver, Detroit, Indianapolis, Kansas City, Milwaukee, Minneapolis/ St. Paul, Philadelphia, Pittsburgh, Richmond, St. Louis, and Washington, D.C.

Southwestern Pennsylvania Manufacturing Workforce

Twenty-five percent of manufacturing workers in the region are at least 55 years old, and more than 27% are between ages 45-54; 4.5% are 65 or older and less than 6% are younger than 25 — the smallest proportion of young workers among all sectors in the regional economy. With 56.4% of the manufacturing workforce 45 or older, filling production jobs over the next decade and longer will remain a challenge.

The 2016 gender breakdown for manufacturing in the region was: 78% male and 22% female; and the race / ethnicity breakdown was 93.5% White, 3.9% African America, 1.1% Hispanic / Latino (Partners4Work, 2016).

Age profile of regional manufacturing workers		
Age	2016 Jobs	2016 Percent
14-18	374	0.4%
19-24	4,793	5.7%
25-34	14,373	17.0%
35-44	17,327	20.5%
45-54	23,176	27.4%
55-64	20,675	24.5%
65+	3,792	4.5%

Source: Partners4Work, 2016

Southwestern Pennsylvania Manufacturing Trends

The Pittsburgh Regional Alliance (PRA) announced in May 2017 that manufacturing was the leading sector for economic activity in the region for the eighth time in ten years. In 2016 the sector had 50 projects, which include company expansions, attractions, relocations, retentions and startups. Manufacturing remains the third largest regional industry in terms of regional Gross Domestic Product (\$137 billion in 2015) and fifth largest in terms of jobs. The 2016 growth in the manufacturing sector is expected to generate 3,667 new jobs in the region (PRA, 2016).

The Pittsburgh area ranked 19th in 2015 among 388 metropolitan areas nationwide in total manufacturing businesses (Catalyst Connection, 2016). Just under 8% of the region's workers hold manufacturing jobs, roughly on par with national averages but down from 25% when the sector was No. 1 in the late 1970s, according to the Allegheny Conference on Community Development.

In 2016 the average annual wage for manufacturing employees—\$59,683—was 12.5% higher than the average job in the region and there are nearly 3,000 advanced manufacturing establishments employing 94,000 people (PRA, 2017).

The Pittsburgh region experienced a -3.5% decline in the number of manufacturing jobs between 2015-2016, compared to a -0.7% decline for Pennsylvania and 0.0% decline in the U.S. From April 2016-April 2017, manufacturing jobs declined in the 10-county Pittsburgh region by 3% from 85,500 to 82,900 - the second-largest decline among the 15 benchmark regions of which Pittsburgh is a part. In overall numbers for the same 12-month period, Pittsburgh's job growth of 0.5% ranked third lowest of the 16 benchmark cities (Pittsburgh Today, 2017).

Mirroring the national trend, production work in the region is shifting towards the roles that support advanced manufacturing and away from many of the lower-level roles that have traditionally been a major source of employment in southwestern Pennsylvania. As a result, there are high levels of long-term unemployed in the manufacturing sector.

While the number of production workers is projected to slightly decline (-1% over the next 10 years), an aging workforce means employers will need to fill nearly 7,000 roles per year due to replacement. According to the Allegheny Conference/ Burning Glass's Inflection Point Report, "looking more narrowly at welders, machinists, and other roles, which typically utilize post-secondary programs, there are over 1,000 projected annual openings, against only 472 completions in 2015" (Burning Glass, 2016).

Southwestern Pennsylvania Employment by Manufacturing Industry

There are a wide variety of types of manufacturing industries in southwestern Pennsylvania, from automotive to food to machinery. Measured by workforce numbers for 2015, the largest are: fabricated metal production manufacturing (16,740 employees), primary metal manufacturing (12,472), machinery manufacturing (10,942), and computer and electronic product manufacturing (8,359) (PRA, 2016).

Southwestern Pennsylvania Manufacturing Industry Types

Of the top twelve manufacturing industry types in southwestern Pennsylvania, those with the greatest number of area employers are fabricated metal products, machinery, and printing and related support. Printing, however, is an industry showing double-digit decline (-12.4% over a five-year period, 2010-2015, and -7.4% in only one year, 2014-2015), and is expected to continue to decline due to technology and automation gains.

Other types of manufacturing that have shown a significant decline between 2010-2015 are: furniture and related (-15.8%), wood products (-14%), and nonmetallic mineral products (-9.5%). A notable outlier in all these trends is the beverage and tobacco industry, which has grown 55.6% in the region between 2010-2015, though it showed a small decline between 2014-2015, and represents a modest number of employers (Catalyst Connection, 2016).

Southwestern Pennsylvania Manufacturing Occupations

There are a number of diverse manufacturing occupations in the region, with the largest number being concentrated in the following occupational groups:

- Fabricated metal products manufacturing (17.8%)
- Primary metals (12.9%)
- Machinery (11.6%)
- Computers and electronic products (8.9%)
- Food (6.0%)

Occupations with the greatest number of workers employed are First-Line Supervisors of Production and Operating Workers, Machinists, and Welders Cutters Solderers and Brazers (PRA, EMSI, 2016).

Pittsburgh MSA by Manufacturing Occupation (as of 2015)		
Occupation	Number Employed	Location Quotient*
1. First-Line Supervisors of Production and Operating Workers	4,670	0.92
2. Machinists	4,338	1.32
3. Welders Cutters Solderers and Brazers	3,821	1.19
4. Electrical and Electronic Equipment Assemblers	2,620	1.47
5. Computer-Controlled Machine Tool Operators, Metal and Plastics	1,932	1.57
6. Cutting Punching and Press Machine Setters Operators and Tenders, Metal and Plastics	1,618	0.99
7. Grinding/Lapping/Polishing/Buffering Machine Tool Setters Operators and Tenders, Metal and Plastics	1,326	2.15
8. Extruding and Drawing Machine Setters Operators and Tenders	1,028	1.69
9. Tool and Die Makers	858	1.36
10. Electromechanical Equipment Assemblers	701	1.77
11. Chemical Equipment Operators and Tenders	695	1.21
12. Chemical Plant and System Operators	607	2.06
13. Rolling Machine Setters Operators and Tenders, Metal and Plastics	594	2.23
14. Structural Metal Fabricators and Fitters	532	0.79
15. Coating Painting and Spraying Machine Setters Operators and Tenders	366	0.4
16. Forging Machine Setters Operators and Tenders, Metal and Plastics	322	1.94
17. Drilling and Boring Machine Tool Setters Operators and Tenders, Metal and Plastics	140	1.12
TOTAL	66,048	0.86

**The Location Quotient is a measure of the concentration of employment in a particular occupation relative to the national average. A Location Quotient above 1.0 indicates an above average concentration.*

Source: BLS (data as of October 2016) as reported by the Pittsburgh Regional Alliance.

Top manufacturing firms in the 10-county region include a wide variety of manufacturing types, including food (Kraft Heinz Co.), coatings (PPG), pharmaceuticals (Mylan NV) and steel (U.S. Steel).

Southwestern Pennsylvania In-demand Skills and Occupations

The regional trend for fewer manufacturing jobs with higher skills mirrors the national trend, with local employers pointing to a growing need for skills such as automation controls, mechanical engineers, robotics expertise and 3D printing. Increasingly workers are needed to not only operate, but program, maintain and manage advanced computer-controlled equipment (Burning Glass, 2016).

The 2016 regional Inflection Point Report identified the top ten baseline skills in demand in the workforce as, respectively: communication skills, troubleshooting, organizational skills, preventative maintenance, computer skills, writing, problem solving, customer service, detail-orientation, and Microsoft Office. The same report identified the top ten in-demand specialized skills as, respectively: repair, inspection, hand tools, welding, machining, HVAC, power tools, machinery, blueprint reading, and mathematics.

Regional manufacturing occupations in high demand in the region include: Machinists, Welders, Industrial Maintenance Technicians, and Mechanical Engineers.

Occupations projected to grow significantly within the region by 2025 include: Industrial Machinery Mechanics (20%), CNC Machine Tool Programmers (19%), Computer-controlled Machine Tool Operators (16%), and Machinist (11%). The occupations projected to have the greatest decline by 2025 are those that are increasingly being automated, such as Printing Press Operators (-19%), Cutting, Punching and Press Machine Operators (-15%) and Grinding, Lapping, Polishing and Buffing Machine Operators (-11%) (Burning Glass, BLS, 2016).

D. Tri-County Workforce and Manufacturing Trends and Developments

Tri-County Population

The age of Pennsylvania residents skews older than in most of the country. This is particularly true for the Pittsburgh region, and the Tri-County area follows that trend, with Armstrong County having the oldest population. The Pittsburgh area was hit with a confluence of events that are playing out now in demographic shifts: a very high percentage of older people who age in place versus an outmigration of the young (this has stemmed in recent years in the City of Pittsburgh but persists in many of the outlying counties). A major outmigration occurred in the 1980s and 90s, due to the collapse of the steel industry, resulting in a 'missing generation' that, had they stayed, would now have children entering the workforce. Add to that the national trend of baby boomers retiring – which one Tri-County manufacturer referred to as creating a “Swiss cheese” effect among the workforce. A SHRM-AARP survey conducted on this topic found “that many U.S. organizations are largely unprepared for the brain drain and skills void that talented, retiring workers will leave.”

These trends are reflected in the following U.S. Census Bureau data:

Area	Total Population	Median Age	18-64 Years	Population by age category				
				Under 5	5-19	20-34	35-64	65+
Armstrong	67,052	46.1	40,148	3,314	10,994	10,608	28,269	13,867
Butler	186,818	43.2	115,858	9,357	34,810	31,733	78,384	32,534

Indiana	86,966	39.1	55,829	4,262	16,230	19,543	31,654	15,217
10-county	2,565,612	42.9	1,592,530	131,634	428,057	493,525	1,032,646	479,750
PA	12,802,503	40.7	7,932,441	714,912	232,6414	251,6542	5,064,841	2,179,788

Source: US Census Bureau, Population Estimates (2015 data, updated June 2016)

Tri-County Employment

Industry in the Tri-County area is currently dominated by:

- 1) education and health services
- 2) trade, transportation and utilities
- 3) professional and business services.

Manufacturing is the sixth largest industry in the area, employing approximately 83,000 workers (BLS, 2017). Top occupations predicted to grow between 2014 and 2024 in the three county area are: Retail Salespersons, Cashiers, Combined Food Preparation and Serving Workers, Waiters and Waitresses, and Registered Nurses (Tri-County Workforce Development Board, 2017).

- Covering the 12-month period of April 2016 to Mar 2017, Armstrong County’s labor force of 33,000 had a higher unemployment rate (6.25%) than the state (4.8%). There were 120 unemployed manufacturing workers who exhausted their unemployment benefits, which is a higher percentage (17%) than the state average (14.5%) for this industry.
- Butler County’s labor force of 98,100 has a slightly lower unemployment rate (4.6%) than the state (4.8%). There were 220 unemployed manufacturing workers who exhausted their unemployment benefits, which is a higher percentage (16.5%) than the state average (14.5%) for this industry.
- Indiana County’s labor force of 39,600 has a higher unemployment rate (6.1%) than the state (4.8%). There were 100 unemployed manufacturing workers who exhausted their unemployment benefits, which is a lower percentage (10.5%) than the state average (14.5%) for this industry (PA Workstats County Profiles, 2017).

In the aggregate, the number of people age 55 - 69 is increasing in the Tri-County region while the number of people under the age of 54 is decreasing. Over the past five years the regional population has expanded due to significant growth in Butler County, while population rates in Armstrong and Indiana counties have declined slightly.

Tri-County Educational Attainment

In the Tri-County region, educational attainment is lowest in Armstrong Country and highest in Butler County. The percentage of residents 25 or older that earned a bachelor’s degree or higher is greatest in Butler (32.3%) and educational attainment is most diversified in Indiana.

Tri-County Educational Attainment (25 years and older, 2015)			
	<i>Armstrong</i>	<i>Butler</i>	<i>Indiana</i>
Less than HS degree	11.1%	6.9%	11.5%
HS degree or equivalent	49.4%	34.9%	43.9%
Some college	15.6%	16.5%	14.0%
Associates degree	8.9%	9.4%	8.0%
Bachelor's degree	10.5%	21.1%	13.5%
Graduate or professional degree	4.4%	11.2%	9.1%

Source: US Census, American Fact Finder, 2017

Tri-County Manufacturing

Butler County is home to significantly more manufacturing firms than its neighbors, but both Armstrong and Butler have more manufacturing firms, and a greater percentage of residents in manufacturing, than the state average. Only Butler manufacturing workers earn more, on average, than the state average for manufacturing workers, whereas Armstrong and Indiana earn significantly less.

Manufacturing companies, employees, employment and wage comparison by county							
	<i># of firms</i>	<i>LQ</i>	<i># of employees</i>	<i>County employment</i>	<i>State employment</i>	<i>County wage</i>	<i>State wage</i>
Armstrong	75	1.18	2,017	11.8%	10%	\$51,825	\$59,564
Butler	271	1.45	12,325	14.5%	10%	\$62,194	\$59,564
Indiana	82	.69	2,178	6.9%	10%	\$44,840	\$59,564

Source: PA Workstats April 2016-March 2017 data, 2017

In the period September 2015-September 2016, manufacturing declined -1.4% in Butler, -7.4% in Indiana, and -7.8% in Armstrong (QCEW State & County Maps, Sept 2016).

The three largest manufacturing employers in the Tri-County area are located in Butler County: Westinghouse Electric Company, AK Steel and MSA Safety. The other counties are home to smaller facilities, like Specialty Tires of America and Herkules Group.

Tri-County top manufacturers by # of local employees		
<i>Employer</i>	<i>Employees</i>	<i>County</i>
Westinghouse	3,400	Butler
AK Steel	1,400	Butler
MSA Safety	800	Butler
Allegheny Ludlum	NA	Armstrong
NORMA Pennsylvania	320	Indiana
Specialty Tires of America	310	Indiana
Herkules Group	220	Armstrong

Sources: Armstrong County Department of Economic Development, July 2016; Community Development Corp. of Butler County, updated July 2016; Quarterly Census of Employment and Wages, CWIA, April 2017; Pittsburgh Regional Alliance, 2016.

E. Key Findings and Challenges for Tri-County Manufacturing

In March-April 2017 C4IOE / TCWIB asked members of the Manufacturing Industry Partnership to respond to an online survey regarding workforce training needs, hiring trends, and industry trends. Thirty responses were received, though some respondents did not answer all questions. The responders were 60% employers and 40% education providers or resource partners.

Although the number of manufacturing survey respondents was not statistically significant to draw quantitative conclusions for the Tri-County region, the results provided qualitative information and served to shed light on how local developments relate to national and regional trends. Key findings from the survey and from interviews with local employers and education providers include:

Industry trends: Respondents identified a number of industry trends affecting Tri-County businesses: fluctuations in the energy industry, especially coal and gas; the expanding medical market; uncertain political climate/ government changes; price competition; automation; outsourcing/off-shoring; and the difficulty of keeping up with market changes and developments.

Workforce challenges: The greatest workforce specific concerns from employers were: aging workforce (91%), lack of job readiness skills among new / potential hires (64%); youth pipeline too small (45%); and employee retention (36%). Also mentioned were a lack of personal drive and passing drug tests. Educators / resource partners chose the same top three challenges.

Hiring projections: Sixty-five percent of employer respondents expect their businesses to grow over the next 12 months, with 86% of respondents needing to hire general skilled labor, and 43% needing general unskilled labor. Twenty-eight percent of respondents will be seeking job roles at the technical professional and managerial levels. The types of positions they expect to hire included: apprentices, assemblers, estimators, machine

operators, tool and die makers, logistics, mechanics, quality managers / supervisors, experienced welders/ machinists/ maintenance technicians; marketing, sales and production workers.

Skills needs: Following are the technical skills and workplace skills (mostly soft skills) that employers who responded to the survey identified as most needed:

	Top Needed Technical Skills
Needed now	blueprint reading; assembly; metrics and measurement; basic manufacturing.
Needed in next 12 months	electrical systems; fork lift operator
Needed in next 2-5 years	additive manufacturing

	Top Needed Workplace Skills
Needed now	time management / productivity / efficiency; and team building / teamwork were highest ranked; followed closely by: organizing skills; customer service; OSHA-related topics; problem solving and decision-making; creativity / innovation; project management; and supervisor / manager / leadership skills.
Needed in next 12 months	conflict resolution (showing the largest increase of any skill over its ranking for immediate need); project management; problem solving and decision-making.
Needed in next 2-5 years	media relations; followed by communications; cultural competency / diversity; mentoring / apprenticeship program; public speaking; research and planning.

Skills gap: The largest skills gaps identified by employers were basic math and blueprint reading, followed by higher math and higher level thinking skills, such as critical thinking, problem solving, and adapting to change. All respondents expect these skills gaps to grow over the next five years. The largest skills gaps identified by educators and resource partners were soft skills (especially communications) and coding / programming. It was felt that these gaps would grow or stay the same over next five years.

Lack of workplace skills: In the area of workforce challenges, a number of employers noted the difficulty in finding entry-level workers with necessary workplace skills, such as reliability, punctuality, ability to work well with others, a good work ethic and general professionalism. They also cited needing people who had basic math, computer (i.e. Microsoft Office and basic internet) and communication skills, as well as the ability to pass a pre-employment drug test. All of these challenges mirror those noted in state and national reports and surveys.

Perception of manufacturing: A negative societal attitude towards manufacturing jobs was often mentioned as a barrier to getting workers in the pipeline for production positions, as was a lack of understanding about what careers are actually available. However, one long-time workforce development professional says this is starting to

change, and that the Millennial generation is more open-minded and does not have as many biases as past generations towards manufacturing. He also noted more young women are taking manufacturing-related courses and entering into apprenticeships.

Workforce training: Overall satisfaction with current workforce training programs was mixed. Some respondents cited a need for greater coordination and collaboration between employers and educators, and 44% felt there was a shortage of training programs for key industry needs, like machining, basic manufacturing and precision grinding.

According to employers, the top barriers to employee training are: can't be absent from shift / work responsibilities (63%), too time consuming (45%) and lack of personal motivation (45%). According to educators and resource partners, the top barriers to attending training are: lack of transportation followed by lack of personal motivation to attend.

High demand courses: Educators and resource partners cite welding and machining as the most in-demand courses currently as well as in the next 2-5 years. Also in demands at this time are managers, sales people and trained cooks.

Training constraints: Educators and resource partners identified the top three training constraints as: funds, limited or out of date tools, and an incomplete understanding of training needs for students and industry, and viewed communication between industry and partners as mixed.

Note: A more complete summary of findings is available on the TCWIB website.

II. Addressing the Needs and Challenges of Manufacturing in the Tri-county Area

A. Opportunities to Strengthen Manufacturing in the Tri-County Region

Following are observations and opportunities for Tri-County stakeholders to consider for strengthening the area's manufacturing workforce. They were derived from a combination of one-on-one interviews with area employers and training professionals, and lessons learned from other geographic areas.

The right message: Craftsmanship and pride in making things is returning, especially among Millennials, says one training professional. "We need to rethink our training and messaging to speak to what a younger generation wants from work – a sense of being part of something bigger. Manufacturing absolutely delivers that." He cited making medical devices so someone can live longer or to replace a joint as examples of how making physical products allows one to add value in society and have a good job. Another long-time worker and trainer in the area advised being specific about opportunities, for example compare the cost of a 4-year degree at the University of Pittsburgh with what a young person can earn in manufacturing over those four years, and what their earning potential is over a lifetime.

New technologies: Another area employer spoke of a need to get out in front of some of the new technologies, rather than waiting and reacting to them. "We need new solutions, new thought patterns. How can new technologies be useful in (various industries)? What opportunities will they create?" He cited 3D printing, the Internet of Things and Virtual Reality as examples of new technologies.

Scarcity mentality: There is a limited pool of talent in the Tri-County area and some employers and trainers spoke about this causing a scarcity mentality around labor issues. Some employers are fearful of losing employees to the competition or to job opportunities in neighboring counties. In reaction, they make choices in the short term that may hurt them in the medium and long term, such as not sending employees to group training programs because they fear such visibility will enable workers to be poached. One area employer noted that employees leaving for other jobs is a two way street: the employer must look at what they can do to retain employees and ask, what could they have done better to foster loyalty and engagement of that employee in their current position?

Education and training: The skills gap in manufacturing will persist and a large percentage of local employers as well as employers mentioned in national reports believe it will get worse in the next few years. This suggests new ways for addressing the skills shortage are needed. Going to school and completing studies before getting a job, is being challenged, especially for industries like manufacturing where the skills need to evolve along with the technology requirements central to the industry. Continuous education models are being explored – with shorter college courses, online learning and targeted upskilling.

Skill evolution: A long-time industry trainer made the point that the future is not about mass worker displacement. "There's a lot of fear about losing jobs, but it's about

retraining not replacing workers; you retrain your workers to run the CAM. It's skill evolution." Another area employer emphasized that workers, employers and partners "must be open to adapt and change" as there is no other option.

Team effort: Some interviewees noted they have seen an adversarial relationship between educators and employers – and, they say, this does not serve the industry well. "As employers, we need to stop thinking this is just an educational problem; it's a whole industry problem and we need to be developing strategies alongside our educators to ensure that we are showing up at job fairs and schools with the right messages." Another area employer felt, "We have done a disservice to young people, especially in the inner cities, by not giving them an understanding of the options they have."

Cracker: opportunity or challenge? Royal Dutch Shell's \$6 billion investment in the ethane cracker in Beaver County is viewed in the Tri-County area with mixed feelings. On a regional level, it creates jobs, infuses money into the economy, and likely will provide opportunities for area manufacturers to make parts for the cracker or its spin-off industries. Some say it raises the profile of manufacturing as an occupation. But a common concern among Tri-County manufacturers is that higher wages paid by the cracker plant will pull good employees away from nearby counties like theirs.

Hard and soft: While the demand for technical skills like STEM will remain high – employers highly emphasize the need for students and workers to develop soft skills. As one Tri-County employer noted: "There's a saying that goes, you can get a job with your hard skills, and you can lose it with your soft skills."

Supply and demand of skills: Area employers emphasized what has been described in national reports, that colleges and training centers need to better align their teaching approaches to rapidly changing workforce needs. Ways of doing this were suggested:

- offer training in packages that are smaller, faster, and more relevant to immediate needs in the labor market;
- rather than a two-year degree, students may take a six- or nine-month course, then use that skill in the workplace and at a later date they may upskill with another such course;
- better connect students to career opportunities by inviting them to the workplace for plant tours and mentoring opportunities; and
- workforce data should be more widely shared to help align the supply and demand of skills.

Diversified education and credentialing ecosystem: Educators and industry partners see a new education and training ecosystem emerging in which some job preparation functions are performed by formal educational institutions in fairly traditional classroom settings, some elements are offered online, some are created by for-profit firms, some are free, some exploit augmented and virtual reality elements and gaming sensibilities, and a much real-time learning takes place in formats that job seekers pursue on their own. Some say alternative credentialing mechanisms will arise to assess and vouch for the skills people acquire along the way.

B. Developing High-demand Skills and Career Pathways:

Based on our research, C4IOE identified six (6) key manufacturing occupational clusters in demand or projected to be in demand in the Tri-County area or region. Following are the clusters and sample occupations for each.

Top clusters currently in the Tri-County area:

- ***Machining***: Machinist, CNC Machinist, CNC Turning Specialist, CNC Machine Tool Operator, Multiple Machine Tool Setters, Operators & Tenders, Tool & Die Maker, Machine Installation and Repair, CNC Setup Programmer, Machine Shop Manager, Industrial Production Manager
- ***Welding***: Welder, Cutter, Solderer, Brazier, Boilermaker/ Pipefitter, Welding Technician, Welding Engineer, Welding Inspector, Welding Supervisor
- ***Production***: Production Technician/ Specialist, First-line Production Supervisor, Mechanical Engineer, Industrial Production Manager, Industrial Production Engineer

Clusters projected to grow in the region:

- ***3D Printing / Additive Manufacturing***: 3D Printing Technician, 3D Printing Designer/ Modeler, Mechanical Engineer, Industrial Engineer, Manufacturing Engineer
- ***Quality***: Quality Improvement Associate, Quality Technician, Quality Inspector, Quality Engineer, Quality Auditor
- ***Logistics***: Forklift Driver, Logistics Planner/ Scheduler, Logistics Technician/ Specialist, Logistics Manager, Supply Chain Manager, Supply Chain Analyst, Logistics Analyst, Logistics Engineer, Reliability Engineer, Systems Engineer

The manufacturing industry offers a variety of career paths and entry points to those paths. Career progressions can branch into multiple job opportunities, such as a skilled machinist or production worker moving into quality control, installation and repair, or safety occupations, as well as management roles. In addition, more jobs are emerging at the intersection of technology and manufacturing, requiring hybrid-skills or a broader base of skills.

Different employers will also expect varying levels of preparation for the same or similar jobs. Apprenticeships and on the job training (OJT) have traditionally played an outsized role in preparation for manufacturing positions, and this is still true today for many jobs, especially entry-level. Expectations also differ for years of experience needed for a position, often reflecting the difference in hiring someone at the early stages of their skills versus someone who is credentialed / certified in that skill set, and this is reflected in the career pathways model.

The manufacturing credentialing and technical skill standards most desired by area manufacturers are primarily in the skilled trades, such as those established by the National Institute of Metalworking Skills (NIMS) and American Welding Society (AWS). Also of benefit are certifications from the American Society for Quality for quality

assurance / control occupations, and the International Society of Logistics and American Production and Inventory Control Society (APICS) certifications for logistics occupations.

Of particular note is the 3D Printing cluster, which is very much an evolving space. Given that this career pathway is still being shaped by technological changes, emphasis was placed on needed skills and how they will most likely be used in the near-term, more than job roles. While this pathway in the report focuses on manufacturing, workers with 3D printing skills will be in demand in many sectors, including but not limited to defense, automotive, materials science, agriculture, medical/ biomedical, aerospace, architecture, and software development. As an entry-level option, 3D printing apprenticeships are starting to be established, such as through a \$4.9 million grant from the U.S. Department of Labor to set up West Virginia's 3D printing apprenticeship program, funded to help train underserved communities learn advanced manufacturing skills. A similar effort is underway in Youngstown, Ohio as part of the Manufacturing USA program.

Engineers, technicians, architects, or scientists have the easiest transition into the 3D printing careers (Bella, 2015). These career paths have already exposed workers to software programs like SolidWorks, Rhino3D, AutoCAD or other 3D modeling and design software. In manufacturing, workers with CNC programming skills, especially for laser cutters, lathes, or mills will find those abilities transferable to 3D printing. According to *Forbes Magazine*, "Manufacturing has the highest number of positions for 3D printing and additive manufacturing skills" (Columbus, 2014).

Both Quality and Logistics, while not in high demand in the Tri-County area currently, are projected to be modest growth occupations either by the state, or in projections about the jobs that will be harder to automate.

III. Recommendations

The following recommendations have emerged from the research data and qualitative input provided by local and regional employers, educators and service providers.

1. **Focus on High Priority Occupations and other occupations showing high growth potential:** As described in the previous section, High Priority Occupations and job growth projections in manufacturing outline areas of employment growth for the Tri-County workforce. Action areas include, ensuring strong alignment between industry demand and skills training opportunities; communicating these needs to students, educators and workers; and proactively preparing for changes in area occupations – such as the need for new skills like digitizing blueprints and 3D printing software.
2. **Proactively seek and attract talent:** Instead of posting a job and waiting for the right employee to apply, bring the employer to the talent pool. Employers can be proactive in investing in and cultivating the labor market in their area, and some Tri-County employers have been engaging directly with schools and training facilities. Employers can play a bigger role in a number of ways:
 - Communicate the job opportunities and the value of manufacturing careers to students and young workers. Send seasoned employees to speak as ambassadors for the industry; have them be judges at STEM competitions, attend job fairs, school science fairs, and other such events where talent coalesces.
 - Visit training classes and speak directly to students/ workers about the opportunities available and skills needed; speak to guidance counselors and job retraining facilities about the positions and skills employers are seeking.
 - Engage non-traditional groups – like women, vets, recent immigrants and minorities – about career opportunities and make them feel welcome in the manufacturing industry.
 - Ensure easy access to workforce demand data to help more students select courses of study aligned with industry demand.
3. **Upskill workers:** Create an environment where more area workers have an opportunity to connect to and prepare for manufacturing opportunities – and convey the reasons and benefits of upskilling. Identify groups that have the potential to increase their skills – such as some among the 7,000 chronically unemployed manufacturing workers in the region; or non-traditional groups that can be tapped for trained – such as women, disadvantaged youth, minorities, new immigrants, and rural youth who don't often learn about opportunities in advanced manufacturing or technology. Work with training providers to determine ways of tailoring courses for upskilling.
4. **Prepare now for an aging workforce:** It is important for employers to be fully aware of the various ways the trends and demographic shifts noted in this report will influence their organizations. For example, employers may need to:

- Conduct a workforce needs assessment to analyze the impact of workers age 50 and older who will be leaving/ retiring from a company/ organization. Consider tracking the percentage of employees eligible to retire in the next few years and develop a human resources continuity plan that helps target and train replacements.
- Adjust their recruiting and retention strategies to specifically target older workers and offer flexible work arrangement for this group.
- Identify the skills and experience most valued in older employees and ensure this knowledge and practical know-how is being transferred to new generations of workers.

Additional strategies to handle a high number of employee retirements include:

- increase training and cross-training
- develop knowledge transfer plans to transfer institutional knowledge from retiring employees to younger employees
- plan who will move into management roles in the next few years and start their training now
- seek new employees from existing employee networks
- build training guides for specific roles where the incumbent employee may be retiring or leaving
- hire retired employees as consultants
- hire temporary workers or part-time workers
- offer flexible work arrangements.

5. ***Strengthen connections to regional resources that support manufacturing:***

Address workforce development from both a local and regional perspective. This allows the industry to:

- Shift thinking to ways to grow and change rather than compete;
- Expand membership of the Manufacturing Industry Partnership to include economic development organizations, organized labor, human services organizations and community based organizations to ensure a “whole person” approach to workforce development (such an approach is underway in Illinois, New York and Ohio);
- Tap into greater information sharing and relevant resources in Pittsburgh, such as the new Advanced Robotics Manufacturing Institute at Carnegie Mellon University - whose goal is to facilitate workforce development in the southwestern Pennsylvania region, and will be connecting the region to seven other U.S. manufacturing regions for sharing of lessons and ideas;
- Share lessons and best practices about how to overcome the challenges facing the industry.

6. ***Explore non-traditional education and new training approaches:*** For example:

- Focus on developing cross cutting skills that can be transferred across occupations and potentially industry sectors
- Develop cross-industry certifications

- Differentiate training offerings so more students / workers can access them – shorter courses, online, time given at work for training, etc.
 - Embrace new digital learning tools coming online that offer simulations and gaming approaches to learning. Educators say such tools will supplement not supplant classroom or hands-on learning and can place a worker at a higher skill level once they move into a hands-on role, saving time and money.
 - Advocate for soft skills to be taught in K-12 and arrange interactions with real employers so students can practice these skills in a real world setting
 - Actively shift the decades-old negative mindset around manufacturing towards sustainable well-paying career paths and further job opportunities – this ties into a larger need to portray a variety of career paths as equally valuable
 - Enable higher education to occur in workplaces as well as schools.
7. ***Play an active role in rebranding manufacturing:*** Find new and non-traditional ways to convey the message that manufacturing is a sustaining, exciting, meaningful career. View it as an industry-wide effort, not just one person's job - with all stakeholders engaged around a few core messages. These messages should be tailored to different audiences: women, vets, urban and rural youth, those seeking retraining or a career pivot; visual images should reflect multi-generational and non-traditional manufacturing workers so students and workers can see themselves in those roles.

Conclusion

Multiple changes and trends are converging on today's manufacturing ecosystem, creating a significant level of uncertainty about what and who to invest in, and how to best prepare and engage the workforce. In response, many educators and employers agree that the best skill for workers to cultivate, is the mindset of a life-long learner. It is not just about skill acquisition, but a perspective that accommodates and even embraces a continually evolving work environment.

IV. Appendices

Appendix 1: Report Methodology

This report addresses key research questions around demographics of the region, industry trends and occupational trends on a national, state, regional, and local level, career pathways, training needs, and skill standards (including credentialing) for key occupations. Additionally, the report describes the Manufacturing related Career Pathways / Skill standards model that was developed as part of this process, and provides recommendations related to career paths, workforce development and training for this industry in the local TCWIB region.

Research for this report consists of a mix of primary and secondary source material. Secondary sources include national, state, regional and local and research reports, print news articles and on-air news segments, and data sets from government agencies and economic development entities. Primary sources include a mix of one-on-one interviews and an online survey developed by C4IOE and administered in April 2017. The survey was sent to employers, education providers and job-related service providers in the Tri-County region that are part of the Manufacturing Industry Partnership. There were 30 respondents to the survey, though some did not answer all questions. The survey results are available on the TCWIB website: www.tricountywib.org The reports and the Career Pathways / Skill Standards models are also available on this website.

Appendix 2: About C4IOE / About TCWIB

About C4IOE

C4IOE is a management consulting firm, founded in 1998, which provides services to businesses, individuals, government and nonprofit organizations. Our services include: human resources strategies/processes, social entrepreneurship/ventures, performance improvement, training and curriculum design, change management, organization development, process redesign, non-profit planning and management, strategic planning, operational planning, technical writing, and other organizational initiatives and practices, for the purposes of improving performance of, and creating positive change in individuals and organizations.

About Tri-County Workforce Investment Board (TCWIB)

The mission of the Tri-County Workforce Investment Board, Inc. is to provide responsive and innovative leadership that meets the current and future needs of employers and job seekers. The vision of the Tri-County Workforce Investment Board, Inc. is that the local area will be a destination of choice for employers and job seekers, where existing businesses experience growth and where new businesses are eager to locate because of the excellent job opportunities, economic vitality, quality of life and the presence of a skilled workforce. The Tri-County Workforce Investment Board, Inc. is comprised of 29 volunteer members from Armstrong, Butler, and Indiana counties. Members are community leaders with policy and decision making experience.

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