WORKFORGE

THE STATE OF THE WORKFORCE IN MANUFACTURING:

AN AMERICAN INDUSTRY OUTLOOK

2022

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EXECUTIVE SUMMARY

THE UNITED STATES IS EXPERIENCING A MANUFACTURING RENAISSANCE.

From the economic shifts experienced during the recession ten years ago, to the onset of the global pandemic in 2020, the manufacturing industry has proven its resilience and competitive spirit as it also continues to evolve with more innovations, developments, and open positions, as well as a rise in demand, wages, and revival of the recently disrupted supply chains. While economic rebound shows promise, manufacturers remain cautiously optimistic, understanding the ongoing risks, unexpected disruptions, and fragile operational margins, as well as the pressure of inflation and talent shortages.

When it comes to industry growth constraints, especially relative to workforce challenges, the disparity between the number of available jobs in manufacturing versus the number of qualified applicants emerges as a leading trepidation for employers. Across the nation, patterns have emerged, and root causes have been preliminarily identified as:

- decreasing population and ongoing retirement of the baby boomer generation
- rapid progression of industrial technology in conflict with delayed or obstinate curricular advancements, as well as limited instructor capacity and archaic equipment within the education system
- persistent industry misperceptions paired with competitive talent attraction and recruitment strategies from other sectors
- ongoing employment barriers exacerbated by the ripple effects of the global pandemic, causing disruptions to job seeking processes and hiring practices.

An integral part of the U.S. economy, manufacturers must continue to defend against national and global disturbances, as manufacturing in America accounts for over 12.8 million employees and 11% of the country's GDP (Chewning & Dua, 2022). Optimistic economic indicators and historic trends combined are signaling growth. After all, even after the rise and fall of manufacturers over the years, America is actively competing with global manufacturing titans; this due in part to advances in aerospace, semi-conductor chips, and robotics, as well as smart factory and sustainability initiatives, and new technologies in the electronic vehicles and plastics/ polymers spaces.

The growth of the manufacturing and engineering technology-based industries, though, are still not consistent across the country; rather, there are regionally recognized pockets where manufacturing employers are building, expanding, and commanding highly and uniquely skilled technicians. California, Texas, and Ohio currently employ the most people in the field of manufacturing in America. States like Maryland and Missouri show promise. Major efforts are underway with mega-site announcements being made in industrial states like Indiana, Michigan, Kansas, Georgia, and Arkansas.

The manufacturing industry in the U.S. is a powerhouse which appears to be proving once again why we refer to manufacturing as the backbone of America. Now, and with urgency and agility, is the time to play matchmaker within the entire manufacturing workforce ecosystem and greater economic development process; solidifying relationships among all the stakeholders and accelerating innovations in workforce training, education, exploration, attraction, and career opportunities.

MANUFACTURING IS THE BACKBONE OF AMERICA.

U.S. MANUFACTURING: THE ECONOMIC IMPACT

MANUFACTURING IS THE BACKBONE OF AMERICA. MANUFACTURING IS HERE TO STAY. AMERICA IS POWERED BY MANUFACTURING.

We have heard and perhaps even echoed those statements for years, and we believe them to be true; after all, manufacturing in America accounts for over 12.8 million employees and 11% of the country's Gross Domestic Products (Chewning & Dua, 2022). However, manufacturing, as an industry, has also found itself rebounding from cyclical risk, operating through turbulent times throughout history, and falling victim to persistent misperceptions which negatively impact workforce attraction, recruitment, and retention.

The manufacturing industry has proven its resilience and competitive spirit though. From the economic shifts experienced during the recession over ten years ago, to the onset of the global pandemic in 2020, manufacturing in America also continues to evolve with more innovations, developments, and open positions, as well as a rise in demand, wages, and revival of the recently disrupted supply chains. The advances in technology, the introduction and implementation of lean manufacturing techniques, increased federal funding, and prominence of business-related best practices and economic impact highlights, are keeping manufacturers well-poised for continued success. Further, with promising economic rebound trends being revealed, manufacturers are remaining cautiously optimistic as they understand and prepare themselves for the ongoing risks, unexpected disruptions, and fragile operational margins, as well as the pressure of inflation and talent shortages they endure.

Reports have more recently and more increasingly revealed strategies to support continued market share growth and international competitiveness of the major manufacturing industries within the U.S. The industry sectors commonly highlighted include aircraft and defense equipment, automobile/parts, basic metals, communications equipment, electrical equipment, electronics, fabricated metals, general machinery, medical devices, other transport equipment, petrochemicals, pharmaceuticals, precision tools, semiconductors, special-purpose machinery, and specialty chemicals. For example, the McKinsey Global Institute researched the aforementioned sectors to generate a study called, Building a More Competitive US Manufacturing Sector (Manyika, et al., 2021).

WITHIN THE STUDY, EACH OF THE REPRESENTED ENGINEERING TECHNOLOGY-BASED COMPANIES WERE EVALUATED BASED UPON OPERATIONAL CHARACTERISTICS, INVESTMENT PROFILES, AND OCCUPATIONAL MIX.

McKinsey Global Institute, in turn, identified four stages in which manufacturing sites might find themselves. The four stages were comprised of detailed "activity types" as demonstrated here:

1. Scale-based and standardized activities

empower companies to invest in creating expansive supply chains, impacting a variety of sectors. These activities include standardization of procedures, high utilization of plants, or investment in tangible capital. When successfully implementing scale-based activities, large U.S. manufacturers may see an average return of 12%-14%, in comparison to the 7%-9% return of European companies or 5%-7% return experienced in their Asian counterparts. (This is often exemplified in auto parts manufacturers and metal foundries.)

2. Learning-curve activities

involve investing in process and procedure gains through time and capital. The manufacturers in this stage engineer to achieve exponential process improvements, and each successive product introduced is expected to drive or generate productivity gains. It is common for American manufacturers to conceive of new process innovations; however, the U.S. often does not scale as efficiently or as broadly as other countries, resulting in an 11% plummet of its share of global GDP. A microcosm of these trends would be the semiconductor industry through which America is recognized as an international leader in chip design; however, as a nation, the U.S. has lagged in production of the next generation of seven-nanometer and five-nanometer chips. In 1990, the national global chip production capacity was 37%; whereas, today, it is down to 10%.

3. Research & Development (R&D) and design-driven activities

(e.g., the development of new pharmaceutical biologics, or the design of next-generation digital devices) draw on large investments in research, intellectual property, design, software, and other intangibles to create differentiated and market-leading products. The actual production often occurs elsewhere, and because of the profitability of R&D efforts, many U.S.-based facilities are gravitating to this part of the value chain, further recognizing the worth of offshoring activities that would otherwise be less profitable. Over the past two decades, in fact, the nation's share of global manufacturing GDP (specific to R&D and design-based activity) increased by four percentage points. However, when it comes to scale-based activity, the U.S. has actually lost six percentage points of its global share. This is a trend that has broadened the trade deficit and has been the demise of some domestic industries.

4. Flexible and customizable activities

(often observed in facilities that manufacture aerospace parts and medical devices) use digital production technologies to reduce the scale in order to be profitable; making it possible to produce smaller volumes or lot sizes. This paves the way for business models built around customization, distributed production, rapid order fulfillment, and after-sale services. American manufacturers within the flexible and customizable activities space are reflecting a four-percentage point deficit (Manyika, et al., 2021).

TO CAPITALIZE ON THE GROWTH OPPORTUNITIES THAT RESULT FROM THESE ACTIONS AND TO THRIVE IN THE GLOBAL MARKET, U.S. MANUFACTURERS MUST CONTINUE TO EMBRACE NEW TECHNOLOGIES

and improve internal processes; all the while, attracting more talent into the industry. The holistic approach is applicable to all sizes of engineering technology-based companies – from the small, locally-owned entities to the medium-sized or large conglomerates. One of the most anticipated and frequently noted challenges is securing capital investment to upgrade aging facilities and equipment. The most frequently cited concern, though, throughout this research was workforce pipeline shortages.

MANUFACTURING CREATES OUTSIZE ECONOMIC IMPACT IN THE UNITED STATES.

US MANUFACTURING DIRECTLY ACCOUNTS FOR...

8%

of the US workforce

11%

of the US GDP

...BUT MAKES DISPROPORTIONATE CONTRIBUTIONS TO THE US ECONOMY

20%

of net capital stock

35%

of productivity growth

55%

of patents

60%

of exports

70%

of R&D spending

Spurs demand in related industries that provide services and inputs

Supports local economies and small suppliers across the country

Source: US Bureau of Economic Analysis; US Bureau of Labor Statistics; McKinsey Global Institute analysis


"EVERY WORKER.
EVERY INDUSTRY.
A STRONG
ECONOMY."
- NATIONAL SKILLS COALITION

WORKFORCE CHALLENGES AND SOLUTIONS IN U.S. MANUFACTURING

"Every worker. Every industry. A strong economy." This is the tagline for the National Skills Coalition (2018). During an online forum, they challenged readers to consider, "What is workforce development?" Collectively, research has described workforce development as a system or a process dedicated to preparing and advancing the unemployed, underemployed or incumbent worker; serving as an engine for economic opportunity and community growth; bridging industry, academics, government and economics.

According to the National Skills Coalition website, "*Workforce development is about investing in people, and making sure that workers and businesses have the skills they need to compete in today's economy. And it's about investing in proven strategies that connect workers with skills training and career pathways that lead to skilled, well-paying jobs at growing companies*" (National Skills Coalition, 2018).

The demand for an engineering technology driven workforce remains on the rise, predominantly in the manufacturing sector, where some experts say the problem is projected to worsen as jobs continue to go unfilled (Gratz, 2018). From dramatic increases in the demand for advanced manufacturing products, and with unprecedented shifts, both in demographics and also in technology, employers and technical educators are forced to explore how to also create a shift in attitudes about technical education and careers that exist in the manufacturing and engineering technology sector. Attracting and retaining skilled talent are among the greatest challenges and limiting factors these employers are facing.

There are several reasons for the workforce conundrum. First, there are more openings than people who have experience to be hired. Many job-postings require hands-on experience and applied training which often span months or years making immediate hiring an impossibility. Also, skills required by advanced employers are evolving at the same pace of the ongoing digital transformation of the industry, yet a large majority of the workforce does not yet possess those skills. Further, while many manufacturing jobs require college degrees and advanced training, there are still misconceptions among college graduates about jobs in manufacturing being reserved for the population that did not pursue a higher education. Similar to the fallacy of those college graduates, there are also still many Americans who are simply unaware of the technological advancements within the manufacturing industry.

Aside from societal impressions and culture shifts over recent years to attract young people into the STEM disciplines, there is still a growing demand for skilled employees and those with advanced technical skills. The availability of skilled labor in industrial fields often impacts the decisions of global organizations seeking to move operations to or expand facilities in the U.S. Employers continue to depend upon a supply of STEM graduates from local institutions and are further showing support for technical colleges that assist in attracting international or foreign-born students and workers for mutual benefit.

There are a multitude of sectors seeking such a skilled workforce, though, from healthcare and computer sciences, to tourism, retail, hospitality, and construction trades. This creates competition and often fractionalizes good talent, as there is a dire need for well-trained, employable laborers with specialized skills in many areas, including the manufacturing and engineering technology-based sectors. Economic development experts are now recognizing these challenges as having reached a critical point. This is reflective of market forces being insufficient in meeting such demands.

To this point, now more than ever, employers are growing more dependent upon providers of technical education and training in the engineering technologies. Data confirms engineering technology-based employers and educators are becoming more aligned as the manufacturing industry sectors grow ever hungrier for a technically skilled, safety-conscience workforce that can think critically, while also having a foundational understanding of industry operations, processes, and equipment. Additionally, this reinforces the notion that advanced skills are being sought to fill in-demand jobs ranging from management and quality assurance to directly creating new products by transforming materials through physical, chemical, or mechanical processes.

Employers have been seeking technically educated students with skills beyond the required technical aspects of the job for decades. Newman and Winston (2016) based an entire book on the premise that at one time, America was an industrial powerhouse, and today, the nation is on the verge of an industrial renaissance. The rising number of positions being vacated and generated is creating a critical concern that some have described as the onset of a labor epidemic. As the economy rebounds and the nation recovers from both a recession and global pandemic that caused a massive reduction in force across sectors, it has become clear that one of the heaviest hit industries was manufacturing (Newman & Winston, 2016).

Alignment is emerging though between the skills engineering technology-based firms are seeking and the federally funded technical skills development initiatives being made available. For example, common expectations from employers now mirror grant-funded job readiness programs that include competency-based applied learning, occupational-readiness skills, problem solving acumen, and higher-order reasoning. Economic development leaders and workforce practitioners are also more readily recommending and supporting industry and educational partnerships to leverage work-based learning opportunities for students so they can gain the practical skills and knowledge employers are seeking.

The American workforce and U.S. economy operate in a competitive, world market. Recognizing students within all levels of education and institutions could benefit from globally enriching learning experiences, educators are being encouraged to design unique, hands-on training experiences and career pathways that count toward the completion of a certificate or degree. They are further being challenged to expand the student experience to include career pathway exploration and to also increase the students' self-awareness and sense of civic purpose.

Additionally, the White House has implemented a strategy to revitalize domestic manufacturing and rebuild the nation's industrial base, creating and increasing the number of good-paying jobs and strengthening American supply chains. Likewise, President Biden signed the Bipartisan Infrastructure Law which has already proven successful in manufacturing semiconductors state-side as demanded by the automobile industry, as well as building out the Electric Vehicle (EV) charging infrastructure. In addition to driving companies to manufacture and produce more on American soil, the federal efforts are also hopeful of reducing costs and bolstering a cleaner energy economy.

Employers have been charged with looking internally at their current labor force to determine what skills the workers need to advance; in turn, opening more entry-level positions as incumbent workers progress through the ranks. The encouragement of leadership development and the creation of career paths for those aspiring to advancement or already actively involved in management is crucial to organizational success and workforce retention. Leaders within the businesses are also encouraged to model the behaviors and attitudes of professional learning, development, and loyalty. These are among the strongest resources for affecting change where teamwork and commitment to organizational goals and industry advancement are impacted by new competencies and enhanced learning.

Research derived from a recent workforce study on preparing for the future of work in such growth fields as aerospace and defense defines Employee Value Proposition (EVP) as a central element to workforce development practices in America (Feeko, 2021). EVP speaks directly to the perceived value that employees gain by working within a particular organization. Therefore, creating a compelling EVP presents a model for proactively and successfully attracting, recruiting, developing, and retaining quality, technical talent. Key recommendations for employers as illuminated in this study include:

Foster distinctive talent partnerships with students.

Building relationships with post-secondary institutions and trade schools enables industry leaders to play an active role in curriculum design, collaborative research, and student engagement, as well as heightening awareness of the manufacturer and their culture.

Develop a future-ready workforce.

Employers can impact the classroom by helping educators at all levels to integrate technology-centered lessons that showcase the relevance of both innovation and also interactive teamwork.

Create a strong value proposition.

Organizations that adopt and practice “humans at the center” philosophies are more likely to attract and retain top talent who understand the value of their contributions. This also helps the firm to achieve business objectives while creating a culture of loyalty.

Enhance the future of work experience.

The Human Resource office is invaluable to creating a successful workforce development strategy and a positive experience for employees. Consider offering rewards and incentives.

Provide a more equitable employee experience.

Though 66% of employer respondents report tracking Diversity Equity & Inclusion (DEI) metrics, DEI efforts should be holistic plans of actions that promise and demonstrate equity in experiences and opportunities across the organization, not just within the leadership representation.

WINNING THE BATTLE FOR TALENT: HOW A&D COMPANIES ARE BUILDING A DIFFERENTIATED EVP

Organizations are looks at providing a differentiated Employee Value Proposition (EVP) offering to attract and retain talent amidst strong competition.

The top three differentiated benefits provided are:

97% Recognition

94% Career development opportunities

94% Tuition reimbursement

Other top offerings included:

85% Flexible work arrangements

76% Overtime pay

70% Retirement

EMPLOYEE AND TALENT OUTLOOK

As the A&D industry evolves, re-skilling will be central to positioning the workforce to accomodate this evolution.

The top five areas of investment that companies are currently prioritizing in re-skilling are:

Leadership

55% of respondents

Engineering Skills

45% of respondents

Cybersecurity

42% of respondents

Digital Skills

33% of respondents

Manufacturing Skills

33% of respondents

Source: Feeko, 2021.

To obtain desired skill sets, workforce planning is critical to the future of the manufacturing industry. One extensive study (Aerospace Talent Survey, 2021), though, reported a large portion of survey respondents (38%) only complete workforce planning activities between six and twelve months into the future, which creates risk to a future-ready workforce. This, combined with university survey respondents who indicate they require, at times, up to five years to modify curricula to meet employer requirements, creates a disparity in timing. Additionally, data have highlighted the need to continue focusing on attracting younger talent into manufacturing, as studies suggest it could take anywhere from ten to twenty years to fully replace retiring employees.

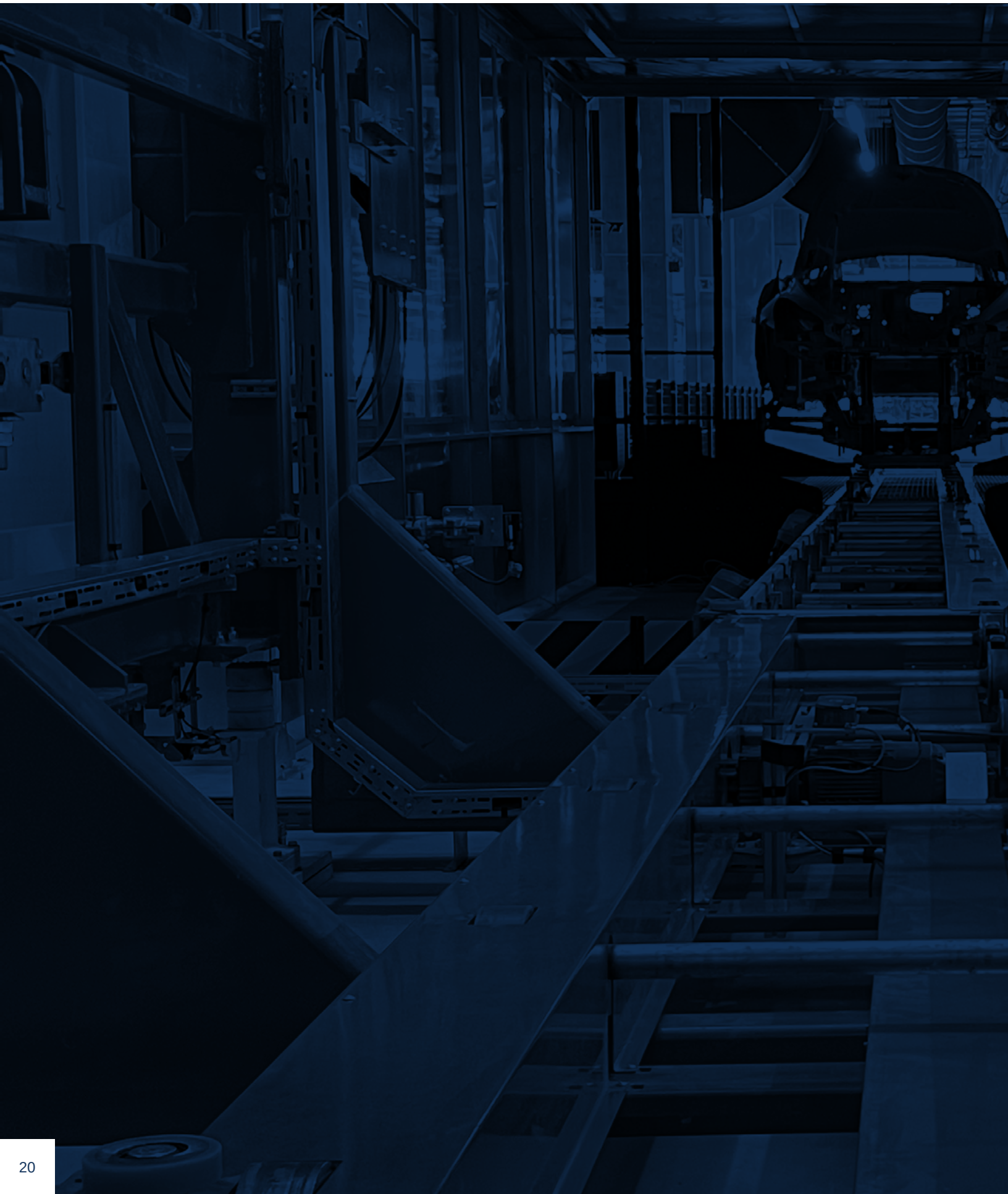
According to the Aerospace Talent Survey (2021), generational differences in career goals should also factor into talent attraction and workforce retention efforts. While millennials (ages 25 to 39) and Generation Z (ages 18 to 24) tend to value flexibility, job mobility, and experience with a sense of purposeful corporate social responsibility initiatives, studies reveal that the generation of baby-boomers generally values stability and tenure.

To best prepare current employees and future leaders for career growth and retention, many educational and training professionals are imploring manufacturers to accentuate the value of learning by establishing a culture and model of learning for new hires and the incumbent workforce. This is often encouraged directly within the production facility where new hires and incumbent workers are more capable of hands-on experiences within the actual work environment; better positioning them to both enhance their abilities and also strengthen organizational competitiveness through their own facilitated training and development experiences.

Relative to preparing and recruiting the workforce of the future, university survey respondents have reported that some advanced technical and engineering technology-based companies do an adequate job of communicating the desired and required skill sets. It should also be noted that many may be missing out on qualified talent when recruiting based solely on academic major. Post-secondary institutions are beginning to integrate new skills across majors; therefore, employers may wish to consider candidates from non-traditional areas of study as they also shift toward a skills-based recruiting approach. To this end, the Aerospace Talent Survey (2021) reported that campus career fairs remain effective, as well as recruitment efforts through student chapters of national organizations (e.g., Society of Women Engineers, National Society of Black Engineers).

The fact remains, there are population declines. Yet, there are increases in baby-boomer retirements. The departure of the graying and most skilled and experienced talent is creating additional pressure on the manufacturing industry.

The U.S. Department of Labor reported an alarming 2.1 million unfilled jobs by 2030, with 425,000 openings for machinists and tool and die makers alone (NAM, 2021). Just as the unemployment rate has fluctuated over the years, manufacturers across the U.S. will have to continue to innovate ways of attracting new talent.



BEST PRACTICES FROM LEADING INDUSTRIAL STATES

ARKANSAS

Arkansas diversified its manufacturing base by adding advanced manufacturing jobs, as the top industry sub-sectors coming out of the recession were food and beverage, paper, transportation, machinery, wood products, chemicals, plastics and rubber, and apparel. Today, metals, aerospace and defense, technology, firearms and ammunition, distribution and logistics, have been added to that list as key drivers.

When Big River Steel first opened in Mississippi County, Arkansas, in 2014, it was one of the largest industrial projects the state had ever witnessed. Recently, U.S. Steel Corp. announced it will locate a new $3 billion steel factory nearby, emerging as the largest capital investment project in Arkansas history (KATV, 2022). An article in Business Facilities (2022) stated the highly sustainable and technologically advanced steel mill, which will create 900 jobs with an average annual salary of $100,000, will be the most advanced in North America. The article further highlighted a food and beverage manufacturing boost in Arkansas as Hostess Brands, Inc. also revealed it will bring 150 new jobs in 2023 to a renovated factory, turned state-of-the-art bakery, further minimizing environmental impacts.

Coming out of the recession in 2013, Arkansas' labor force was projected to grow by 4% over the next two years (Crawford, 2013). Trade & Industry Development (March 2022) confirmed, today there are 78,000 more residents of Arkansas employed than there were seven years ago. Job postings will continue to rise. According to the Arkansas Economic Development Commission (AEDC) report, in 2021, more people moved into Arkansas than any other state in the nation, with 44% more people moving into Arkansas than moving out of state. By the end of 2021, the state was boasting a 3.4% unemployment rate; compared to an already impressive 4.6% at the beginning of the same year.

A number of training programs have been created and implemented, contributing to the success of Arkansas workforce development initiatives. Arkansas Economic Development Commission acknowledged their Future Fit program hosted 1,800 face-to-face meetings with Arkansas companies to evaluate workforce needs, resulting in the placement of qualified trainees into well-paying jobs. Employers are also leaning on the National Career Readiness Certificate program to identify applicants who meet job requirements and assessment metrics. The Arkansas Institute for Performance Excellence is another opportunity that permits public or privately held organizations in Arkansas to apply for Governor's Quality Award based training and consultation metrics. The Modern Workplace program links education and employers, providing local career opportunities and the skills needed to be successful in securing the jobs available. Additionally, North Arkansas College was the recipient of a $2 million EDA American Rescue Plan grant for expanding the school's robotics and manufacturing workforce training programs through the construction of the Center for Robotics & Manufacturing Innovation; a project that will be matched with $5.4 million in state and local funds (Moreau, 2022).

CALIFORNIA

Dating back to 2012, California has been hailed as a leader in job creation, with over 257,000 private-sector jobs created that year alone. It had low unemployment rates and was outpacing national averages with the Bureau of Labor Statistics illuminating the more than 1 million people who were employed in manufacturing positions. The National Association of Manufacturers (NAM) bragged on the state's high percentage of manufacturing workforce and total overall industry output reaching nearly $230 billion the year prior (Crawford, 2013).

Just four years later, California unseated Texas as the top manufacturing state. As George Brown College (2022) revealed, massive technology companies like Amazon, Microsoft, and Boeing Company were contributing to the rapid economic boom, as collectively, the largest manufacturers across the state were contributing more than $881 billion to the economy. Soitec, an international manufacturer of semiconductor materials and photovoltaic systems, was also well-established in their $150 million San Diego site.

Today, according to the National Association of Manufacturing website (NAM.org, 2022), California's total output from manufacturing is nearing $325 billion, and over 1.2 million employees are earning an average annual wage of $112,381 in this booming industry. The West Coast state, along with its neighbors, Oregon and Washington, serve as the gatekeepers for international trade with major ports supporting Asian and American trade relations.

Milken Institute recently published a study for the recovery, resilience, and recalibration of workforce strategies across California (Wang et. al., 2022). The importance of developing tailored regional plans emerged as being central to the long-term employment redevelopment solutions given the short-term talent shortages California is currently experiencing. One of the actions from the strategy list is to establish a model that cultivates regional competitiveness for the manufacturing industry; another is to integrate career technical education and employment programming throughout the statewide community college system. Given the demand for more advanced engineering technology-based and digital skills, leaders are also reviewing potential educational reform that will be necessary for reskilling and/or upskilling the current and future workforce. Also, when considering policy improvements, they believe consideration should be given to workforce development funding sources in addition to the local and state tax incentives that are offered to incoming businesses.

Further, to create jobs and generate economic activities that will build and sustain an innovation-driven economy, the study divulged that California leaders are designing a regional collaboration and partnership model to enhance community development. These investments, when properly implemented, should help the state and local municipalities to overcome budget shortfalls, while also improving unemployment woes (Wang et. al., 2022).

GEORGIA

Manufacturing is thriving in Georgia. Chemical and paper products, food and beverage, and transportation equipment are budding as the sectors in highest demand. The National Association of Manufacturers (2020) spotlighted the state for the more than 411,000 manufacturing employees in 2019 (or 89% of the total workforce) who earned an average annual wage of $71,500. Thanks to these efforts, Georgia produced an output of $64.57 billion in 2018. Site Selection magazine also took notice, announcing Georgia for a fifth straight year as the top state in which to do business (Trubey, 2017).

According to the state's Kia website (KiaGeorgia.org), Georgia has continued making a run for car plants, landing the only U.S.-based Kia plant which covers over 2,200 acres and produces 340,000 vehicles each year. In addition to investing in the manufacturing site, Kia teamed up with the Technical College System of Georgia (TCSG) for the Georgia Quick Start initiative through which they operate a training center. The Kia Georgia Training Center houses the necessary welding and electronics labs, classrooms, robotics, programmable logic controllers, and other equipment for training the over 2,700 Kia employees. Additionally, according to the Georgia Quick Start website, they are ranked as the nation's number one training program available at no cost to qualified companies (GeorgiaQuickstart.org, 2022).

This is just one demonstration of a successful workforce development strategy and initiative in the state. The TCSG also collaborates with the Georgia Tech Manufacturing Institute (GTMI) to successfully integrate the TCSG-GTMI Internship Program into the manufacturing workforce ecosystem. A consortium of college faculty incorporates 21st century learning, literacy, and life skills into technical training programs through which there are also two internships. The students are integrated into the entire manufacturing lifecycle and are expected to meet with clients, participate in the design, fabrication, and inspection processes, meeting with customers, and then be evaluated upon their work. The interns receive stipends and travel resources, as the program also respects their academic course schedules. The TCSG-GTMI Internship Program was one of the closely examined Georgia manufacturing workforce initiatives which was published in the research by Rumsey, et. al. (2019).

Another effective program within the Rumsey, et. al. (2019) manufacturing workforce study comes from the Center for Innovation for Manufacturing (COIM) and InVenture. They have established a summer program for K-12 students to use creativity in productive development to further build skills and change student and parent perceptions of manufacturing. COIM also sponsors an event for high schoolers to learn about both manufacturing and entrepreneurship. A similar event for college students implores them to pitch a concept and brainstorm with the high school students to develop solutions to real-world problems in the manufacturing business. Additionally, there is a program through which students explore coding and robotics.

The same research cited a Deloitte and Manufacturing Institute report which found while 80% of Americans view manufacturing as being vital to economic success, only 50% of the respondents believe manufacturing jobs are appropriate for them. Additionally, only 30% of those surveyed through Deloitte responded that they would recommend manufacturing jobs for their own children. Manufacturers' concerns centered on the workforce lacking advanced problem-solving and critical thinking skills. This led them to consider setting some Georgia-centric goals and expectations for the incoming manufacturing workforce. As industry leaders, collectively, they determined they must continue to address skills gaps concerns so Georgia can thrive in improving the perception of manufacturing among students, parents, teachers, and administrators, while also raising awareness of manufacturing in a manner that aligns students' skill sets with rewarding careers in this industry. There is also a committed focus on continuing to develop the technical skills and the 21st century skills that are required in the state's modern manufacturing careers.

INDIANA

A Conexus Indiana report (2022) publicized the highest concentration of manufacturing jobs in the U.S. are in Indiana. With more than 520,000 workers, representing 17.4% of all jobs (public and private), the manufacturing sector accounted for over 26% of the state's economic output in 2019 which totaled over $100 billion. This success is due, in part, to the combined traditional production and progressive technology model that has created an attractive environment for manufacturers. Additionally, the state's proximity, skilled workforce, and well-maintained infrastructure and transportation network make it an ideal location.

Top manufacturing sectors include metals, machinery, plastics and rubber, chemicals, computers and electronics, with automotive (parts and transportation equipment) being among the most dynamic of the sectors. More than 11% of all automobiles produced in the U.S. are made in Indiana, which is now home to more than 630 automotive companies. Three Japanese automotive companies have facilities in the state, and over the past two decades, automotive announcements have continued to be made in Indiana's favor. For example, Toyota Motor Manufacturing invested $131 million; Honda had a $40 million expansion project; and Greenville Technology added 325 new jobs in Anderson by opening a $21.37 million plant (Crawford, 2013)

According to recent U.S. Bureau of Labor Statistics data (2022), Indiana's labor force participation rate, 62.2%, continues to decline as evidenced by the 63.5% rate in 2015 and 64.4% in 2010. Though Indiana's seasonally adjusted unemployment rate is the lowest recorded since 1976 at 2.2% (compared to the national average of 3.8%), the population has also shown an increase of over 2%. That said, statewide private employment only increased by .7% in the past five years, but a Burning Glass report found a total of 212,000 open job postings in August 2021, which is an increase of more than 59,000 year-over-year (Conexus Indiana, 2022).

The Conexus report (2022) also exposed some widespread concern throughout the state relative to the number of students participating in secondary Career and Technical Education (CTE) courses. Primarily delivered through vocational career centers associated with high schools across Indiana, fewer than six out of every 100 high school students are enrolled in advanced manufacturing and logistics CTE programs. Specifically, only 19,020 students are currently enrolled or have recently completed at least one advanced manufacturing and logistics focused CTE course. Just 6,580 students have a concentration (currently defined as 2+ years of completed coursework) in advanced manufacturing or logistics.

Compare these numbers with estimated, rising job openings ranging from 36,200 to 56,900 in the sector, and it becomes clear that the high school CTE pipeline could be a much larger contributor to filling existing workforce gaps. As it stands, only 18% of the existing demand for workers could be met if all students with one of these concentration areas entered the workforce in these fields.

It's worth clarifying that high school based CTE programs would provide sufficient preparation for the majority of current openings in advanced manufacturing. According to information assimilated from the 2022 State of Indiana's Advanced Manufacturing Workforce survey, respondents reported that the positions most in demand are production and machine operators, and 77% of the posted positions require a high school degree, while 16.6% command a bachelor's degree or higher in engineering, IT, administration and leadership.

Also of great concern are the estimated 83,000 unfilled advanced manufacturing positions at the end of 2022. These will cost the state up to $6.8 billion in net losses for advanced manufacturers and tax revenue. (See graphic provided by Conexus, 2022.)

	Per Hour	Per Day	Per Month	Per Year
Cost of One Unfilled Position				
Lost Sales	-$273	-$2,185	-$45,526	-$546,313
Minus Savings from Reduced Wages and Materials				
Wages for Unfilled Position	$39.7	$317	$6,609	$79,312
Material Costs (Each Hour of Production Loss Reduces Material Costs)	$200	$1,597	$33,267	$399,208
Net Loss **(Net Loss = Lost Sales - Payroll Savings - Reduced materials Cost)**	**-$34**	**-$271**	**-$5,649**	**-$67,793**

What does the State lose in Taxes?

Personal Taxes				
Income Taxes 3.25%	-$1	-$10	-$215	-$2,578
Sales Tax Lost (Wages for Unfilled Position * 70% Estimated Discretionary Spending * 7% Sales Tax)	-$2	-$16	-$324	-$3,886
Total Personal Taxes	**-$3**	**-$26**	**-$539**	**-$6,464**
Corporate Taxes				
Corporate Sales Taxes (7% * Net Loss * In State Sales)	-$2	-$19	-$395	-$4,746
Corporate Income Tax (4.9% * Net Loss * In State Sales)	$0	-$2	-$50	-$598
Total Corporate Taxes	**-$3**	**-$21**	**-$445**	**-$5,343**

Detailed estimates of the cost of one unfilled position. Conexus. 2022.

KANSAS

As of November 2012, nearly 60% of the Kansas workforce was employed within the manufacturing industry (Crawford, 2013). At that time, advanced manufacturing - predominantly aviation and aerospace – were recognized as a major factor in the Kansas economy. In an article published in the Wichita Eagle (2011), more than 40% of the world's general aviation aircrafts have been produced in Wichita.

Bioscience was emerging with an animal health and nutrition corridor running through central Kansas and employing 16,000 people who were working in the biosciences (Crawford, 2013). Major employers and research centers were conducting cutting-edge research and innovations. Hill's Pet Nutrition (2012) confirmed the corridor accounted for nearly one-third of the more than $19 billion global world sales in the animal health market. Coming out of the Great Recession, timing seemed perfect, as the Kansas Bioscience Authority announced in 2013 a $580 million investment to further support R&D in this field and to accelerate cluster growth and commercialization (Crawford, 2013).

The Kansas Reflector (Carpenter, 2022) described a recently assembled Kansas economic incentive toolkit valued at over $829 million which led to an investment of $4 billion by Panasonic who will develop the world's largest vehicle battery manufacturing plant. The 3 million square-foot manufacturing plant to be located in De Soto, Kansas, is estimated to deliver an annual, statewide economic benefit of about $2.5 billion, generating 4,000 direct jobs with an average wage of $30 an hour (Magill, 2022). Approximately 80% of the jobs at the De Soto site will be devoted to production, with 20% of the jobs being white-collar positions. It will further foster nearly 3,800 supplemental jobs in the region. It should be noted, one of Panasonic's key business partners is Tesla Motors, as Tesla is a leader in lithium-ion battery powered vehicles with their manufacturing plant in Austin, Texas. Together, the two conglomerates already operate a battery manufacturing plant near Reno, Nevada, called a Gigafactory, where they have already shipped out more than 6 billion EV battery cells (Magill, 2022).

In order to attract Panasonic to Kansas, the Kansas Legislature and state administration crafted a competitive incentive portfolio called APEX: Attracting Powerful Economic Expansion. Within it, Kansas will pay 10% of Panasonic's total state payroll in for five years, also offering Panasonic $234 million in payroll rebates, a sales tax exemption of up to $60.2 million, and a $25 million pledge specifically for workforce education and training programs including an additional $10 million to support talent relocation to Kansas (Carpenter, 2022).

KENTUCKY

According to the Team Kentucky Cabinet for Economic Development (2022), manufacturers in the Commonwealth have announced over 1,100 facility location or expansion projects, nearly 39,000 additional jobs, and a capital investment that exceeds $21 billion – and that's just been in the past five years. To date, over 260,000 Kentuckians work in one of the more than 4,500 manufacturing facilities, and economic momentum continues to build as the Commonwealth resiliently rebounds from the effects of the pandemic.

In 2021, a record $11.2 billion in total planned investment and commitments were announced by Governor Beshear which would create more than 18,000 full-time jobs. The incentivized $24 hourly wage for these projects increased by 9.4% over the previous year. Further, Ford Motor Co. (2021) announced Hardin County, Kentucky as the recipient of a transformative $5.8 billion investment through which they (Ford) and SK Innovation expect to create 5,000 jobs. Another $2 billion investment was announced on the Warren County website to create 2,000 jobs thanks to Envision AESC. Together, these projects elevated Kentucky as an EV battery producer in the U.S.

Ten years ago, manufacturing was recognized as Kentucky's third-largest employment sector; a statistic that has remained consistent over the years. According to Kentucky.gov, the state's manufacturing sector employment has seen a 13.9% boost in the past 10 years. Further, the Commonwealth has increased jobs by 2.9% over the past year (2021), gaining 6,900 jobs for a total of 242,400 positions.

MICHIGAN

Former Michigan Governor Rick Snyder once said, "Michigan is a leader in making things and making things work" (Crawford, 2013). Michigan has long been a world-leader in manufacturing, research & development (R&D), engineering, and a skilled workforce. These advantages along with bold reforms made years ago continue to generate new opportunities for manufacturers in the state.

Witnessing a 32.4% employment growth in manufacturing since 2009, and coming out of the recession in 2012, the durable goods manufacturing output in Michigan increased 41% in just two years, reaching a value of $55.9 billion (Haglund, 2012). Several manufacturing industries have contributed to the resurgence, but in Michigan, automotive manufacturing dominated with over 370 vehicle-related R&D and technical centers (Friedeberg, 2015). The automotive portfolio included research, product development, and production facilities for eight of the ten largest original equipment manufacturers, as well as a vast network of automotive suppliers. During the timespan when automotive manufacturing was booming, Area Development (2012) disclosed Chrysler would invest $240 million in three sites and hire 1,250 new employees. Additionally, Ford invested $773 million in six plants, and General Motors created 1,500 new jobs by opening an innovation center (Szczesny, 2012).

Fast forward to 2022, and Ultium Cells, a joint venture of General Motors and LG Energy Solution, have announced a $2.6 billion investment to build a 2.8 million-square-foot battery cell manufacturing plant in Lansing generating 1,700 new manufacturing jobs (GM.com, 2022). This is in addition to the more than 14,000 other manufacturing establishments.

Over 600,000 workers are employed in the manufacturing cluster in Michigan, with three in ten of all manufacturing workers in the subcluster of auto manufacturing. Michigan's automotive industry actually represents 22% of the U.S. automotive industry workforce. In a 2007 Michigan senate report, it was noted that one-fifth of all automotive manufacturing was in this state. Michigan produces 23% of all U.S. vehicles, and 70% of all U.S. auto-related research dollars are invested in Michigan. The Greater Grand Rapids region alone has over 2,500 manufacturers, producing more than $6.3 billion in annual exports. Saginaw County's key industries are also automotive and advanced manufacturing, and Macomb County manufacturers produce an average of $8.6 billion in goods annually, employing 66,000 people in the manufacturing industry.

Additionally, Michigan boasts a top ranking nationally in concentration of industrial designers and engineers. In 2019, the Michigan Economic Development Corporation (MEDC) completed a comprehensive strategic planning process focused on regional impact industries that could create long-

term economic opportunities for the state. As part of this process MEDC identified six industry clusters, including Engineering, Design, and Development (EDD), that showed significant competitive advantage based on their alignment with statewide assets, current economic activity, and projected growth.

Michigan's EDD industry plays a significant role in the state's economy and advancement related to Industry 4.0. Understanding the components of this industry cluster, related value chains, and statewide resources will position the state for strategy, collaboration, and deliberate action to strengthen the EDD ecosystem for global competition. Michigan's EDD industry is built on a long history of innovation and talent development supported by the state's high-quality education and research institutions. Opportunity to develop and retain EDD talent has long been supported by world-class manufacturing and engineering operations that consistently maintain a global presence alongside worldwide companies.

As the EDD sector evolves there are emerging opportunities to leverage public and private investment including venture capital networks and non-dilutive funding streams that prioritize investment based on national and global competition. Well-developed plans are critical to growing, diversifying, and sustaining emerging industry sectors that promise increased valuation when combined with calculated long-term strategy.

Recent research (Research, Engineering, & Design, 2021a) has revealed the six-county Detroit MSA, with a Location Quotient of 2.95, has the largest concentration of engineering talent with 92,865 Engineers & Technicians, the second highest among all U.S. metros. Each year, the University Research Corridor invests $2 billion in new R&D activity, and the private sector invests a total of $19 billion. Job growth in the area is forecasted to exceed the New York & Los Angeles markets.

OHIO

The World Economic Forum 2021 Annual Report (2022) profiled Ohio as the third ranking manufacturing state in America for both total manufacturing employees and total annual payroll. Accounting for more than 650,000 jobs for Ohioans and an annual payroll of $42 billion, manufacturing touts the highest total annual wages of any Ohio industry sector. This is especially impressive when considering nearly 50% of Ohio manufacturing firms employ fewer than 10 people, while 0.4% of firms employ 1,000 or more people (OMA, 2022).

Calling out advanced manufacturing as a central pillar of the state's $745 billion economy, Ohio was also recognized by The World Economic Forum (2022) for driving advanced manufacturing-centered partnerships (e.g., Ohio Manufacturers Association, Additive Manufacturing Cluster of Ohio, Smart Manufacturing Cluster of Northeast Ohio). In 2020, Ohio's manufacturing sector GDP was $105.3 billion with $45 billion in exported products going to 209 countries and territories. (OMA, 2022).

Coming out of the Great Recession, Ohio was in the national spotlight for the resurgence of manufacturing as well as the economic prosperity and jobs the industry was creating for Ohioans. Even during such a bleak period in the nation's history, the U.S. Bureau of Labor Statistics reported massive gains in Ohio's job growth (50,000) and output ($8 billion). At that time, the most prominent manufacturing sectors were in transportation equipment, food manufacturing, plastics and polymers, chemicals, structural steel, and fabricated metals (Crawford, 2013). Today, Ohio continues to be powered by manufacturing and has continued receiving recognition as a trending hot spot for the industry.

Modern manufacturers are selecting Ohio for the combined technology and tenacity that the workforce within the state brings. For example, Intel chose Ohio for their new, $20 billion mega-fab project which will create a robust semiconductor ecosystem throughout the state and region. Ford recently announced an electric commercial vehicle factory near Cleveland which will garner 1,800 new jobs; plus, they are also expanding in Lima and Sharonville. (Krisher, 2022). GE Aviation Systems employs about 6,500 workers in Cincinnati, where the city is home to over 1,100 other manufacturing companies. First Solar chose Perrysburg for operating the largest vertically integrated solar manufacturing complex in the nation. President Biden recently visited Hamilton, Ohio for the Additive Manufacturing Forward initiative which was designed to align U.S.-based suppliers with large manufacturers to strengthen supply chains through 3D printing. Already committed to the project are manufacturing giants, United Performance Metals, GE Aviation, Honeywell, Lockheed Martin, Raytheon and Siemens Energy (Landis, A. & Taylor, L. 2022).

Like other states, the greatest constraint to industry growth in Ohio continues to be the disparity between the number of available jobs in manufacturing and the number of qualified applicants for them. According to Ohio Manufacturing Counts (OMA, 2022), root causes in this gap include the ripple effects of the global COVID-19 pandemic, a decreasing population, and the retirement of the baby boomer generation. Additionally, misperceptions continue to linger about manufacturing, creating aggressive recruitment from competing industry sectors. Likewise, rapid advancements in industrial technology have exacerbated a misalignment between educational curriculum, instructor capacity, and state-of- the-art equipment.

One of the most prominent and promising solutions for addressing workforce development challenges within the state is the industry sector partnership model. According to the National Skills Coalition, industry sector partnerships bring together multiple employers within an industry to collaborate with colleges, schools, labor, workforce agencies, community organizations and other community stakeholders to align training with the skills needed for that industry to grow and compete. The Ohio Manufacturers' Association supports a network of endorsed industry sector partnerships throughout Ohio that are implementing statewide earn-and-learn models, building talent pipelines using career pathways and credentials, developing career coaching toolkits, and building capacity to provide supportive services. These efforts are also aligned with the state's public workforce development system and are working to establish a clear, statewide manufacturing workforce development alignment system (OMA, 2021).

PENNSYLVANIA

Pennsylvania's manufacturing companies were leading the state's economic resurgence following the Great Recession. With gross state product (GSP) exceeding $70 billion in 2012 and $93.75 billion in 2018, Pennsylvania manufacturers accounted for more than 12% of the state's GSP, and productivity was on the rise as companies began to adopt process innovations and accept new technologies, including automation and additive manufacturing (Crawford, 2013).

Spring forward to 2020, and according to a report produced by the National Association of Manufacturers (NAM), manufacturers in Pennsylvania accounted for 11.89% of the total output in the commonwealth, employing 9.33% of the workforce. Additionally, as confirmed by Governor Wolf (2019), there were approximately 565,000 manufacturing employees in Pennsylvania, with an average annual compensation of $75,948.

While the top manufacturing sector for job growth in 2019 was Pharmaceutical and Medicine at 28%, followed by Navigational, Measuring, Electromedical and Control Instruments at 8%, Pennsylvania has prided itself over the years for its highly diversified economy with no single industry accounting for more than 5% of the total number of businesses in the commonwealth. The National Association of Manufacturers (NAM) 2020 Pennsylvania Manufacturing Facts report further elaborated upon key sectors such as transportation, metal machining and fabrication, glass, chemicals, and plastics have all positioned themselves to further support growth in emerging markets such as energy, medical devices, and life sciences.

Twenty years ago, Pennsylvania's government passed legislation called The Small Business Regulatory Reform Act to reduce costly mandates and clunky processes for small businesses. This was in part to create a business climate where smaller manufacturers could prosper and create more jobs for the citizens of Pennsylvania. At that time, manufacturing was already adding more than $70 billion annually to the commonwealth's economy and employing over 570,000 residents.

Today, business-ready sites are being designed to stimulate family-sustaining jobs and improve the attraction of other manufacturers to the area. Governor Wolf recently confirmed (July 2022) that his administration approved nine projects to receive grants and loans totaling more than $48 million through the Commonwealth Financing Authority to bolster economic development across the state. As validated by the 2022 Pennsylvania Business Report, among those projects are a manufacturing center and an innovation campus at the airport.

TEXAS

In a 2022 report by George Brown College highlighting the top 10 manufacturing states, Texas emerged as the second largest manufacturing state in America. The governor's office highlights Texas as boasting over 25,000 manufacturing companies which account for 10% of the nation's 2019 manufacturing GDP. (See graphic.) Once thought to be just an oil and gas state, Texas manufacturers recognize the oil and gas production technologies introduced over the years have benefited their industry which relies heavily on natural gas as an energy source.

With over 1.2 million manufacturing workers (up from the over 900,000 reported by the governor's office in 2019), Texas has continued to diversify the economy, witnessing an escalation in the aerospace and aviation, digital technology, and biotechnology industries. Houston alone employs over 250,000 people in these manufacturing and engineering technology-based industries with over 3,500 companies calling the city home.

Texas has an incredibly diverse manufacturing economy. Our State's resources make it a natural leader in petroleum and chemical manufacturing. Texas' research institutions have fostered computer and other high-tech manufacturing and its business-friendly environment and skilled labor have nurtured a burgeoning automotive manufacturing sector.

TEXAS MANUFACTURING ACCOUNTED FOR 10% OF U.S. MANUFACTURING GDP IN 2019.

TEXAS IS SECOND IN THE NATION FOR NUMBER OF MANUFACTURING FIRMS WITH

25,401

COMPANIES

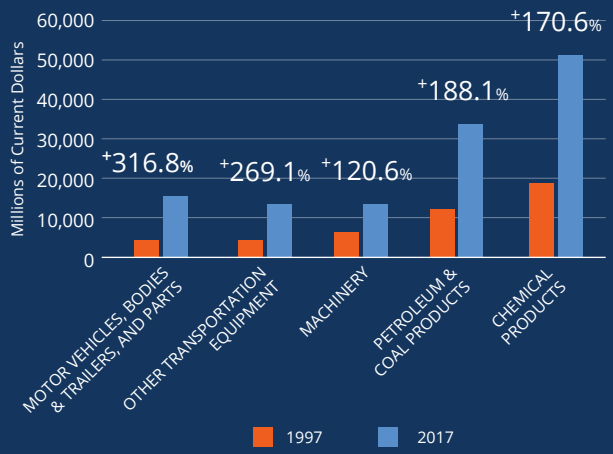
IN 2019 THE STATE EXPORTED

$243.9B

IN MANUFACTURED GOODS

TEXAS IS THE TOP TECH EXPORTING STATE FOR THE 7TH YEAR IN A ROW

Largest Manufacturing Subsectors in Texas by GDP: Growth from 1997 - 2017



TEXAS COMPANIES DOMINATE THE LIST OF

AMERICA'S 500 LARGEST

PUBLIC MANUFACTURING COMPANIES

IN 2019, TEXAS' MANUFACTURING INDUSTRY DIRECTLY EMPLOYED

917,800

Source: Office of Govenor Greg Abbott, Economic Development & Tourism, www.gov.texas.gov/business

According to the Central Texas Manufacturing Workforce Study (2017), 46% of manufacturers and 67% of staffing firms reported workforce retention as a top obstacle. About half of the respondents cited retirement as a talent turnover challenge, and many expressed recruitment concerns which closely mimicked their retention woes, including cost of living/wage pressure; working conditions; low unemployment/tight job market/competition for workers; worker eagerness for advancement; cultural fit; and soft skills.

Hiring hurdles were also expressed which included in-house training capacity, identification of appropriate curriculum/training materials, and reluctancy to pay for onboarding with high turnover patterns and time lost during the onboarding period. The same manufacturers explored solutions to building a talent pipeline; thus, identifying, a manufacturing workforce partnership, a manufacturing careers campaign to increase awareness, and a short-term certification program which would prepare entry-level workers. They are also committed to advancing policy changes and exploring apprenticeship opportunities for hard-to-hire positions.

Workforce challenges must continue to be addressed as manufacturing does not seem to be slowing down in Texas. In 2013, the state leveraged the Texas Enterprise Fund (TEF) to attract advanced technology companies like Caterpillar and Samsung. The TEF initiative was the largest of its kind in the country (Crawford, 2013), and today, Samsung has announced on KXAN.com (2022) that they anticipate bringing at least 10,000 new jobs to Texas, as they also invest another $192.1 billion in the form of additional semiconductor chipmaking plants. Two new facilities will be added to the Austin campus, with nine more coming to the Taylor site. The current Taylor-based site is offering internships to high schoolers with hopes of encouraging the students to continue pursuing post-secondary education and remaining in or returning to the community. Additionally, according to Samsung.com (2022), a Samsung Skills Center for the Taylor Independent School District will be created to help students develop skills for future careers.

Celebrating 25 years of manufacturing semiconductors in America, Samsung has expressed a commitment to continue making advanced semiconductor fabrication more accessible while meeting surging demand for advanced logic semiconductor products. At the Texas sites, they will manufacture products using advanced process technologies like artificial intelligence (AI), and mobile, 5G, high-performance computing (HPC). By expanding their manufacturing capacity, they will contribute to the stability of the global semiconductor supply chain while advancing local training and talent development. Samsung chose to invest further in the two Texas sites because of the proximity to the established sites and semiconductor ecosystem, as well as the stability of the infrastructure and local government support (Samsung.com, 2022).

OPPORTUNITY FOR MANUFACTURING GROWTH IN MARYLAND

THE FUTURE LOOKS BRIGHT FOR MARYLAND'S MANUFACTURING SECTOR AS THE REGION OFFERS THE RICH RESOURCES AND SKILLED WORKFORCE THAT HAVE ATTRACTED SOME OF THE TOP INDUSTRIAL PRODUCERS IN THE COUNTRY.

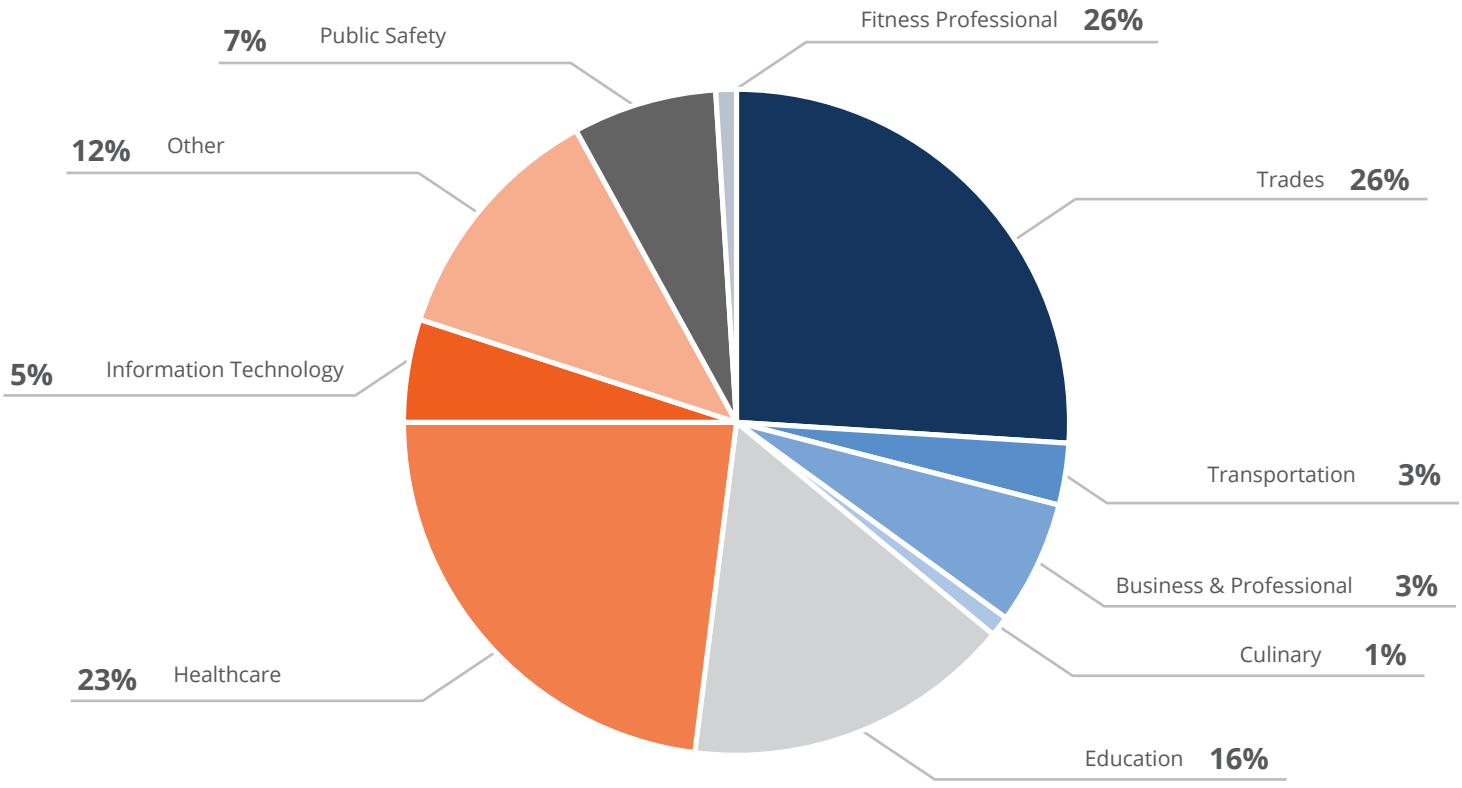
Dating back to the late 1800's, the world's top spice manufacturer, McCormick, was started in Baltimore and has since growth sales across 150 countries and territories to a $5.35 billion business. Fast forward to 2018, and another household brand, and the world's largest producer of alcoholic beverages, Guinness, opened the company's sole brewery in the U.S. in Baltimore County (Maryland Manual Online, 2022). Also add to the list leading defense contractors Lockheed Martin and Northrop Grumman; technology guru IBM; pharmaceutical and biotech companies Bayer and MedImmune; sports apparel giant, Under Armour; and one of the largest conglomerates in the world, GE. Further testament to the quality and standard of the workforce and products being manufactured in Maryland, the state received over $2.5 billion in federal contracts for manufactured products, up from $2.4 billion in 2019.

Perhaps it goes without saying, manufacturing is a vital part of Maryland's economy, contributing $25.4 billion in 2020 and $27.6 billion in 2021 to the state's Gross Domestic Product (GDP). Growth in recent years can also be tracked through the $9.74 billion in exports (2019). Additionally, the Maryland government's online resource, Maryland Manual (2022), reported the state boasts over 4,000 industrial stateside operations that provide jobs for over 190,000 people and wages worth $9.26 billion. When quantifying and ranking sector-specific employment, the manufacturing of computer and electronic products industry (20,134 jobs) rises to the top of the list, followed by food manufacturing (17,008 jobs), chemical manufacturing (13,807 jobs), and fabricated metal products (7,879 jobs).

The Maryland community college system, comprised of 16 community colleges, plays a critical role in the state's workforce development efforts. An active, college-represented consortia is the Maryland Community College Association for Continuing Education and Training (MCCACET), which develops strategies to meet regional and statewide workforce needs. Collectively, they advocate on behalf of continuing education and workforce development; designing and implementing curriculum and training programs to prepare and upskill the pipeline of technical talent – both incumbent workers and job seekers.

In the most recent MCCACET fiscal report (2020), it was conveyed that over 38,000 students participated in one or more of the 175 courses offered by the community colleges. Offerings include licensure, certification, or an industry credential. The largest number of students were reportedly in trades-based programming (including manufacturing) with 9,872 students enrolled, plus another 3% completed transportation-specific courses. (See graphic provided from the MCCACET FY20 report.)

STUDENT HEADCOUNT PERCENTAGE BY CATEGORY



(Source: MCCACET FY20 report)

OPPORTUNITY FOR MANUFACTURING GROWTH IN MISSOURI

ACCORDING TO MISSOURI ECONOMIC RESEARCH AND INFORMATION CENTER (MERIC), AS OF 2020, MANUFACTURING IS A MAJOR COMPONENT OF MISSOURI'S $321.7 BILLION ECONOMY; ACCOUNTING FOR 11.7% OF THE STATE'S PRIVATE SECTOR EMPLOYMENT AND 11.8% OR $37.97 BILLION OF THE 2020 TOTAL GROSS STATE PRODUCT (GSP).

With 266,439 jobs across 6,864 established manufacturing facilities, the industry has also added 5,111 jobs since 2015, growing 0.39% per year over five years. The Missouri Manufacturing Industries report (2021) also confirmed wages continue to grow statewide and nationally, as the state's 2020 manufacturing payroll totaled $16.48 billion, with a $61,842 average annual wage, which is higher than the state's $54,776 average wage for all private sector industries.

Performing below the national compound annual growth rate (CAGR) of 1.3% over the past five years, Missouri's manufacturing GSP averaged -0.7%. In 2020, employment in this sector declined by 10,665; whereas manufacturing employment nationwide declined by 693,046 when compared to 2019. State manufacturing industry reports indicate manufacturing exports recently totaled nearly $12.8 billion dollars which are also down from roughly $13.4 billion in 2019 and $14.5 billion in 2018. Of the top 10 exports, Computer and Electronic Products revealed the most significant state weakening, falling from $742 million in 2019 to $613 million in 2020. Nonetheless, there were also some gains with Food Products rising by 8.1% in 2020 and the highest industry exports being reported as Transportation Equipment and Chemical manufacturing (Mo.gov, 2021).

Challenges throughout Missouri and the U.S. are in part due to the impact of the COVID-19 pandemic, but the state is proving to be resilient. According to the Missouri Partnership's annual report (2021-2022), manufacturers in Missouri have created 16 new facility projects adding nearly 1,500 additional jobs and accumulating $93 million in new payroll with capital investments totally $1.2 billion over the past year.

A recent announcement was also made by the Missouri Partnership indicating Meta, formally known as the Facebook company, is building its newest hyperscale data center in Kansas City, Missouri. The new data center is the first of its kind in Missouri. Meta is investing more than $800 million and supporting up to 100 jobs in the region. The nearly 1 million square-foot data center will be located in the Golden Plains Technology Park. It will be supported by 100% renewable energy and will be one of the most sustainable data centers in the world.

An announcement was also made by Ford regarding their plant near Kansas City, as a third shift is being added to meet the increased demands of the electric and combustion-engine Transit vans they manufacture there. This will net the region an additional 1,100 new jobs (Krisher, 2022).

EMERGING TECHNOLOGIES AND ADVANCED MANUFACTURING INDUSTRY INSIGHTS

VARIOUS TECHNOLOGIES, INCLUDING ROBOTICS, COMPUTERS, AND ARTIFICIAL INTELLIGENCE, HAVE HAD AN INCREASING IMPACT ON EMPLOYMENT AND THE NATURE OF WORK FOR YEARS, AND THAT IMPACT WILL CONTINUE TO GROW IN COMING YEARS.

The effect of artificial intelligence is likely to be especially significant. Likewise, emerging technologies within America's hotbed of advanced manufacturers include Aerospace & Defense, Semiconductor Chips, Robotics, and Electronic Vehicles (EV) and EV Batteries. These influences on economies, employment, and the nature of work are far-reaching. They are demanding a revolution of advanced skilled trades and emerging work trends while also empowering the national and global workforce and bolstering the economy.

Because knowledge increases as it is shared and exercised, and because much of this sharing occurs in communities, leaders of cities and counties have an important role in facilitating the knowledge economy. According to a publication by LaFayette et al. (2019) the transformation to a knowledge economy can create insurmountable barriers for lower-income individuals – especially those in rural America. Relevant knowledge is essential to survive and thrive in the knowledge-driven economy, but knowledge can be difficult to obtain for an individual with limited skills who may be working multiple,

low-wage jobs in order to make ends meet. If this challenge is not addressed, the result could be an increasing number of individuals falling behind and a further widening of the wage gap and workforce crisis.

One McKinsey Global Institute study found that wages at the beginning of the Industrial Revolution stagnated for several decades. To mitigate this impact, investments in educational and training programs, along with the wrap-around services that make them accessible, are vital. Thoughtfully designed, proactive, and authentic national and statewide strategies help retain people and their skills while also helping to attract new talent. The continuing shift to a knowledge economy will continue to impact work in the emerging and advanced sectors of manufacturing.

Concerns have been widely raised that the spread of artificial intelligence, high-speed mobile internet, big data, and cloud computing will result in massive unemployment in many sectors. However, a recent report from the World Economic Forum's Centre for the New Economy and Society (2018) predicts a net growth in the number of jobs as a result of the spread of the knowledge economy in the relatively near term. However, that net growth will be accompanied by both job creation and destruction as well as an estimated 59% of the workforce that will require some level of reskilling over the next five years. This points to a compelling need to direct resources for innovation and creative learning to help the labor force adapt to emerging technologies, and a need for workers to commit to ongoing upskilling to prevent their skills from becoming obsolete.

To this end, in this section, we will briefly highlight Aerospace & Defense, Semi-conductor Chips, Robotics, and Electronic Vehicles (EV) and EV Batteries and the pervasive impact they are having on the national economy and on the future of the workforce in America.

AEROSPACE & DEFENSE

The aerospace and defense (A&D) industry has witnessed persistent workforce trends with negative impacts amid the COVID-19 pandemic's economic fallout; yet, government defense spending remains stable and national security requirements continue to evolve. Given the technological trends in expanded unmanned capabilities, advances in hypersonic technology, and investments in cyber resiliency, the commercial aerospace market requires a dynamic workforce with enhanced digital skills. The A&D industry represents a dynamic workforce composed of many types of workers. These workers span a wide range of skill sets, from skilled trade technicians to space scientists, engineers to accountants, with many becoming more digitally focused. It is critical that all acquire an acumen for engineering knowledge, particularly in software fields.

In the 2021 Aerospace Talent Survey , companies representing the breadth of the A&D industry, including the supply chain, integrators, and prime contractors, addressed key workforce challenges and provided recommendation for seizing opportunities to continue to maintain the vitality of the A&D industry workforce. (See graphic.)

As a best practice illustration, Boeing's operations in Alabama span a variety of research, design and manufacturing activities; contributing over $2.7 billion annually to Alabama's economy; and over 9,400 direct and indirect jobs in its sprawling operations and support network (Azok, 2022). The high caliber of Alabama workers reflects the state's investment in workforce training. For example, Alabama Industrial Development Training (AIDT) services are free for employers or trainees. The Alabama Technology Network of the Alabama Community College System also works closely with companies to provide the skill sets they need.

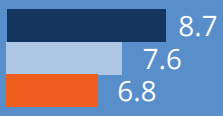
AEROSPACE AND DEFENCE (A&D) WORKFORCE STUDY

The survey respondents represent a total global headcount of over 950,000 employees, with 370,000 employees with security clearance globally and more than 130,000 veterans in the US across all the organizations that participated.

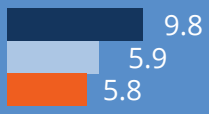
OVERVIEW OF A&D WORKFORCE DEMOGRAPHIC TRENDS IN THE US.

Trend data is critical to effectively manage the A&D workforce in the US for the companies surveyed.

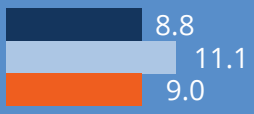
% workforce - Women



% workforce - Hispanic

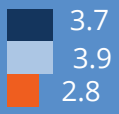


% workforce - Black

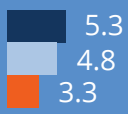


% workforce - Asian

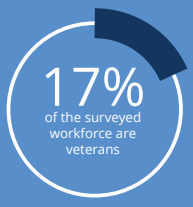
% Executives - Women



% Executives - Hispanic



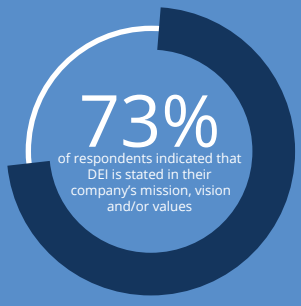
% Executives - Black

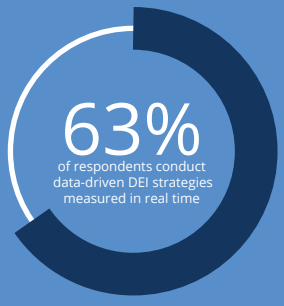


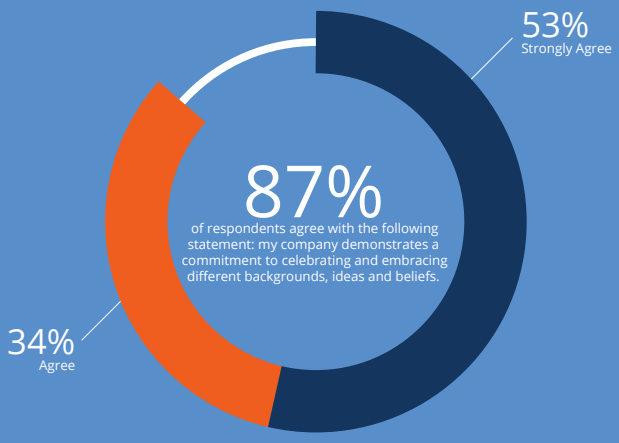
Historical data is from a separate survey. As a result, it is directionally informative. We expect to utlilize this year's data to serve as a solid foundation for trend data going forward.

Diversity, equity and inclusion (DEI)

Organizations are increasingly focused on their DEI agenda, including improving their DEI metrics, investing in different initiatives and expanding their outreach.







Source: Feeko, 2021.

SEMICONDUCTOR CHIPS

Prior to the widespread global semiconductor shortage experienced primarily since the COVID-19 pandemic, many people throughout the U.S. may not have been familiar with chip production and innovations in domestic chip manufacturing, research, or design. We have since learned about the quarter-sized piece of silicon that enables smartphones, wireless networks, coffee machines, automobiles, medical devices, and gaming applications. The chip shortage increased awareness not just in daily conveniences but also in semiconductor supply chains from coast to coast, even commanding the attention of national leadership and urging Senate and House approvals to help fortify the demand. This is not a new industry for the U.S. though. Dating back to the late 1990s, America has been leading the global semiconductor industry with nearly 50% of the sales market share.

The Semiconductor Industry Association produced a report (2022) that illuminates the 277,000 direct jobs the semiconductor industry provides on U.S. soil. The American workforce is made up of semiconductor designers, manufacturers, testers, and researchers. That multiplies when taking into account the additional 1.6 million other indirect or induced jobs the industry supports in the U.S. economy. Globally, an estimated $3 trillion in global GDP is reported to have been directly attributed to semiconductor innovation. The world has also seen an indirect impact valued at $11 trillion. Domestically, semiconductors make up the fourth-highest ranking export for the U.S.

SEMICONDUCTORS ARE ONE OF AMERICA'S TOP EXPORTS.

U.S. exports of semiconductors totaled $49 billion in 2020, fourth-highest among U.S. exports behind only airplanes, refined oil and crude oil. This consistently high level has been due to the fact that over 80% of semiconductors sold today are sold outside of the U.S. market.

While those in the semiconductor production business have maintained their U.S. manufacturing base, there has been a slow yet steady decline over the past 8 years.

Aircraft

$72B

Refined Oil

$65B

Crude Oil

$50B

Semiconductors

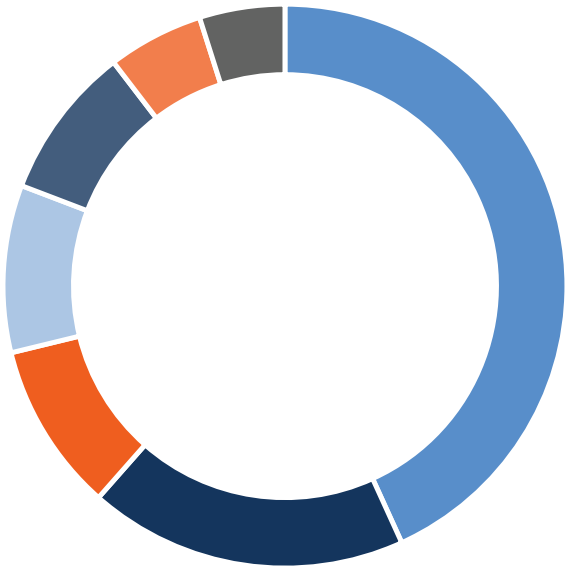
$49B

Source: Semiconductor Industry Association, 2022

The semiconductor industry is represented throughout 49 states across the nation. Various states across the country have been in the news recently for achieving success in the semiconductor industry. This comes after an unforeseen demand for semiconductors skyrocketed during the pandemic response. Texans learned of at least 10,000 new jobs coming to their state as Samsung announced a $192.1 billion investment in expanding their semiconductor chipmaking plant footprint (Samsung.com, 2022). California has landed international semiconductor materials manufacturer, Soitec, as well as technology icons that contribute over $881 billion to the west coast state (George Brown College, 2022). Ohio is celebrating Intel's $20 billion initial investment in two chip factories that will increase chip production and help bridge the advanced semiconductor gap. (JobsOhio, 2022).

While the semiconductor industry has been in the spotlight, it also faces challenges. American manufacturers have experienced peaks and valleys over the years, and the country will continue to compete with global industrial titans. This is due in part to the rapid advances in technologies like semiconductor chips. Therefore, our national industry leaders must continue to work harmoniously to maintain and protect America's foothold as a trailblazer in this foundational, indispensable technology. According to the Semiconductor Industry Association (2022), a strong domestic semiconductor industry with strong manufacturing capabilities combined with a competitive domestic workforce is essential for the U.S. to continue to thrive in this space.

PERCENT OF U.S. SEMICONDUCTOR MANUFACTURERS' CHIP-WAFER CAPACITY BY LOCATION



US	43.2%
Singapore	18.3%
Taiwan	9.7%
Europe	9.6%
Japan	8.8%
China	5.5%
All Others	4.9%

Source: Semiconductor Industry Association, 2022

ROBOTICS

As manufacturing progresses with technology, and with advances in artificial intelligence and computerization, robotics will play an even larger role in the manufacturing workforce. The use of robots in industrial production has grown in prominence since the 1990s. The implementation of automation through robotics will likely continue to impact most advanced industrial economies including manufacturing in America. This also creates widespread effects on training and education as the workforce is prepared to operate in an automated environment.

Research conducted by the Federal Reserve Bank of St. Louis (2019) reported the largest global user of robots is the automotive industry. When comparing the ratio of robots to workers in the automotive industry to those in all other manufacturing industries combined, it was found that the American automobile industry employs 136 robots per 1,000 workers (comparable to France and Germany's utilization of robotics), with other U.S.-based manufacturing industries relying upon only 8.6 robots per 1,000 workers.

In research conducted by the Rand Corporation (2020), three primary questions were addressed regarding robots in advanced manufacturing. The first question was centered around the economic context of manufacturing using robotics. The second inquiry involved whether modern education and training programs are preparing people to work with robots in manufacturing. The final query was of practices that could improve training programs and desired educational outcomes.

Regarding the economic context of manufacturing using robotics, research found that though America is adopting robotics in manufacturing, it is at lower rates of adoption compared to Japan and China. This indicates the U.S. is missing an opportunity to advance productivity. Researchers believe although there is the potential to increase productivity through robotics, there are also risks that need to be addressed as well. For example, workers with less education might struggle to maintain their place as more advanced skills and educational levels are required. Another study argued that while robots may raise overall productivity and efficiency, there is greater opportunity for demand increases in jobs (i.e., technicians) that are robot complementary (Bharadwaj. A. & Devorkin, 2019). While it is possible that robotics and automation may create spikes in employment, the overall estimated effects will require additional time and research.

Researchers at the Rand Corporation examined nearly 4,000 universities and colleges (including two-year institutions) and found that only 743 of the 271,497 individual programs offered technician training in manufacturing. Andrew et al. (2020) purported that because of the prevalence in technician-based careers within the automation, robotics, and advanced manufacturing industry, a shocking 2.4 million jobs could be left unfilled because of this lull in education and training. However, there are some best practices involving educational institutions and workforce training providers.

Indiana's Vincennes University (VU) has established a Center for Applied Robotics and Automation (CARA) with a vision for creating innovative and timely training solutions to accelerate key technical skills necessary to meet demands in robotics and automation (VinU.edu, 2022). The facility will act as a hub for best preparing Indiana's workforce and fostering industry partnerships, while offering training, certifications, and educational opportunities for the State of Indiana. In a newly imagined shared workspace between humans and robots, collaborative robots, or cobots, are emerging in the manufacturing, medical, and aviation industries; therefore, VU has stepped up with partners to proactively meet the demand. Partners include the Indiana Manufacturing Competitiveness Center (IN-MaC) at Purdue University and the Indiana Office of Work-Based Learning and Apprenticeship, as well as local manufacturers for the integration of a workforce development initiative called Career Advancement Partnership (CAP). Additionally, high schools have collaborated with the university to implement the Automation and Robotics Academy (ARA).

In summary, there is a critical need for recognizing and strengthening robotic and automation workforce initiatives, policies, and ecosystems, as they will play a crucial role in American and global manufacturing. They are not only responsible for the output of quality products, but they are invaluable to the productivity and quality measures within the industry.

ELECTRIC VEHICLES (EV) & BATTERIES

According to the U.S. Department of Energy, at least 13 electric vehicle (EV) battery manufacturing sites are slated to open in the U.S. with locations largely concentrated in the Midwest and the South. In Spring 2022, through the U.S. Department of Energy, President Biden announced the availability of $3.1 billion specifically for battery and component manufacturing, including battery recycling (Newburger, 2022). GM has a plan to increase EV sales to more than 1 million electric cars sold in North America alone by the end of 2025 (Lopez, 2022).

Ultium Cells, a joint venture of LG Energy Solution and General Motors, announced a $2.6 billion investment to build its third battery cell manufacturing plant in the U.S. The 2.8 million-square-foot facility in Lansing, Michigan is expected to create 1,700 new manufacturing jobs (GM, 2022). Scheduled to open in late 2024, the manufacturing facility will supply battery cells to Michigan's Orion Assembly plant as well as other GM-operated sites serving the EV sector. Pushing toward a zero-emissions future, Ultium battery cell manufacturing sites are also being constructed in Ohio and Tennessee where, when fully operational, the battery facilities will employ more than 2,300 workers.

The electric vehicle leader, Tesla, continues to see rising sales of electric vehicles; therefore, their battery giant and partner, Panasonic, is doubling down on battery production and capacity. In December 2021, Panasonic Energy of North America announced it would expand Tesla's Gigafactory 1 site in Sparks, Nevada, and they will also build a battery production campus in Reno, Nevada. Competitor, LG Energy Solution, announced two major facility plans, including one in Arizona and another in Michigan which would produce battery cells - the third of its kind in partnership with GM. (Noble, 2022).

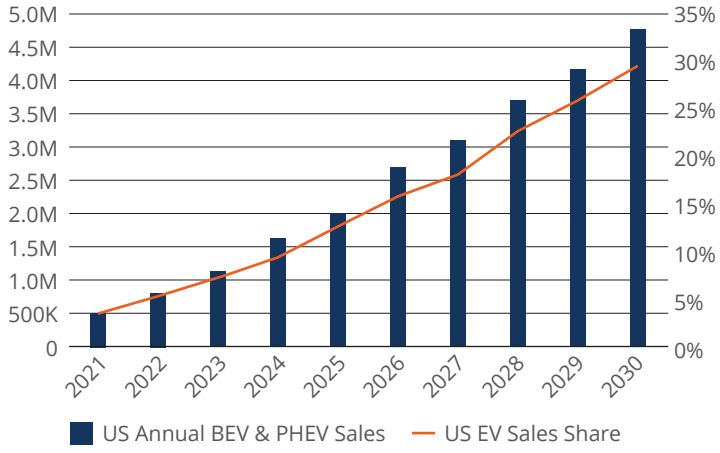
Additionally, the Ford Motor Co. chose Stanton, Tennessee, as the home for building out $5.6 billion worth of electric vehicle assembly and battery manufacturing plants. And Panasonic selected De Soto, Kansas for building a $4 billion electric vehicle battery production facility.

The state of Indiana has recognized that as electric vehicle manufacturing increases (as evidenced in the recent Stellantis Kokomo announcement), so will access to and acceptance of EVs. As of early 2022, just over 7,000 electric cars were registered in Indiana; however, this number has more than tripled since 2019 and future growth projections are robust. An increase in Hoosiers owning these electric vehicles will also increase the need for mechanics specializing in EV repair.

To this end, Indiana is poised to invest $100 million into charging stations around the state (Map 1). These will be located in urban, ex-urban and rural areas, offering all Hoosiers access to necessary infrastructure as the consumer market continues to move to EVs. These circumstances highlight the need for Indiana to take a proactive approach to building a workforce pipeline of EV automotive technicians. Where Indiana stands at this moment, the state is dramatically underprepared for the level of electric specializing mechanics needed to meet the quickly increasing demand (Map 2).

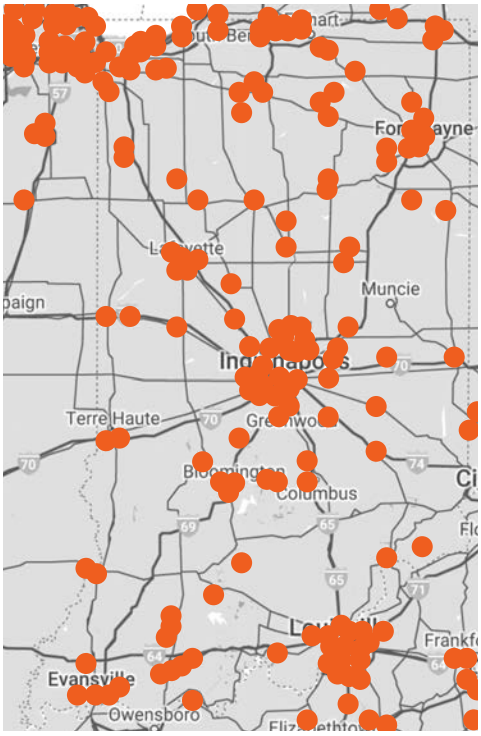
The development of an EV mechanic workforce training strategy for the state of Indiana is underway with stakeholders from both the private and public sectors being connected along with post-secondary institutions being tapped for providing the necessary workforce education and training. There is also an exploration of federal funding initiatives to support the strategy.

US EVS (BEV & PHEV) SALES & SALES SHARE FORECAST: 2021-2030

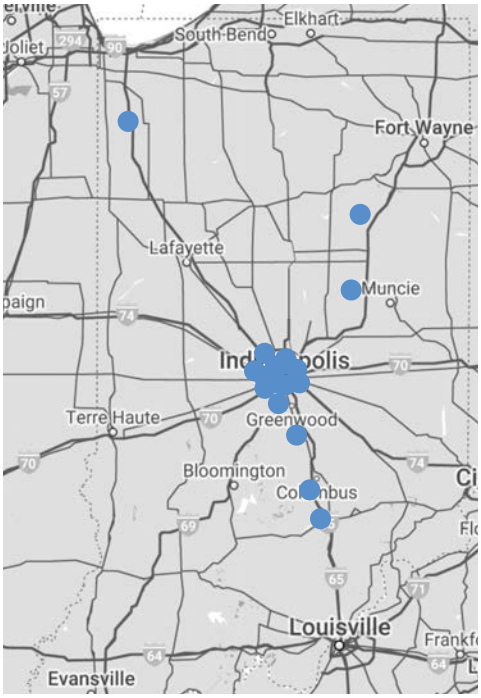


Source: Historical sales data: GoodCarbadcar.net, InsideEVs, IHS Markit / Auto Manufacturers Alliance, Advanced Technology Sales Dashboard | Research & Chart: Loren McDonald/EVAdoption

MAP 1



MAP 2



PLASTICS/CHEMICALS/POLYMERS

The plastics industry is big business in America, accounting for over 945,300 jobs. While the state of Texas boasts the highest number of plastics industry jobs (70,500), Indiana and Wisconsin, are close behind, each averaging about 15.6 out of every 1,000 non-farming employment opportunities. In ten years, plastics manufacturing employment grew 1.2% per year, outpacing the entire manufacturing industry which experienced a growth rate of 0.6% during the same 2010-2020 timeframe.

Additionally, the copious number of plastic products produced in America have catapulted the plastics industry into the ranking as the eighth-largest U.S. industry (Pineda, 2019). Another recent finding (polymerdatabase.com) revealed that when including plastic suppliers into the mix, the plastics industry employs 1.4 million workers across over 16,000 sites, elevating it as the third largest American manufacturing industry. According to Future Market Insights (2022), the U.S. plastic market is valued at over $90 billion.

OPPORTUNITIES IN THE U.S. PLASTICS INDUSTRY

Average annual job openings*

ENGINEERS

71,500

MACHINISTS

40,900

MECHANICS

33,100

PRODUCTION WORKERS

99,300

MACHINE OPERATORS

14,500

Aside from engineering positions, many job openings in plastics do not require a bachelor's degree, with companies providing on-the-job training.

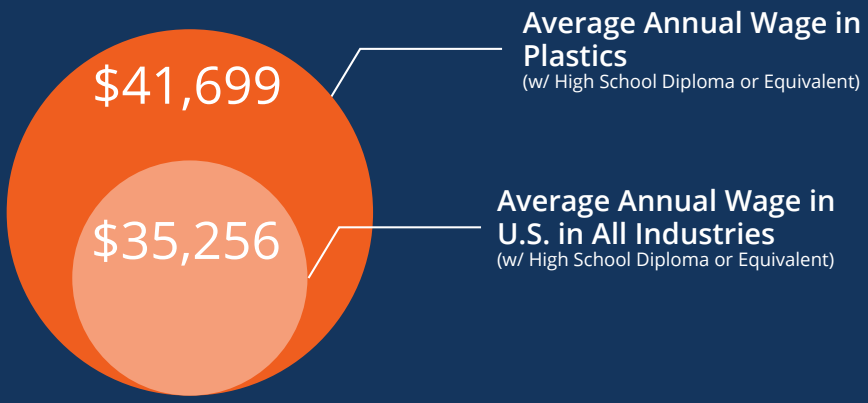
*Average annual job openings from 2016-2026 for selected occupations
Source: U.S. Bureau of Labor Statistics, 2019.

According to the Office of Energy Efficiency & Renewable Energy (2022), much like the plastics industry, the U.S. is a top producer of chemicals. The American chemicals industry accounts for about one-fifth of the world production, making our nation the top chemical producer in the world. Over 70,000 products are actually converted from raw materials such as air, metals, water, oil, natural gas, and minerals.

Even with such accolades, the U.S. chemical industry was scathed by the global pandemic and is working toward recovery efforts. They are creating flexibility across their production systems and exploring collaborative ecosystem-building initiatives. Deloitte (2022) reports that with sustainability and decarbonization as areas of focus, chemical companies will likely diversify their workforce and present new opportunities within chemical research and development (R&D). Likewise, with supply chain challenges easing, many chemical employers are poised for welcoming back the workforce they had lost during the disruption of the pandemic.

WAGES

Wages for plastics workers routinely outpace national averages.



National Median Wage by Job Type in Plastics** (currently in demand)

ENGINEERS	MACHINISTS	PRODUCTION WORKERS	MACHINE OPERATORS	MECHANICS
$100K+	$43K+	$39K	$40K+	$52K+

National 90th Percentile Wage by Job Type in Plastics** (currently in demand)

ENGINEERS	MACHINISTS	PRODUCTION WORKERS	MACHINE OPERATORS	MECHANICS
$136K+	$63K+	$54K	$58K+	$70K+

** Varies by state

Source: U.S. Bureau of Labor Statistics, 2019.

Given the rebound of the automotive industry in America, researchers at Deloitte (2022) anticipate the automotive sector will drive demand for both chemicals and plastics in 2022 and beyond. Future Market Insights announced in July 2022 that ExxonMobil will pilot a method for recycling plastic scraps into the components required for the production of polymers. This is an innovation in resource utilization given the increasing demands and the efforts to minimize environmental pollution and plastic waste.

Additionally, in response to regional employer demands in Ohio, North Central State College in Mansfield is developing a customized, short-term certificate program in Polymer Engineering. In this partnership with The Ohio State University-Mansfield, the technical and community college will also offer a two-year degree, placing students on a career pathway for pursuing a four-year degree and employment in the advanced manufacturing and polymer industry (Center for Design and Engineering Excellence, 2022).

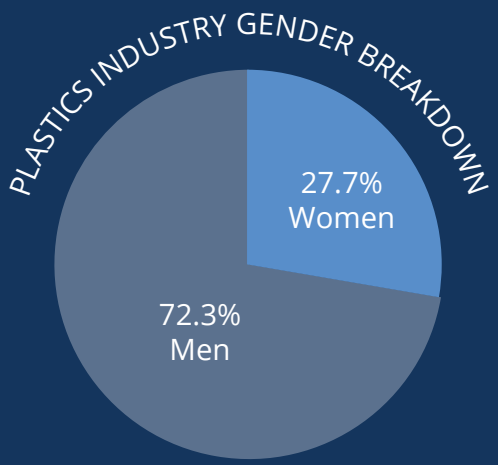
WORKFORCE

22.3% of the plastic product manufacturing workforce is aged 55 and older

That is approximately **145,000** potential job openings in plastics product manufacturing in the next 5-10 years

9.6% of the plastic product manufacturing workforce is aged 16 to 24 years old.

ENGINEERS (paid the highest median salary in the US plastics industry) comprise just 6.8% of plastics industry workforce - but engineering jobs in plastics are poised to grow **8.7%** annually between 2016 NS 2026.



GRADUATES with degrees in plastics engineering should expect a robust job market when they graduate **regardless of economic conditions.**

GROWTH OPPORTUNITIES IN PLASTICS FOR **WOMEN.**

Source: U.S. Bureau of Labor Statistics, 2019.

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