CONNECTED AND AUTOMATED VEHICLES
EMERGING TECHNOLOGY SKILLS GAP ANALYSIS

Compiled by the Workforce Intelligence Network for Southeast Michigan on behalf of the Ralph C. Wilson, Jr. Foundation

SPRING 2020

WIN
WORKFORCE INTELLIGENCE NETWORK

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ABOUT THIS REPORT

The Ralph C. Wilson, Jr. Foundation is supporting two reports detailing the emerging technologies talent system in southeast Michigan. This report is focused on connected and automated vehicles (CAV) and will analyze the current and emerging technology workforce in southeast Michigan. Where appropriate, national comparisons are included as well.

This report builds upon and updates the original CAV Skills Gap Analysis published by the Workforce Intelligence Network for Southeast Michigan (WIN) in 2017 in connection with the ATLAS Center and the Macomb/St. Clair Workforce Development Board, with financial support from the Office of Economic Adjustment, Department of Defense[1]. The WIN special report on connected and autonomous vehicles was among the first of its kind in the public space to measure the impact of CAV on the workforce.

This complementary report seeks to analyze changes in the emerging technologies talent system. Understanding the complexity of the talent supply for CAV development and other upcoming technologies will aid continued economic growth in the region. New occupations will be created to sell, maintain, service and grow these technologies and their integration into teaching and service occupations. Tracking emerging technologies and their impact on the workforce is key to preparing secondary, post-secondary, and other educational markets for changing workforce demands from employers.

CAV manufacturing presents an opportunity to both create new jobs and upskill the existing workforce. Given the high number of training providers in southeast Michigan, the region is poised to make the most of this opportunity. CAV is the new frontier of transportation for personal vehicles, public transportation, and first responders, and proponents feel it will enhance safety and efficiency of travel. As development of CAV is happening across the nation, this analysis includes data for the entire United States where applicable. Necessary occupations for CAV development include IT design and cybersecurity workers helping vehicles to communicate with each other and with surrounding infrastructure and to keep travel data secure; design and testing engineers and manufacturing workers; quality control specialists ensuring vehicle safety; and civil engineers and planners creating the intelligent transportation systems needed to make CAV effective and efficient on roadways. Each of these groups of workers requires a distinct skillset and training, while experienced workers may need more information to work on emerging technologies.

Continued advancements in cybersecurity, and other, less mature technologies such as artificial intelligence and virtual reality are entwined with many facets of human life, though the impact these technologies have created is yet to be determined and analyzed. In particular, CAV technology is closely related to the Internet of Things (IoT) due to the similarity of technologies needed between the two and the increased prevalence of automation in manufacturing. Cybersecurity is important to all kinds of increasingly connected businesses, and especially to connected device creation.

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[1]The original report content reflected the views of the Macomb/St. Clair Workforce Development Board and did not necessarily reflect the views of the Office of Economic Adjustment.
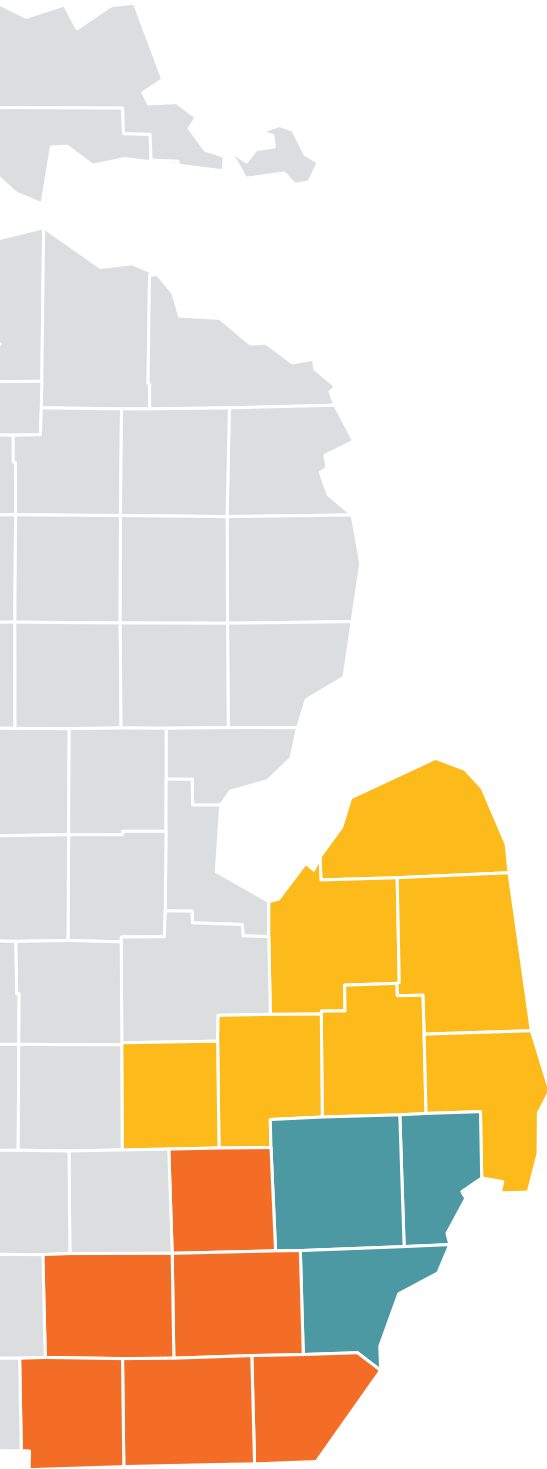
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ABOUT WIN

ABOUT WIN

The Workforce Intelligence Network for Southeast Michigan (WIN) is a partnership of community colleges and workforce development boards, known locally as Michigan Works! Agencies (MWAs), in greater southeast Michigan. It was established in 2011 to create a comprehensive and cohesive talent development system in the region to ensure workers are prepared for success. Accordingly, WIN serves three primary roles:

1. Gathering, analyzing, and distributing real-time labor supply and demand intelligence on workforce characteristics specific to the Southeast Michigan Region;

2. Convening, facilitating, and engaging employers, and serving as the connection point for business, industry and other stakeholders as it relates to workforce development; and

3. Developing strategies and funding proposals for the delivery of regional workforce development programs through its partners.

To learn more about WIN and to explore past reports, visit WINintelligence.org.

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MICHIGAN WORKS! SOUTHEAST

Acknowledgements

EXECUTIVE

SUMMARY

EXECUTIVE SUMMARY

REPORT OVERVIEW

In the time since WIN's Connected and Automated Vehicle (CAV) Skills Gap Analysis was published, CAV has begun a transition from distant transportation frontier to emerging technology. Automakers, delivery companies, and transit providers have launched pilot vehicles and shuttle routes; partial automation has become common across new vehicles in the form of safety features, such as lane and brake assist; states and municipalities grapple with broad questions of CAV regulation as well as narrow ones such as machine-friendly traffic lights and pavement markings. As major automotive manufacturers and technology companies around the world design and test new automated vehicle technology, current employees are learning new skills and future workers will be asked to apply a specific skillset to CAV projects as the product cycle for this disruptive technology continues to mature.

In order to better understand future workforce demands in the CAV space, WIN partnered with the Ralph C. Wilson, Jr. Foundation to analyze job postings for a broad set of occupations involved in the design, manufacture, and infrastructure development necessary to catalyze the CAV product cycle.

In this report, WIN examines occupations that are critical in developing CAV by analyzing data on the workforce's employment trends, local demand, entry requirements, and regional specialties. Due to the broad range of occupations — including engineers, software developers, cybersecurity professionals, and transportation planners — that are integral to the rollout of connected vehicles, as well as the wide range of other industries seeking these versatile workers, the government's standard occupation codes are not nuanced enough to truly capture CAV workers. The analysis carried out for this report features job posting data from Economic Modeling Systems International (Emsi) for 76 unique occupation codes linked to CAV-specific projects through the application of keyword and industry filters in data collection. Using data from job postings in the CAV space nationally, from 2016 to 2019, WIN researchers present analysis on the demand for CAV workers.

Key Findings

1. In 2017, 8.4 percent of nationwide postings (10,403 online job advertisements) for these occupations included automation keywords, while in 2019, 12.1 percent (25,726 advertisements) expressed specific interest in automation. The state of Michigan accounts for 2.4 percent of all postings for these occupations nationwide, while southeast Michigan accounts for 1.6 percent of all national CAV-related postings. By comparison, Michigan accounts for 2.9 percent of national employment overall and 3.4 percent of employment in CAV-related occupations.

2. In 2019, CAV-related occupation employment totaled 504,400 workers, meaning 18.8 percent of all workers in southeast Michigan are employed in occupations with skills helpful in developing CAV. Though only 103,700 of these workers are employed in auto manufacturing and development industries and not all workers may be on automation-related projects, this indicates a wide talent pool in the region to draw potential workers from.
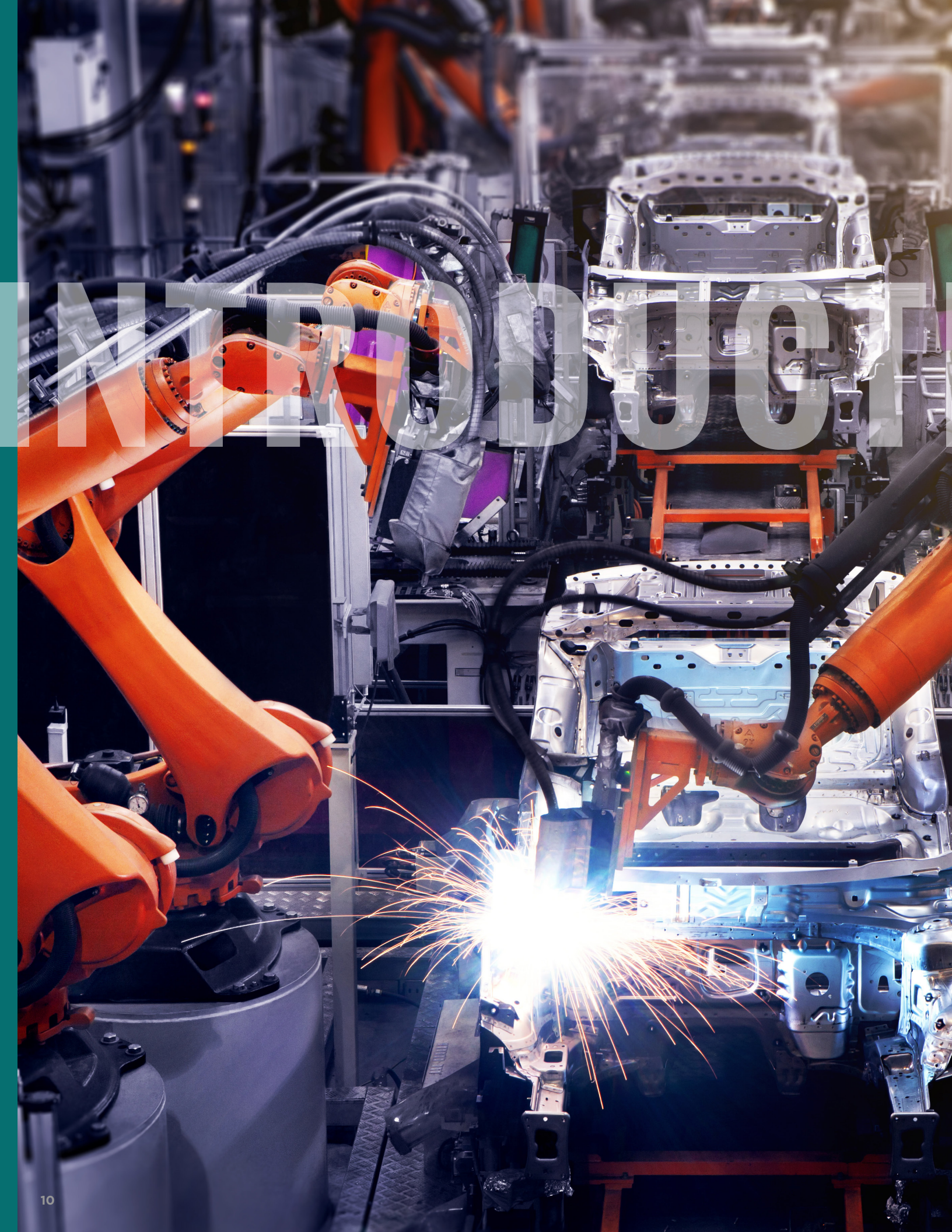
3. The enormous growth in automated vehicle worker demand has led to a variety of strategies for meeting workforce needs. Changes in the CAV ecosystem have led to rapidly evolving skill needs, such as cybersecurity and other safety concerns that have arisen with more widespread deployment. Educational providers, auto manufacturers, and industry groups alike are seeking long- and short-term solutions for upskilling the CAV workforce.

4. The strong presence of automotive manufacturing infrastructure in southeast Michigan has helped provide ample pathways for CAV workers. The 37 higher education institutions providing programs related to CAV-related occupations, industry collaborations considering talent attraction, and

existing manufacturing workforce interested in upskilling all lead to a diverse talent pool. Encouraging CAV development in the region can help provide long-term pathways in vehicle and engineering technology can assist with talent retention in the state overall.

5. Increased utilization of automation and robotics within the manufacturing industry are in turn impacting automated vehicle workers. Available machining and modeling technology is leading job growth in well-paying technology-focused occupations while slowing growth in others. Posting and employment changes, an academic automation index, and other metrics can be considered in developing curriculum for emerging high-demand occupations.

Recommendations

The WIN team also takes this opportunity to look forward. The following recommendations, discussed in detail in the conclusion, suggest considerations and strategies that may help the CAV workforce in southeast Michigan continue to mature. They will also help build capacity for the region to lead the way in autonomous vehicle development.

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1. Degree requirements should be made flexible when possible, allowing workers without a bachelor's degree to enter the CAV workforce provided the right skills and training. Expansion of middle skill positions has the potential to meet talent demand and strengthen the region's overall economy. At this time, many occupations in technology roles have high degree requirements for positions that could be filled with an individual who had completed short-term training or an apprenticeship in the right skills.

2. Educators, employers, and workforce boards must collaborate in creating robust training pathways to fill both short- and long-term skill needs. In particular, upskilling existing production workers is still a major opportunity.

3. To meet demand and continue transforming the connected vehicle space, employers must focus efforts on attracting technology talent to southeast Michigan.

INTRODUCT

ION

INTRODUCTION

CONNECTED AND AUTOMATED VEHICLES IN SOUTHEAST MICHIGAN

In this Report

In this update to the 2017 CAV Skills Gap report, we aim to examine the demand metrics covered in the original report and explore major changes since publication. These metrics include the top posting employers, skills, certifications, and degrees for CAV workers, salary distributions, education and experience requirements, and geographic concentration. Industry standards, including training, certifications, and entry-level worker qualifications, will be considered along with their evolution over the past two years. Factors such as updated occupation codes, security clearance, and other factors crucial to the original report will also be touched upon.

The landscape for CAV has changed dramatically in the short years since the original report was published. Driver assistance safety features have become not imagination or luxury, but a requirement in new vehicles; major automakers and technology companies have expressed an intent to release a fully automated vehicle by 2040[2]; short-distance autonomous shuttles are running in downtown Detroit and also Columbus, Providence, and Grand Rapids, among others; rideshare and delivery companies are testing limited implementation. Employers across tiers of manufacturing are paying attention. In 2017, 8.4 percent of nationwide postings for these occupations included automation keywords, while in 2019, 12.1 percent of job advertisements expressed specific emphasis on automation-related skills.

Updated findings and recommendations begin on page 8.

Connected Vehicle Development and the Workforce

Southeast Michigan is in a unique position to advance the future of automated vehicles due to the strong historic presence of auto manufacturing and high concentration of research and development centers in the region. To meet demand and continue transforming the connected vehicle space, employers must both attract tech talent and create training pathways for traditional production workers. Manual occupations such as assembly workers and manual tool operators are declining while overall employment in CAV-related occupations is growing. This growth is concentrated in high tech IT roles and in technician and tool programming positions[3]. Uncovering the relative strengths and opportunities in our region will help ensure southeast Michigan remains competitive and the overall economy remains strong.

Training institutions in southeast Michigan must consider developing curriculum specific to CAV occupations to catalyze growth, a process often reliant upon industry models and public-private sector collaborations. Beyond four-year degrees, middle skill, middle wage (MSMW) occupations provide pathways to good-paying employment on short term training and are prevalent across CAV employment, including engineering and production technicians and some computer support and logistics roles. This designation is described in detail within the Methodology section. Each subgroup section highlights the available middle skill opportunities, and detailed training and curriculum information is available in the Training Provider Preparation section on page 60.

Many workers are needed to design, produce, and distribute CAV, and though most must be familiar with each step of the process, they need distinct skillsets. Occupations are grouped as in the previous report, with some updates following occupational coding changes and evolving employer needs. They are categorized by similarity in role, job function, education and training requirements, skillset, and pay scale. A new category has been added, as human factors have become increasingly important to CAV development. The next section will provide an overview of these subgroups, and detailed workforce information about them begins on page 26.

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[2] Center for Automotive Research (2018)

SUBGROUP DESCRIPTIONS

There are many workers needed to solve the challenges facing the emerging connected and automated vehicle industry. In the effort to better inform readers about the workforce needs of this industry, seven CAV subgroups were created, described below.

Design and Testing

The Design and Testing group employs many engineers involved in the ongoing research, design, and testing of CAV projects. Each of these occupations has a hand in the early development and design of vehicles, aftermarket devices, and connected infrastructure. Occupations associated with design and testing processes include Mechanical Drafters, Commercial and Industrial Designers and Electrical and Electronics Engineering Technicians.

Vehicle Manufacturing

The occupations in the Vehicle Manufacturing group are positions that already exist at original equipment manufacturers (OEMs). Occupations in this group are needed throughout the entire vehicle manufacturing process. Typical CAV manufacturing occupations found in this group are Architectural and Engineering Managers, Industrial Engineers, Production, Planning and Expediting Clerks, and Electricians.

Information Technology (IT) Design

The IT Design group occupations develop hardware and write software for use in connected and automated vehicles as well as after-market devices designed to retrofit the existing fleet of vehicles already on the road. These occupations include Computer and Information Research Scientists, Computer Programmers, Computer Hardware Engineers, and Computer Network Support Specialists.

Quality Assurance

The Quality Assurance subgroup is small and made up of occupations integral to the vehicle manufacturing process. The occupations found in this subgroup are Industrial Production Managers, Compliance Officers, Life, Physical, and Social Science Technicians, All Other, and Inspectors, Testers, Sorters, Samplers, and Weighers.

Data Management and Cybersecurity

Data Management and Cybersecurity is a large and important subgroup for CAV. Occupations found in this group include Computer Systems Analysts, Information Security Analysts, Database Administrators, and Network and Computer System Administrators. Workers typically work on projects that protect data being collected and communicated by connected infrastructure and automated vehicles.

Intelligent Transportation Systems (ITS) and Infrastructure Design

Intelligent Transportation Systems and Infrastructure Design occupations are key in the implementation of connected vehicle infrastructure and intelligent transportation systems. Occupations in this industry include Transportation, Storage, and Distribution Managers, Logisticians, Civil Engineers and Traffic Technicians. Workers in this group are employed for state and local departments of transportation or private consulting firms.

Business, Legal, and Marketing

Occupations in the Business, Legal, and Marketing subgroup exist in nearly every type of business and possess the skills necessary for marketing, deploying, and insuring CAV. Management Analysts, Lawyers, Public Relations Specialists and Training and Development Specialists are occupations found in this group.

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[3] *US Bureau of Labor Statistics. See Subgroup sections for detailed analysis.*

METHODOLOGY

This update to the CAV Skills Gap report released by WIN in 2017 was compiled using data on employer demand, gleaned from online job advertisements from Emsi. It also includes employment and wage data from the Bureau of Labor Statistics (BLS). The data contained in this report is primarily for the 16 southeast Michigan counties covered by WIN unless otherwise noted. All data is focused on occupations categorized by the WIN research team with input from the ATLAS Center. For a complete list of occupations please see Appendix A.

Connected and automated vehicle occupations are emerging and on-the-rise, so typical occupation codes are not nuanced enough to truly capture all CAV workers. WIN's method begins with Standard Occupational Classification (SOC) codes, which are government-defined occupation codes, refined through industries and keywords to better catalog job postings that may be for CAV-related workers. Combining the list of keywords and occupations that likely align with CAV allows WIN to analyze the data about different areas of CAV workers in depth.

The first step in the research process was to review the original connected and automated vehicle list to re-sort and update based on the scope of this report. Using automation-focused keywords and industry staffing pattern data, WIN researchers defined occupations with applicable knowledge and skillsets necessary to meet the growing demand for connected and autonomous vehicles. See the Subgroup Descriptions on page 13 to learn more about the categories used in this report. See Appendix B for a list of all documents used for the literature review, and Appendix C for a list of the keywords and industry filters used.

WIN research typically uses occupations, as opposed to industries, to narrow labor market analysis to the level of the worker. Individuals working in specific occupations can be employed across multiple industries. In collecting job posting data, 14 industries — including motor vehicle manufacturing, software publishers, and scientific research and development services — served as filters to capture CAV-related job postings. The original list

of CAV-related keywords that resulted from an initial literature review was refined to 60 keywords that also served as filters in job posting data collection.

Data pertaining to standards for CAV-specific workers is scarce even though many companies are expanding their CAV-related operations. Job postings provide insight on what skills companies desire and get a sense of upcoming trends. Data on the top 10 to 15 in-demand degrees, certifications, and skills needed are presented in this report, along with top posting employers. This data is not comprehensive for the number of CAV workers employed within organizations. The possibility exists that other employers currently employ more CAV workers than those listed but lack current job openings.

Middle skill, middle wage (MSMW) occupations are important to this industry because they offer pathways for skilled workers without a four-year degree and provide the skills necessary for advancement in these occupations. Middle skill occupations are those that require some education and training beyond high school, but do not require a bachelor's degree. Typically, a wage component is also included when denoting middle skill jobs, i.e., these occupations must earn more than the national, state or local median wage. The importance of middle skill jobs to the United States (and regional economies) cannot be understated – while in the coming years there will be negative job growth for those occupations requiring only a high school diploma or less, middle skill jobs in all occupation groups and industries are expected to grow by eight percent by 2028 in the U.S.

FINDINGS

# FINDINGS

WORKFORCE OVERVIEW

Worker Demand Trends

In southeast Michigan, connected and automated vehicle employment has been gradually increasing since 2009 and is expected to continue growing through 2028. In 2019, employment for the 76 CAV-related occupations analyzed in this report totaled 504,389 workers, or 18.8 percent of all workers in southeast Michigan. Of these, 103,697 are currently employed in the 14 industries related to automobile development. Further information about those workers specifically focused on CAV must be inferred through job posting data. For all workers in these occupations, employment is expected to continue trending upward by 3.4 percent through 2028, indicating sustained demand for workers over the next ten years.

Between October 2018 and September 2019, there were 240,086 total online job postings for CAV-related occupations in southeast Michigan, and about 21,000 of those were made by employers in auto manufacturing and research and development industries. Narrowing further, 3,245 of these ads specifically included automation-related keywords. The demand for workers with skills applicable to CAV development in this region accounted for 66.1 percent of all CAV-related postings across the state of Michigan. Statewide, there were 363,220 job postings between October 2018 and September 2019 and 3,713 adhering to both auto industry and keyword filters. With southeast Michigan experiencing such consistent growth in emerging CAV occupations, it is important to advertise the different career pathways available in this industry to avoid a workforce skills gap.

All CAV-Related Occupations Employment Over Time, WIN Region
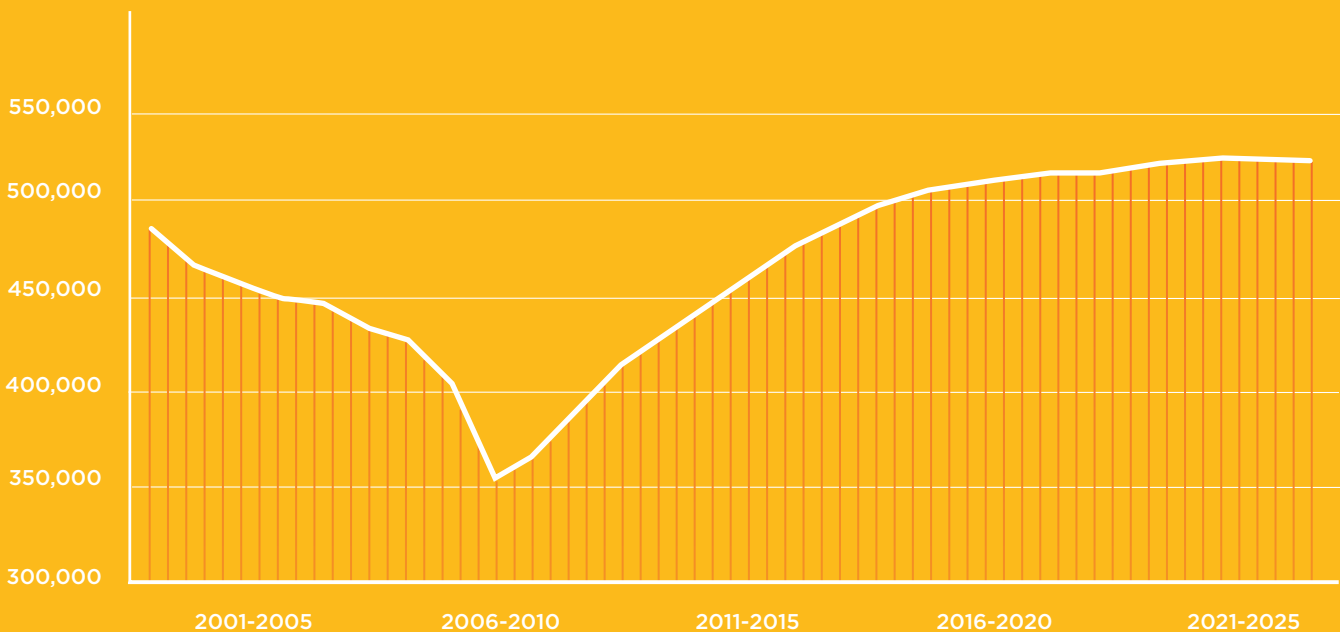
The source for all information throughout this section is Emsi and analysis was conducted by WIN.
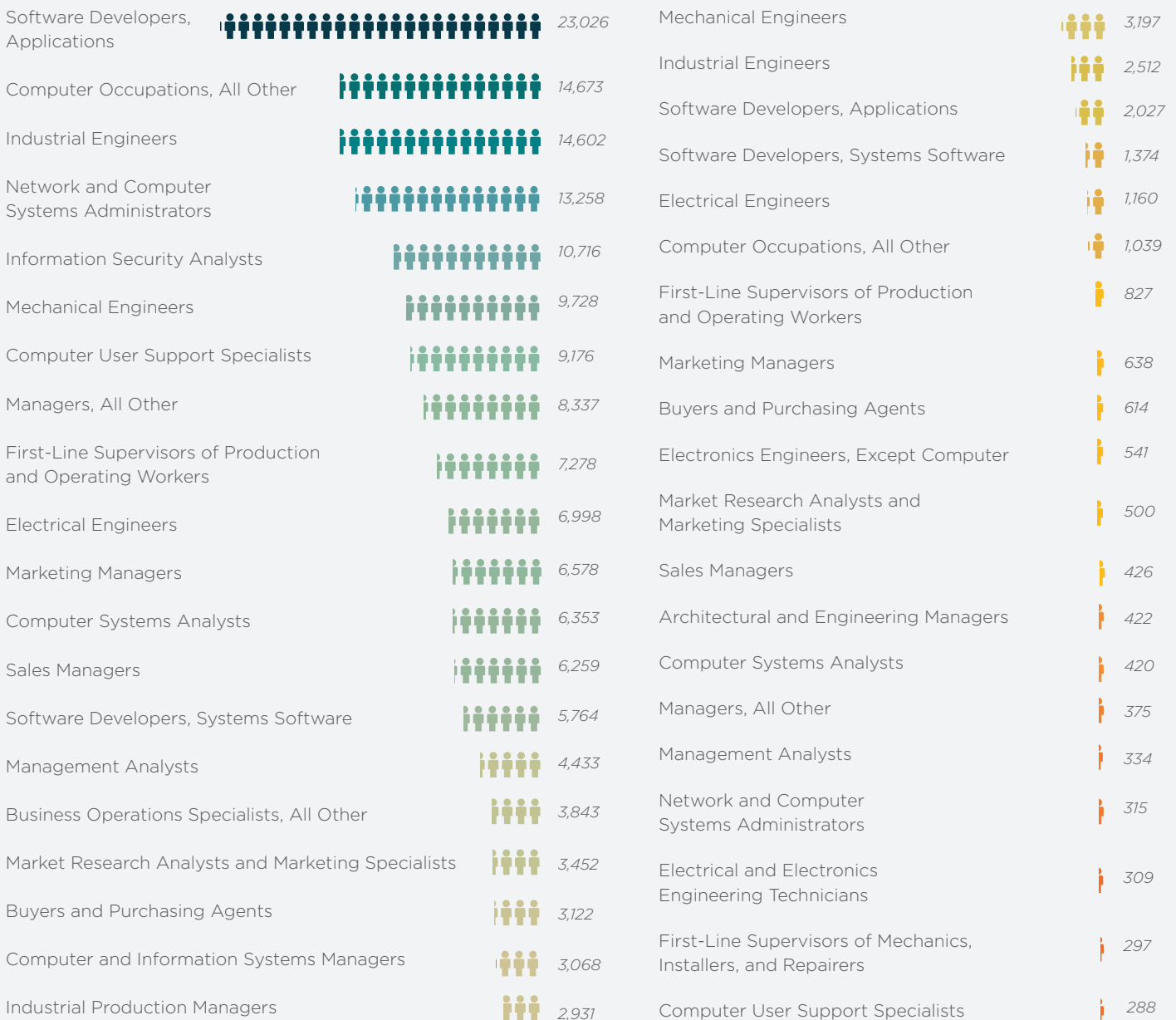
Regional and National Top CAV Jobs

The high demand for CAV workers in southeast Michigan, and the region's specialties, stand out when the postings are considered in context compared to the United States. Nationally, between October 2018 and September 2019, there were 15 million online job postings for connected and automated vehicle-related occupations, of which just over 200,000 were in designated industries. The state of Michigan accounts for 2.4 percent of all postings, while southeast Michigan accounts for 1.6 percent of all national CAV-related postings. Although the demand for CAV workers is strong for the region, this industry is still emerging and relatively new across the nation. Below, the manufacturing specialization in southeast Michigan and its strong automotive focus can be seen by comparing the top jobs for both geographies.

Top CAV Jobs, US and Southeast Michigan

= 1000 Job Postings

Job	Postings
Software Developers, Applications	23,026
Computer Occupations, All Other	14,673
Industrial Engineers	14,602
Network and Computer Systems Administrators	13,258
Information Security Analysts	10,716
Mechanical Engineers	9,728
Computer User Support Specialists	9,176
Managers, All Other	8,337
First-Line Supervisors of Production and Operating Workers	7,278
Electrical Engineers	6,998
Marketing Managers	6,578
Computer Systems Analysts	6,353
Sales Managers	6,259
Software Developers, Systems Software	5,764
Management Analysts	4,433
Business Operations Specialists, All Other	3,843
Market Research Analysts and Marketing Specialists	3,452
Buyers and Purchasing Agents	3,122
Computer and Information Systems Managers	3,068
Industrial Production Managers	2,931

Job	Postings
Mechanical Engineers	3,197
Industrial Engineers	2,512
Software Developers, Applications	2,027
Software Developers, Systems Software	1,374
Electrical Engineers	1,160
Computer Occupations, All Other	1,039
First-Line Supervisors of Production and Operating Workers	827
Marketing Managers	638
Buyers and Purchasing Agents	614
Electronics Engineers, Except Computer	541
Market Research Analysts and Marketing Specialists	500
Sales Managers	426
Architectural and Engineering Managers	422
Computer Systems Analysts	420
Managers, All Other	375
Management Analysts	334
Network and Computer Systems Administrators	315
Electrical and Electronics Engineering Technicians	309
First-Line Supervisors of Mechanics, Installers, and Repairers	297
Computer User Support Specialists	288

Distribution of Demand Across Sectors

In 2019, employment across all connected and automated vehicle-related occupations in southeast Michigan totaled 504,389 workers. The Business, Legal and Marketing occupation subgroup employs 151,648 workers, accounting for 30.1 percent of all CAV occupations, the highest employment of all subgroups. The Vehicle Manufacturing subgroup follows closely behind with 149,815 workers, equaling 29.7 percent. The Design and Testing (57,737 workers or 11.4 percent), Data Management and Cybersecurity (54,055 workers or 10.7 percent), and IT Design (50,730 workers or 10.1 percent) subgroups all employ around the same number of workers. Employment in Quality Assurance (31,271 workers) and ITS and Infrastructure Design (27,155 workers) subgroups accounts for the remaining number of CAV employment at 6.2 percent and 5.4 percent respectively.

Comparatively, of the 240,086 postings in southeast Michigan for CAV-related occupations, the IT Design subgroup has the highest demand with 45,620 postings, or 19.0 percent. Following closely is Data Management and Cybersecurity with 42,343 postings, accounting for 17.6 percent. These occupation groups are similar in that they both work heavily with technological data and databases. Vehicle Manufacturing (37,185 postings or 15.5 percent) and Design and Testing (26,827 postings or 11.2 percent) both deal with assembly and testing to ensure consumer safety. ITS and

Employment by Subgroup

● Business, Legal, and Marketing	30.1%
● Data Management and Cybersecurity	10.7%
● Design and Testing	11.4%
● IT Design	10.1%
● ITS-Infrastructure	5.4%
● Vehicle Manufacturing	29.7%
● Quality Assurance	6.2%

Job Postings by Subgroup
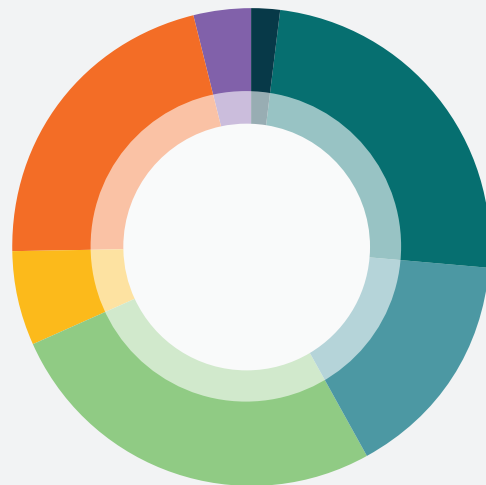
● Business, Legal, and Marketing	1.5%
● Data Management and Cybersecurity	17.6%
● Design and Testing	11.2%
● IT Design	19.0%
● ITS-Infrastructure	4.5%
● Vehicle Manufacturing	15.5%
● Quality Assurance	2.6%

Infrastructure Design (10,685 postings or 4.5 percent), Quality Assurance (6,268 postings or 2.6 percent), and Business, Legal, and Marketing (3,710 postings or 1.5 percent) subgroups complete the total number of CAV-related occupation postings for southeast Michigan. Notably, while similar proportions of employment and postings are exhibited by established fields like Vehicle Manufacturing and ITS, consider the significantly greater proportions of job postings for technology subgroups IT Design and Cybersecurity. These occupations may have greater competition from different kinds of firms in southeast Michigan and may have still-developing talent pipelines to fill growing demand in the region.

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[4] *Frey & Osborne (2013)*

Automation Index

The automation index is a metric of automation risk for any given occupation based on individual job tasks. It can provide additional insight to the employment growth trends, wage adjustments, and changes in job description. Especially in manufacturing and technology positions, workers with a high level of potentially automated tasks may keep an eye on rapidly changing occupation needs. The metric, calculated by Emsi, analyzes the potential automation risk of occupations based on job task content derived from O*NET work activities. That data is combined with Frey and Osborne's 2013[4] automation risk findings at the occupation level to identify which job tasks are "at risk" and which are resilient. The calculation and sources for the automation index are discussed at greater length in the glossary, Appendix D.

REGIONAL WORKFORCE DEMAND
Why consider regional demand?

Gaining national perspective is important to get an accurate picture of an increasingly mobile, connected workforce. Advantages such as low cost of living and high industry concentration are a boon to talent attraction efforts. Strategies working well for developing and deploying CAV in one city are likely to provide insight to another. Additionally, it provides a better understanding of how southeast Michigan compares to similar regions and how it can remain competitive moving forward. There are many ways to measure and compare demand by region, and we will consider location quotient, percentage of job postings and Gross Regional Product (GRP) over time. To provide a holistic picture, training programs, industry initiatives, positive testing legislation and other resources encouraging development are considered as well. Regional influences impact specialization, available talent and infrastructure. Large cities…sensor design. Historic manufacturing areas have production- and vehicle-savvy talent and testing and development facilities that can be repurposed for connected vehicles.

In addition to the potential for talent attraction, best practices may be shared among cities with different specializations in the CAV space. Training and upskilling the existing vehicle manufacturing workforce for more technology-heavy positions, and training information and business workers to be familiar with the manufacturing process, are a major undertaking. Other areas that are strong in the CAV space, such as Washington DC and the California Bay area, have this training conundrum as well, so it is helpful to see how they compare to southeast Michigan. Other metropolitan statistical areas (MSAs) with high numbers of CAV postings include Washington DC, San Francisco-Oakland-Hayward California, New York, New York, and Boston, Massachusetts, all large cities with high presence of the technology industry. Below, several other ways of considering demand concentration are considered.

[5] Regression equation for trend line: $y = 4130.9x + 65265$; $R^2 = 0.2851$

Location Quotient

Location quotient is a way of quantifying how concentrated an industry or occupation is in a region compared, in this case, to the nation. It is calculated by comparing the industry or occupation's share of the region's employment to its share of employment nationwide. Location quotient is helpful in determining dominant and emerging industries and their impact on the economy at large. It also helps indicate a relatively large talent pool. In southeast Michigan, Motor Vehicle Manufacturing and Motor Vehicle Parts Manufacturing have location quotients of 9.7 and 10.0 respectively, meaning they are 10 times more concentrated than the national average. Together, these industries employ over 100,000 workers, with thousands more demanded by specialized machinery and materials supply firms, research and development agencies, or design agencies. Location quotient is discussed in detail for standout occupations within each subgroup section.

Wage Analysis

Wage information and its relationship to education and experience needs and automation risk is discussed in detail within each subgroup section. Below is a table of median wages for each occupation subgroup. These wages represent all workers employed in CAV-related occupations. Median pay for these workers is well above the regional median for every subgroup, indicating the high demand for the technical skillsets represented.

The relationship between salary information and skill demand can also be considered by plotting average earnings per worker in the industry — in this case, automobile manufacturing — against regional industry concentration. The average earnings are adjusted for cost of living in each MSA to account for regional differences in pay. For automobile manufacturing, adjusted average wages trend higher in concert with concentration. Detroit, as well as nearby Flint, Toledo, and to a lesser degree Ann Arbor, are notable outliers in terms of high demand and comparatively high wages, showcasing the high level of worker competition[5]. In the figure on page 24, observe that average automotive

Wage Distribution by Subgroup

Occupation Subgroup	Hourly Earnings				
	Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
Vehicle Manufacturing	$18.47	$22.92	$29.79	$38.49	$45.39
Business, Legal, and Marketing Services	$19.44	$27.17	$39.65	$57.72	$79.73
Data Management and Cybersecurity	$23.33	$30.00	$39.26	$51.06	$63.48
Design and Testing	$27.37	$32.99	$41.55	$51.19	$59.46
IT Design	$22.34	$28.73	$37.15	$46.59	$55.30
ITS and Infrastructure Design	$21.46	$27.26	$34.84	$43.27	$52.66
Quality Control	$17.41	$21.77	$28.58	$36.94	$45.99

worker earnings are generally higher for cities with higher auto manufacturer concentration.

In addition to the high concentration of workers and job opportunities, cost of living and rising relative wages for vehicle technology workers are among strengths for attracting CAV talent to southeast Michigan. The next section explores other connected vehicle hubs and regional comparison metrics.

CAV Postings by Volume

Another method of comparing regional demand concentration is to consider the volume of postings for CAV occupations within manufacturing industries. By this metric, Huntsville, Alabama is more concentrated than the Detroit-Warren-Dearborn, Michigan MSA, though also much smaller, due to its focus on aerospace advanced manufacturing. Durham, North Carolina, Washington DC, and Baltimore, Maryland are also highly concentrated, with between one and three percent each of their total postings focused on CAV occupations and industries.

Collaboration Strategies

Mobility alliances and similar industries groups in different regions can provide an excellent source for collaboration whether in a complementary specialization or experiencing similar challenges. Mobility alliances tend to be tailored to a region's needs and strengths. Other areas with automaker influence or a focus on connected vehicles and advanced manufacturing infrastructure more closely resemble automaker organizations in southeast Michigan, while those in congested areas focus on collaboration with transit, construction workers, and others in addition to vehicle technology. See Regulations and Testing and Training Provider Preparation for more information.

Worker Earnings by Regional Industry Concentration
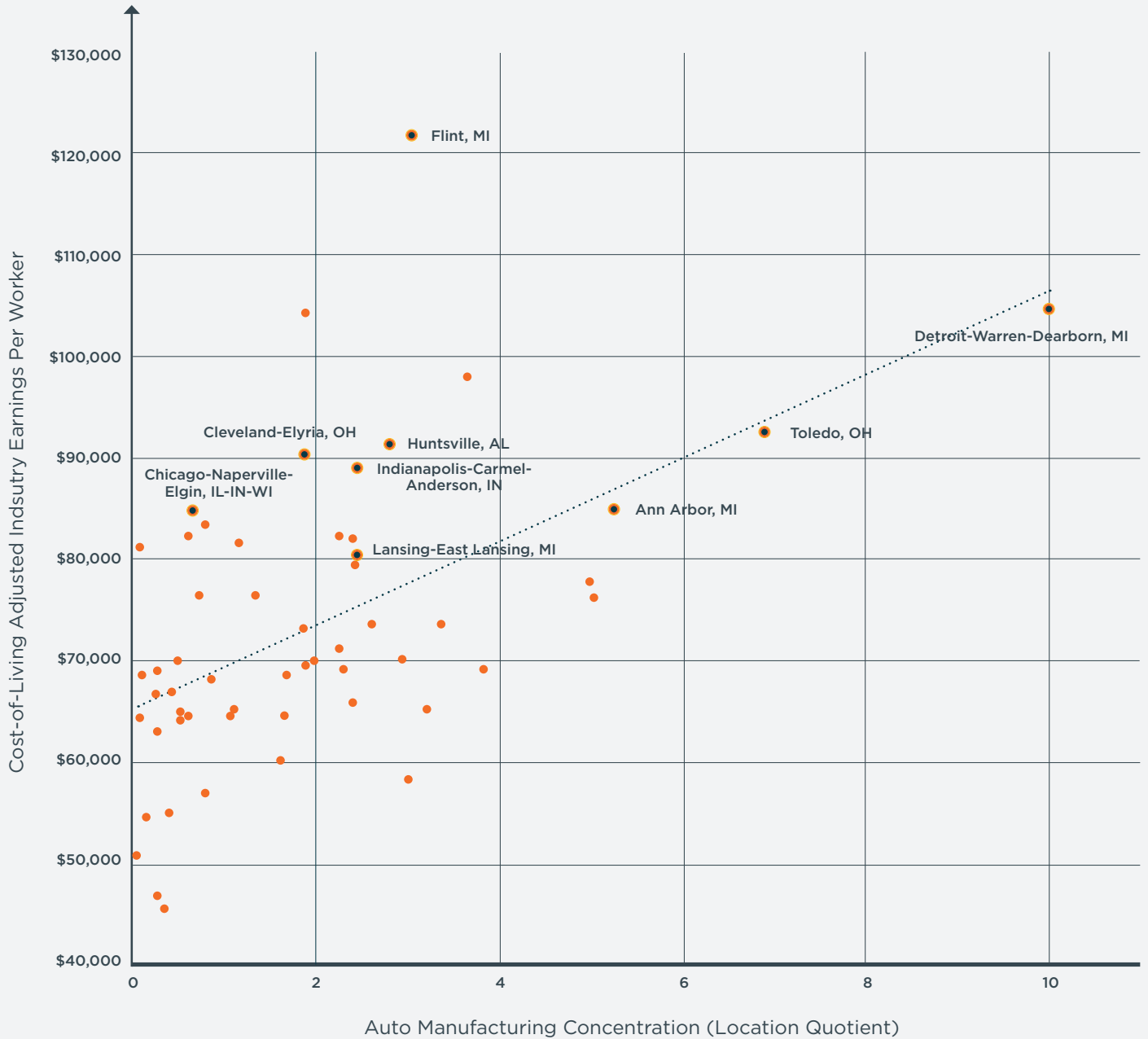
Average automotive worker earnings are generally higher for cities with higher auto manufacturer concentration.

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[5] Regression equation for trend line: y = 4130.9x + 65265; R^2 = 0.2851

SUBGROUPS
Design and Testing

The connected and automated vehicle Design and Testing group employs many engineers involved in the ongoing research, design, and testing of CAV projects. The group includes many types of engineers, including electrical engineers, mechanical engineers, and commercial and industrial designers. Each of these occupations has a hand in the early development and design of vehicles, aftermarket devices, and connected infrastructure.

In general, there are two interesting patterns for this occupation group: first, for most occupations, there are more completions than openings. This is most likely due to the high number of training providers and opportunities in the region and may increase emphasis on building skills for these high-demand jobs. Second, the highest rates of growth in the group (often over 15 percent) are projected for jobs open to those with an associate degree.

Demand Trends

Employment in design and testing occupations has demonstrated generally stable growth following a recession slowdown. Mechanical Engineers are by far the largest occupation in the subgroup, accounting for about half of all jobs and projected to grow to an even larger proportion. Since 2001, employment has grown 21.9 percent in all design and testing occupations, with a particularly dramatic increase after 2013 when it surpassed pre-recession levels. It is projected to continue to slow slightly and grow another 8.8 percent through 2028. There were about 27,000 online job postings between October 2018-September 2019 for those in these occupations across all industries. These occupations are critical to both early stages of CAV development and product design. They are employed in many testing laboratories and research and development firms, as well as across a variety of automotive part manufacturing companies.

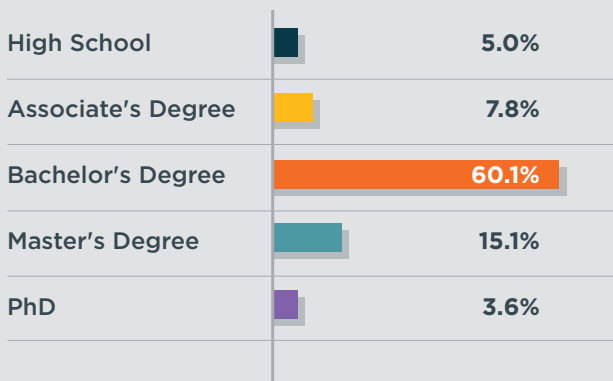**Design and Testing Employment Over Time**
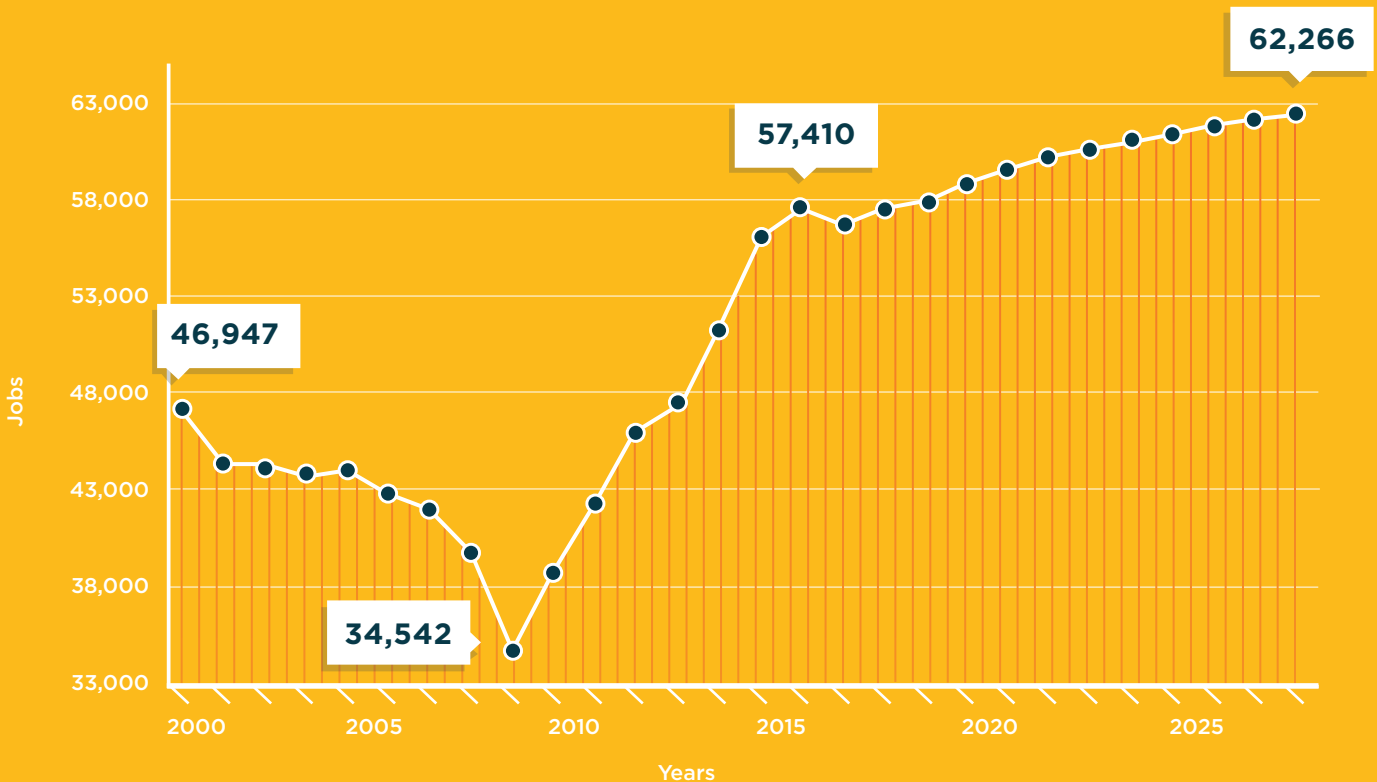
Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Design and Testing workers are listed below[6].

- ALTAIR ENGINEERING, INC.

- FCA US LLC

- Ford Motor Company

- General Motors Company

- Gtech Services, Inc

- Wilson, Jeff Chrysler Automobiles, Inc

- Endevis, L.L.c

- Kelly Services, Inc.

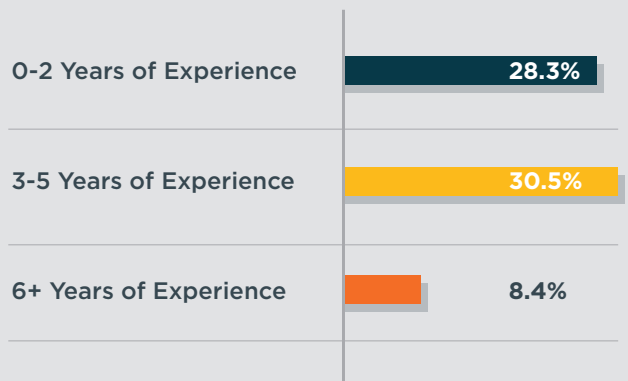- Robert Bosch LLC

- Cybercoders, Inc.

Employment Regional Specialization

The strong manufacturing presence and automotive specialization in southeast Michigan has led to a highly concentrated talent pool for Design and Testing occupations. Mechanical Engineers, in addition to having the largest employment, have a location quotient of 6.59 meaning they are nearly seven times more concentrated in the region than nationwide. Only Electrical and Electronics Engineering Technicians, which are employed in many nationally distributed industries outside of automotive manufacturing, have a location quotient under one. There are a low number of completions compared to openings for high-demand design occupations in the region. As all occupations require either a bachelor's or associate degree, this emphasizes the importance of attracting talent and developing diverse training pathways in southeast Michigan.

Education Required in Postings

High School	5.0%
Associate's Degree	7.8%
Bachelor's Degree	60.1%
Master's Degree	15.1%
PhD	3.6%

Experience Required in Postings

0-2 Years of Experience	28.3%
3-5 Years of Experience	30.5%
6+ Years of Experience	8.4%

[6] *Employer names are listed as they appear in online job postings.*

Experience and Educational Attainment

According to BLS data, all Design and Testing occupations require either a two- or four-year degree for entry. Engineers generally require at least a bachelor's degree while Technicians typically require an associate degree or post-secondary credential. Over half (65.6 percent) of Design and Testing postings advertising minimum education requirements asked for candidates with a bachelor's degree. An additional 8.6 percent of postings with education listed asked that candidates have an associate degree, though this is often underreported in job postings compared to BLS data and employer preference. Skills in Computer-Aided Design software, electronics, and test equipment, as well as an Automotive Service Excellence (ASE)

Certification are in high demand for technicians. All technician and drafter positions are also middle skill occupations. Engineer positions typically prefer expertise in product development and simulations and Six Sigma certifications. Required Master's degrees often refer to MBAs, which are suggested in 181 postings, reflecting the need for strong management skills in many engineering team leaders.

There are openings for Design and Testing workers across all experience levels as long as they have the correct skills. About 42 percent of postings specifying experience requirements were open to entry-level jobseekers, while another 45 percent require between three and five years.

Subgroup Wage Distribution

SOC Code	Occupation	Hourly Earnings				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
17-2071	Electrical Engineers	$29.77	$35.85	$44.60	$54.53	$62.82
17-2072	Electronics Engineers, Except Computer	$30.03	$35.75	$43.71	$53.60	$63.78
17-2131	Materials Engineers	$26.19	$31.51	$38.97	$48.47	$60.19
17-2141	Mechanical Engineers	$30.19	$35.71	$44.40	$54.96	$63.80
17-3013	Mechanical Drafters	$17.39	$22.29	$29.20	$36.58	$43.33
17-3023	Electrical and Electronics Engineering Technicians	$16.95	$22.41	$30.34	$35.64	$40.11
17-3024	Electro-Mechanical Technicians	$17.93	$23.78	$29.78	$35.36	$38.92
17-3027	Mechanical Engineering Technicians	$15.78	$19.34	$26.04	$33.58	$40.37
17-3029	Engineering Technicians, Except Drafters, All Other	$17.35	$22.72	$32.27	$41.27	$49.09
27-1021	Commercial and Industrial Designers	$22.37	$30.49	$40.69	$47.12	$52.37

In-Demand Skills

In-Demand Degrees

- Mechanical Engineering
- Electrical and Electronics Engineering
- Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology/Technician
- Electrical, Electronic and Communications Engineering Technology/Technician
- Commercial and Advertising Art
- Electrical, Electronics and Communications Engineering, Other
- Industrial and Product Design
- Materials Engineering
- Manufacturing Engineering Technology/Technician
- Mechanical Drafting and Mechanical Drafting CAD/CADD

Technical Skills

- Electrical Engineering
- Mechanical Engineering
- New Product Development
- Electronics
- Powertrain
- Computer-Aided Design
- Product Design
- Systems Engineering
- Prototype (Manufacturing)
- Design Failure Mode and Effects Analysis

Foundational Skills

- Communications
- Innovation
- Management
- Problem Solving
- Leadership
- Troubleshooting (Problem Solving)
- Integration
- Presentations
- Microsoft Office
- Microsoft Excel

Qualifications

- Six Sigma Green Belt Certification
- Professional Engineer
- Six Sigma Black Belt Certification
- Licensed Professional Engineer
- LEED Accredited Professional (AP)
- Project Management Professional Certification
- Microsoft Certified Professional
- Automotive Service Excellence (ASE) Certification
- Product Certification
- PMI Certified

Vehicle Manufacturing

The occupations analyzed in the connected and automated Vehicle Manufacturing group are positions that already exist at original equipment manufacturers (OEMs). Workers in this group include industrial engineers, mechatronics and robotics engineers, and team assemblers — workers needed throughout the vehicle manufacturing process. Additional training of existing employees may be necessary for workers to understand new equipment and processes involved in manufacturing an automated vehicle.

Demand Trends

Employment in manufacturing occupations has rebounded following a decline beginning before the Great Recession. Current employment is at its highest level since 2005 and is expected to remain stable over the next ten years. Since 2001, employment has fallen 19 percent in all manufacturing occupations, resulting from a pattern of slow decline before the recession. However, 2018 employment was 3 percent above pre-recession levels and is projected to continue to remain stable through 2028. In particular, industrial engineers, production supervisors, and technicians are projected to grow, while assemblers and fabricators are expected to decline. This is reflective of an overall shift away from manual production occupations toward computer-focused ones. There were about 42,000 online job postings between October 2018 and September 2019 for these occupations across all industries.

Vehicle Manufacturing Employment Over Time
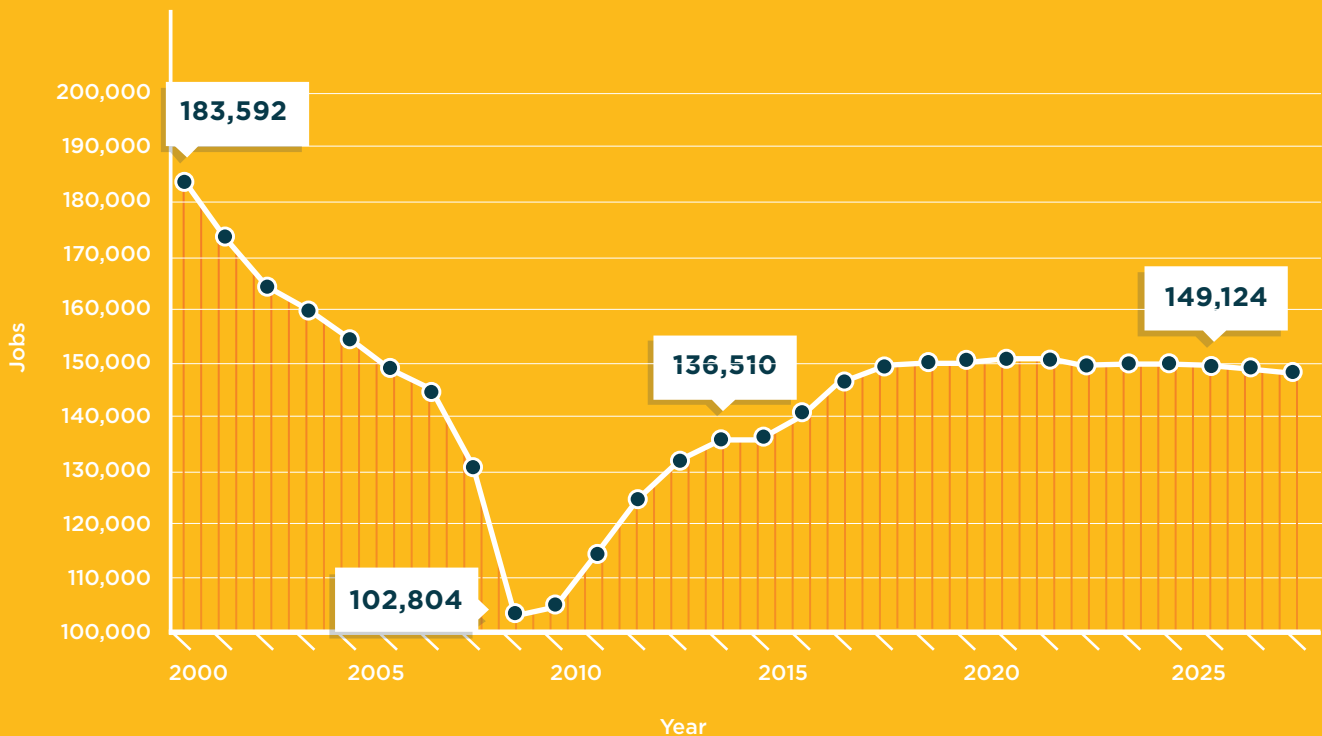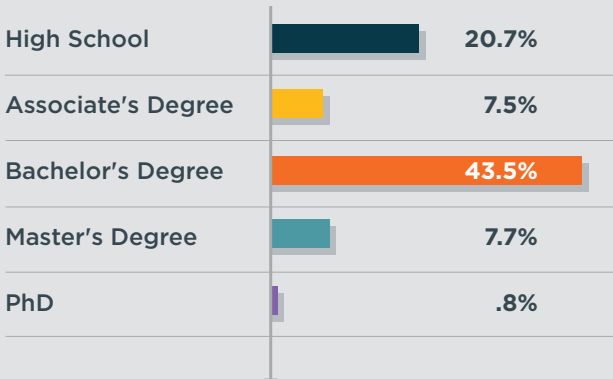
Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Manufacturing workers are listed below. In addition to automotive and parts manufacturers, several staffing companies operate in the area to help match talent.

- FCA US LLC
- Kelly Services, Inc.
- Ford Motor Company
- Endevis, L.L.c
- General Motors Company
- Express Services Inc
- Aerotek, Inc.
- Wilson, Jeff Chrysler Automobiles, Inc
- ALTAIR ENGINEERING, INC.
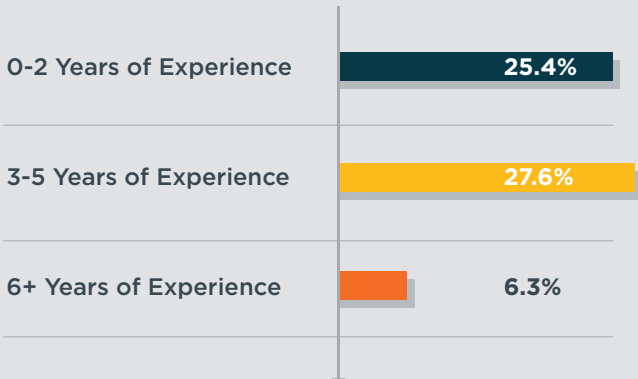- American Axle & Manufacturing, Inc.

Employment Regional Specialization

The strong manufacturing presence and automotive specialization in southeast Michigan means a highly concentrated talent pool for vehicle manufacturing occupations. Industrial Engineers, in addition to having a large number of annual openings, have a location quotient of 4.95 meaning they are nearly five times more concentrated in the region than nationwide. Only Production, Planning, and Expediting Clerks, which are needed in distribution and production environments in nearly all industries nationwide, have a location quotient under one, and most are far greater.

Education Required in Postings

High School	20.7%
Associate's Degree	7.5%
Bachelor's Degree	43.5%
Master's Degree	7.7%
PhD	.8%

Experience Required in Postings

0-2 Years of Experience	25.4%
3-5 Years of Experience	27.6%
6+ Years of Experience	6.3%

Experience and Educational Attainment

There are manufacturing positions available for candidates with anything between a high school diploma and an advanced degree. Due to higher posting rates for industrial engineers and similar roles than for skilled trades, about half (54.2 percent) of manufacturing postings advertising minimum education requirements asked for candidates with a bachelor's degree, while just over a quarter (25.9 percent) require a high school diploma. Industrial and Health and Safety Engineers and related positions often require at least a bachelor's degree, while Production Supervisors, Assemblers, and Skilled Trades roles tend to require a combination of experience and postsecondary credentials and apprenticeships. Among all manufacturing postings, a broad familiarity with the manufacturing process is in demand; auditing and purchasing, quality control, and continuous improvement are mentioned across education levels. For workers with a high school diploma or associate degree, tooling and mechanical proficiency are sought after, while product development and specific software and project management skills are needed for workers with at least a college degree. A broad range of manufacturing occupations, then, are classified as middle skill occupations. Electricians, which require an apprenticeship, are available, and so are production clerks, assemblers, and engineering technicians.

Much like the range of educational opportunities, vehicle manufacturing workers can find career opportunities across education levels. About 43 percent of postings specifying experience requirements were open to entry-level job seekers, while another 47 percent require between three and five years. Industrial Engineers and Architectural and Engineering managers are the most likely to require at least three years of experience, while Assemblers, Clerks, and Technicians are generally open to entry level workers.

Subgroup Wage Distribution

SOC Code	Occupation	Hourly Earnings				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
11-9041	Architectural and Engineering Managers	$46.03	$54.13	$64.13	$76.55	$91.69
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	$26.76	$30.62	$39.60	$53.00	$63.81
17-2112	Industrial Engineers	$30.90	$36.28	$44.45	$53.70	$61.29
17-2199	Engineers, All Other	$23.29	$33.48	$43.78	$55.78	$64.35
17-3026	Industrial Engineering Technicians	$16.89	$20.91	$26.67	$33.86	$39.89
43-5061	Production, Planning, and Expediting Clerks	$15.51	$19.01	$24.72	$31.12	$36.45
47-2111	Electricians	$14.76	$20.05	$30.86	$37.34	$43.31
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$17.13	$24.21	$32.68	$43.24	$51.44
51-1011	First-Line Supervisors of Production and Operating Workers	$18.69	$23.98	$31.72	$40.96	$50.69
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$11.29	$13.66	$17.99	$26.03	$30.93

In-Demand Skills

In-Demand Degrees

- Mechanical Engineering
- Electrical and Electronics Engineering
- Industrial Engineering
- Computer Engineering, General
- Bioengineering and Biomedical Engineering
- Architectural and Building Sciences/Technology
- Chemical Engineering
- Civil Engineering, General
- Aerospace, Aeronautical and Astronautical/ Space Engineering
- Industrial Production Technologies/ Technicians, Other

Technical Skills

- Auditing
- New Product Development
- Corrective and Preventive Actions
- Manufacturing Processes
- Tooling
- Continuous Improvement Process
- Automotive Industry
- Lean Manufacturing
- Purchasing
- Mechanical Engineering

Foundational Skills

- Management
- Operations
- Leadership
- Communications
- Problem Solving
- Innovation
- Microsoft Office
- Microsoft Excel
- Troubleshooting (Problem Solving)
- Sales

Qualifications

- American Society for Quality (ASQ) Certified
- Associate Ergonomics Professional
- Certified Associate in Project Management
- Certified Benefits Professional
- Certified Broadcast Radio Engineer
- Certified Business Manager
- Certified Case Manager
- Certified First Responder
- Certified Hazardous Materials Manager
- Certified in Production and Inventory Management

IT Design

Workers in IT Design are tasked with developing hardware and writing software for use in connected and automated vehicles. Computer hardware engineers working on connected and automated vehicle projects are developing hardware for fully automated vehicles as well as after-market devices designed to retrofit the existing fleet. Computer programmers and software developers write code that governs the automation of the vehicles, with an eye toward safety.

Demand Trends

IT Design occupations make up 11.2 percent of all connected and automated vehicles jobs. Since 2010, IT Design occupations has been on an upward trend and is projected to continue to increase by 9.6 percent from 2018 through 2028. Software Developers, Applications and Software Developers, System Software are growing quickly in southeast Michigan. Between October 2018 and September 2019 there were 45,620 online job postings. Software Developers, Applications and Computer User Support Specialists were the highest demanded occupations with 25,521 and 9,140 online postings respectively. The automation index for IT Design occupations ranges from 78.2-86.9, meaning that every occupation in this subgroup has a lower than average risk of becoming automated.

IT Design Employment Over Time
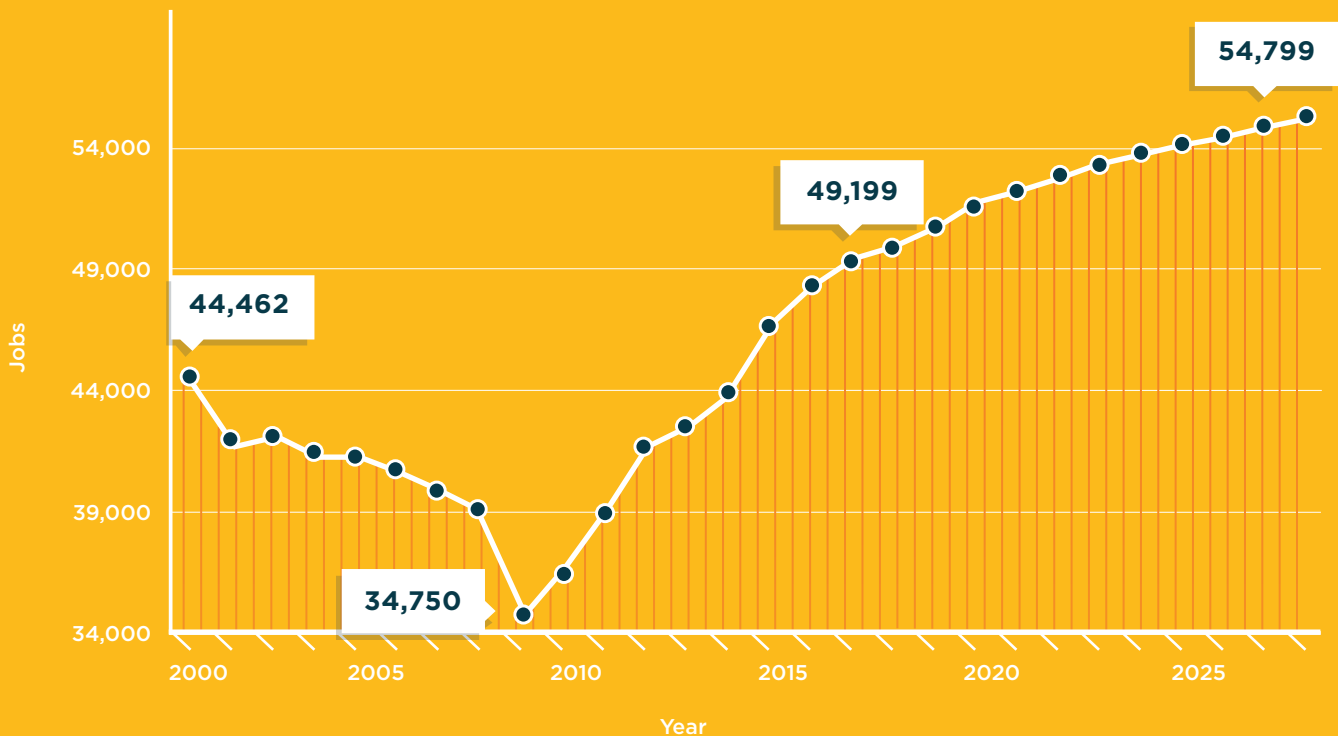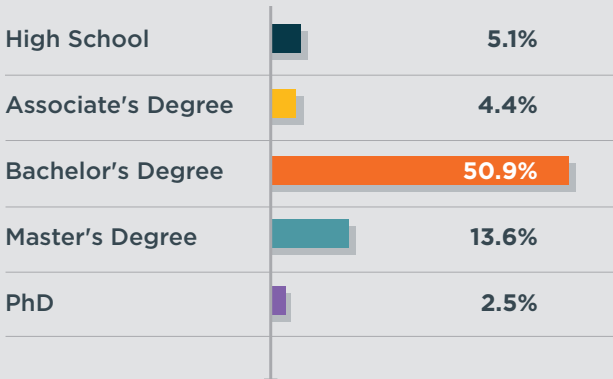
Top Posting Employers

The employers posting the highest number of job openings in IT Design are listed below.

- Ford Motor Company
- Revature
- Oracle Corporation
- Teksystems, Inc.
- ALTAIR ENGINEERING, INC.
- General Motors Company
- Cybercoders, Inc.
- Robert Bosch LLC
- Kelly Services, Inc.
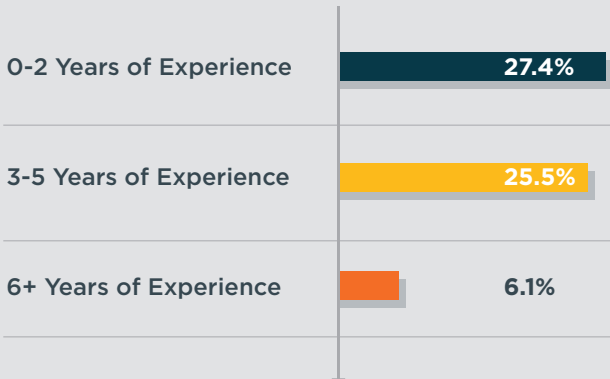- Fast Switch, Ltd.

Employment Regional Specialization

The location quotients for IT Design occupations depict reasonable concentrations of workers related to connected and automated vehicle development. Software Developers, Applications, Software Developers, System Software, Computer User Support Specialists, and Computer Hardware Engineers all have a location quotient of over 1.0. The top posting industries demanding IT Design occupations in southeast Michigan are professional, scientific, and technical services, administrative and support and waste management and remediation services and manufacturing. Across the region, between October 2018 and September 2019, Detroit had the highest demand for IT Design occupations with 11,311 job postings and Troy had the second largest demand with 4,455 postings.

Education Required in Postings

High School	5.1%
Associate's Degree	4.4%
Bachelor's Degree	50.9%
Master's Degree	13.6%
PhD	2.5%

Experience Required in Postings

0-2 Years of Experience	27.4%
3-5 Years of Experience	25.5%
6+ Years of Experience	6.1%

Experience and Educational Attainment

Many IT Design jobs are attainable with a bachelor's degree (23,203 postings) or a master's degree (6,190 postings). Employers indicating three to five years of experience coupled with some college or a bachelor's degree as a requirement for Computer Hardware Engineers and Computer User Support Specialists occupations had 11,632 postings, which makes up 25.5 percent of all IT Design postings. Although higher education and experience is desired by employers, entry-level workers are still heavily demanded with 12,489 postings, accounting for 27.4 percent of all postings for occupations such as Computer Network and Computer Programmers. While there are many

opportunities for entry-level workers, a large number of employers want candidates with experience for work on connected and automated vehicle development. Though many information technology occupations have high educational requirements, both Computer User Support Specialists and Computer Network Support Specialists are middle skill occupations. In the future, this may become more common as IT employers adopt apprenticeships as a training option.

Subgroup Wage Distribution

SOC Code	Occupation	Percentile Wages				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
15-1111	Computer and Information Research Scientists	$29.48	$39.40	$49.69	$59.01	$66.87
15-1131	Computer Programmers	$19.91	$27.66	$36.40	$44.95	$52.69
15-1132	Software Developers, Applications	$28.02	$34.49	$43.66	$54.54	$63.25
15-1133	Software Developers, Systems Software	$23.32	$33.52	$43.19	$52.85	$62.79
15-1151	Computer User Support Specialists	$13.13	$16.74	$22.62	$29.50	$37.58
15-1152	Computer Network Support Specialists	$17.79	$21.99	$28.89	$37.04	$46.18
17-2061	Computer Hardware Engineers	$20.15	$28.72	$43.82	$56.49	$65.46

In-Demand Skills

In-Demand Degrees

- Computer and Information Sciences, General
- Computer Programming/Programmer, General
- Computer Engineering, General
- Information Science/Studies
- Management Information Systems, General
- Computer and Information Systems Security/Information Assurance
- Information Technology
- Computer Systems Networking and Telecommunications
- Computer Science
- Network and System Administration/Administrator

Technical Skills

- Software Engineering
- Software Development
- JAVA
- SQL
- Agile
- JavaScript
- C++
- Python
- Debugging
- Automation

Foundational Skills

- Communications
- Management
- Innovation
- Computer Sciences
- Troubleshooting
- Problem Solving
- Integration
- Leadership
- Operations
- Research

Qualifications

- Microsoft Certified Professional
- CompTIA Network+
- ITIL Certifications
- Microsoft Certified Systems Engineer
- CompTIA A+
- ITIL Foundation Certification
- Cisco Certified Network Associate
- Microsoft Certified Systems Administrator (MCSA)
- Salesforce Certification
- CompTIA Security+

Quality Control

The Quality Control subgroup is small and made up of quality control systems managers, quality control analysts, and inspectors and testers. The workers employed in this subgroup are integral to the vehicle manufacturing process. Positions for workers already exist at vehicle manufacturers. However, some upskilling may be necessary for employees to work on connected and automated vehicle projects.

Demand Trends

Employment in Quality Control occupations has grown steadily since the recession and is projected to remain stable at around 31,300 workers through 2028. Since 2001, employment has grown by 8.1 percent, with little change in growth anticipated in the next ten years for the group overall. Inspectors, Testers, Sorters, Samplers, and Weighers, the largest occupation by employment, have relatively low wages and are declining, due to the slightly higher risk of automation, while higher-skilled roles are projected to grow. This presents an opportunity to retrain workers who have already developed a strong focus on detail, to other occupational pathways, where additional skills can be obtained. There were about 42,000 online job postings between October 2018 and September 2019 for quality assurance occupations across all industries, with 3,400 job openings expected per year. These occupations make up around 5.5 percent of total auto manufacturing and research and development industry employment.

Quality Control Employment Over Time
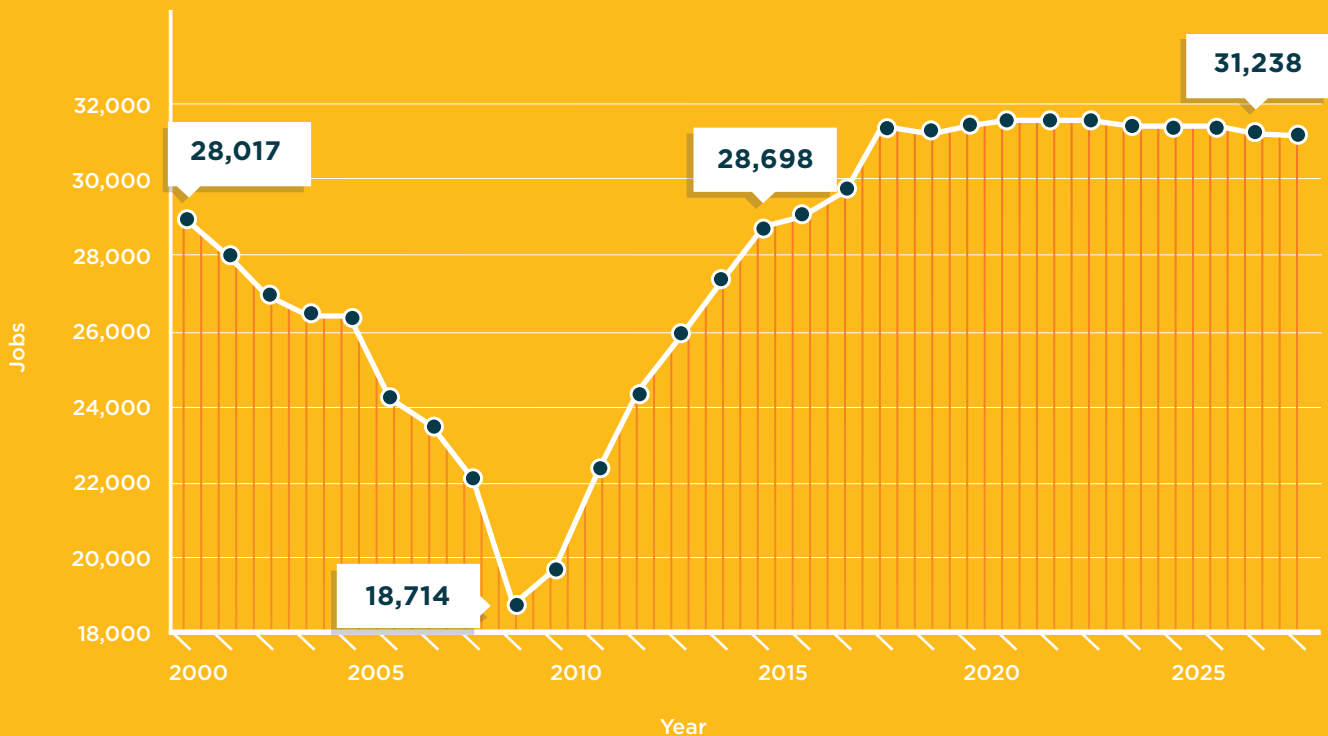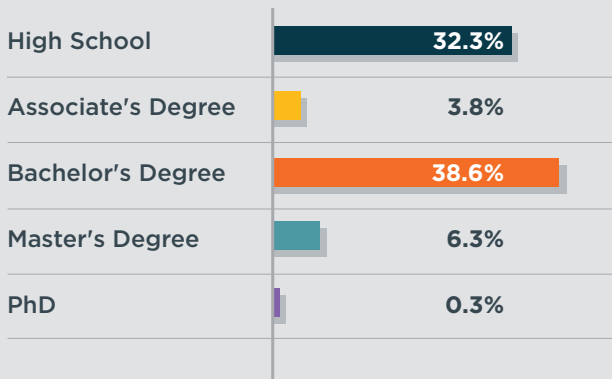
Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Quality Control are listed below.

- American Consumer Products Corporation
- Kelly Services, Inc.
- Homeadvisor, Inc.
- Pic Group, Inc.
- Express Services Inc
- Nesco Resource
- ManpowerGroup Global
- Aerotek, Inc.
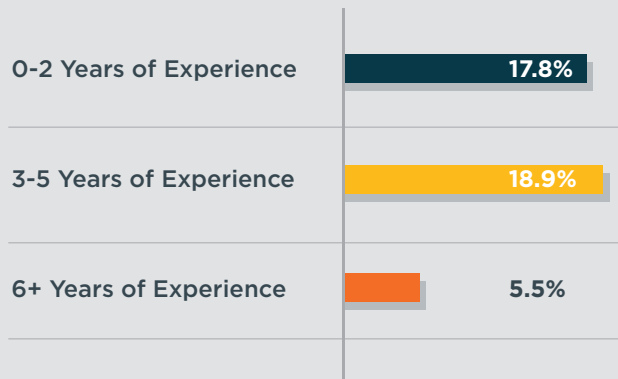- United Continental Holdings, Inc.
- FCA US LLC

Employment Regional Specialization

Due to the high concentration of manufacturing in southeast Michigan, Quality Control workers all have unusually high location quotients compared to the nation. Industrial Production Managers, and Life, Physical, and Social Science Technicians, All Other, which includes Quality Assurance Technicians, both have location quotients over two.

Education Required in Postings

High School	32.3%
Associate's Degree	3.8%
Bachelor's Degree	38.6%
Master's Degree	6.3%
PhD	0.3%

Experience Required in Postings

0-2 Years of Experience	17.8%
3-5 Years of Experience	18.9%
6+ Years of Experience	5.5%

Experience and Educational Attainment

Quality Control occupations are available for workers with many education levels. Of the four occupations analyzed here, BLS data on typical entry requirements indicates that two require a bachelor's degree (Industrial Production Managers and Compliance Officers), while Technicians require an associate degree and Inspectors, Testers, Sorters, Samplers, and Weighers require a high school diploma and on the job training. Real-time job postings indicate that 38.6 percent of job openings require a college degree, spread among all occupations here. These postings are often focused on quality at all stages of production, including a high number of openings indicating product development and testing.

The data show that nearly all Quality Control jobs related to automated and connected vehicles are within reach for workers with fewer than five years of experience (37 percent of postings). Most Inspector, Tester, Sorter, Sampler, and Weigher postings require two or fewer years of experience. Those jobs requiring more experience, six years and beyond, are nearly all for Industrial Production Managers. Familiarity with Lean Manufacturing is especially valued in highly experienced workers.

Subgroup Hourly Wage Distribution

SOC Code	Description	Hourly Earnings				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
11-3051	Industrial Production Managers	$35.08	$44.22	$56.26	$70.93	$87.31
13-1041	Compliance Officers	$19.73	$26.60	$35.71	$44.46	$49.12
19-4099	Life, Physical, and Social Science Technicians, All Other	$11.18	$13.90	$18.96	$25.80	$31.01
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	$10.23	$12.24	$16.58	$22.39	$29.75

In-Demand Skills

In-Demand Degrees

- Business Administration and Management, General
- Industrial Engineering
- Business/Commerce, General
- Science Technologies/Technicians, Other
- Public Policy Analysis, General
- Logistics, Materials, and Supply Chain Management
- Engineering/Industrial Management
- Operations Management and Supervision
- Quality Control Technology/Technician
- Legal Professions and Studies, Other

Foundational Skills

- Communications
- Management
- Sales
- Leadership
- Operations
- Customer Service
- Research
- Problem Solving
- Writing
- Data Entry

Technical Skills

- Auditing
- Packaging and Labeling
- Quality Control
- Warehousing
- Microsoft Access
- New Product Development
- Accounting
- Product Testing
- User Feedback
- Market Research

Qualifications

- Product Certification
- American Society for Quality (ASQ) Certified
- Six Sigma Black Belt Certification
- Certified Quality Engineer
- Six Sigma Green Belt Certification
- Certified Quality Manager
- Quality Certification
- Certified Quality Auditor
- Certified Welding Inspector
- ASNT Non-Destructive Tester
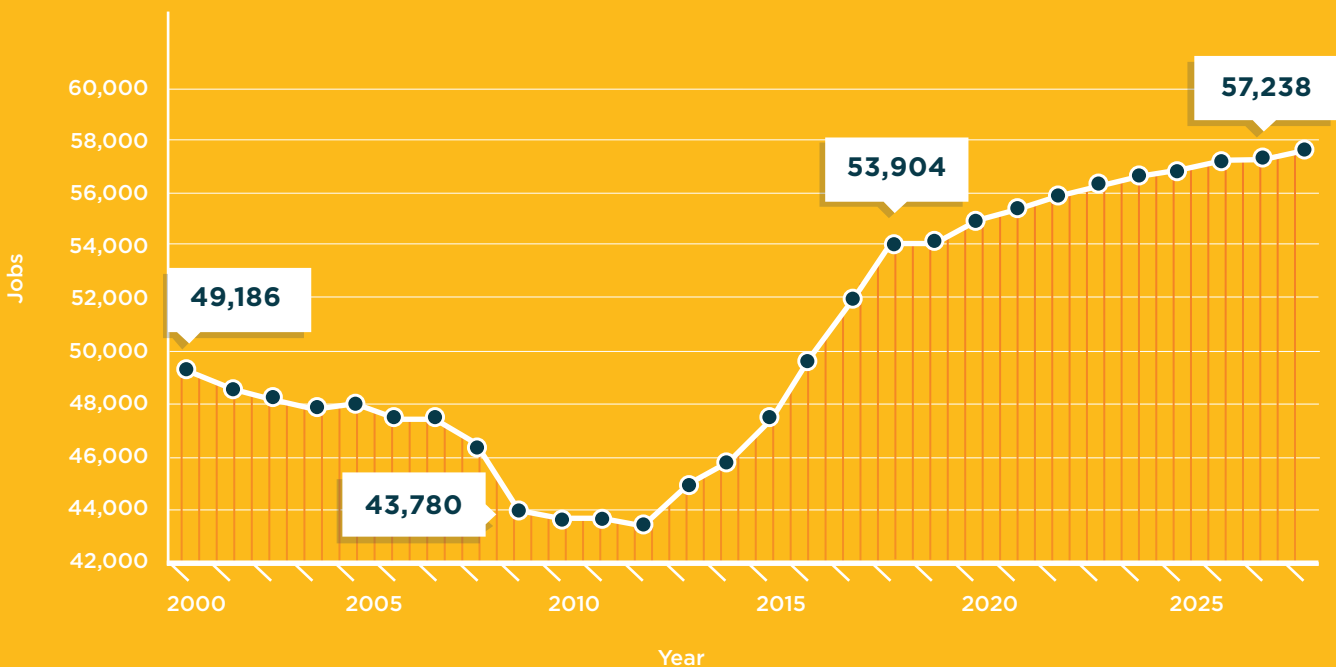
Data Management and Cybersecurity

Data Management and Cybersecurity is a large and important subgroup for connected and automated vehicles occupations. The data warehousing specialists, information security analysts, and other computer- and network-related occupations in this sub-group work protect data being collected and communicated by connected infrastructure and automated vehicles. Skills necessary for these occupations will be valuable to private owners of the new data as well as private individuals concerned for their physical safety and privacy as data is collected on their travel behavior.

Demand Trends

Employment in cybersecurity occupations has demonstrated stable growth following a recession slowdown, with Business Operations Specialists, All Other and Computer Systems Analysts as the largest occupations. Information Security Analysts did not experience a major decline during the recession and

are projected to continue this steady growth pattern. Since 2001, employment has grown 9.6 percent in all cybersecurity occupations, with a particularly dramatic increase after 2012. Through 2028, employment is projected to slow slightly, yet grow another 6.6 percent. There were about 42,000 online job postings between October 2018 and September 2019 for cybersecurity occupations across all industries. These occupations represent a small but important part of auto manufacturing employment and have greater representation in research and development firms. Cybersecurity occupations are critical to the security of classified machine algorithms and coding and represent the leading edge of data privacy. Due to cybersecurity workers' role in ensuring that security best practices are easily communicable to end users as well as designing the algorithms, these occupations are all at a less than average risk of automation.

Data Management and Cybersecurity Employment Over Time
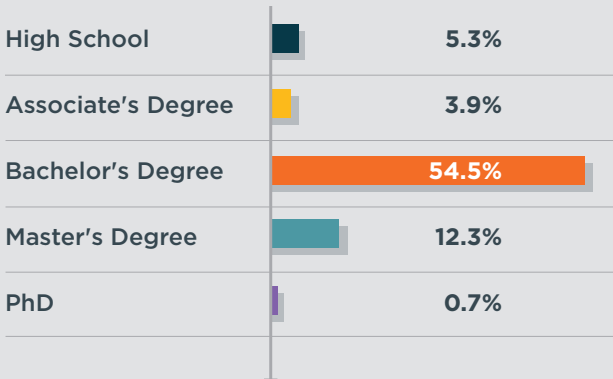
Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Data Management and Cybersecurity workers are listed below.

- Deloitte LLP

- Oracle Corporation

- Anthem, Inc.

- Teksystems, Inc.

- Ford Motor Company

- University of Michigan

- V2soft Inc.

- Computer Task Group, Incorporated

- Henry Ford Health System
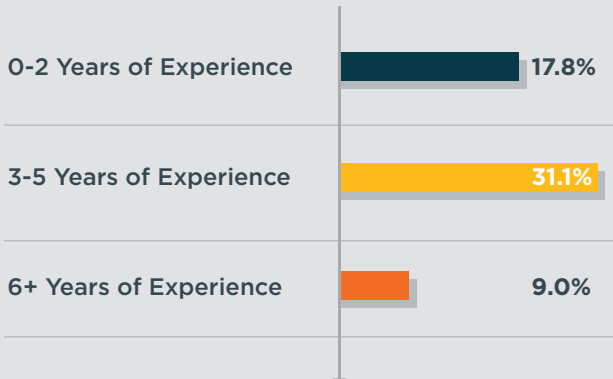
- Fast Switch, Ltd.

Employment Regional Specialization

Unlike many direct manufacturing-focused roles, cybersecurity occupations show approximately average concentration in southeast Michigan due to their broad applicability. Computer systems analysts, with a location quotient of 1.18, are more concentrated in the region than the nationwide average. However, all occupations report steady employment growth and increasing specialization for embedded technology security. There are a low number of completions compared to openings in the region, with about half as many program completions as available jobs. For a group requiring so much education, attracting technical talent and developing diverse career training pathways will be important for southeast Michigan.

Education Required in Postings

High School	5.3%
Associate's Degree	3.9%
Bachelor's Degree	54.5%
Master's Degree	12.3%
PhD	0.7%

Experience Required in Postings

0-2 Years of Experience	17.8%
3-5 Years of Experience	31.1%
6+ Years of Experience	9.0%

Experience and Educational Attainment

According to BLS data, only Computer Operators typically do not require a college degree, though as competition for talent grows, employers are often becoming more versatile in their education requirements. An overwhelming majority (71.0 percent) of Data Management and Cybersecurity postings advertising minimum education requirements asked for candidates with a bachelor's degree. An additional 16.9 percent of postings with education listed asked that candidates have education beyond a bachelor's degree. These high education requirements comprise nearly 90 percent of cybersecurity postings with specific education needs, and about three quarters of cybersecurity postings overall. Several of the larger occupations in this group are "All Other" codes encompassing many varied and emerging occupations, so it is helpful to look at posted titles when comparing skill and occupation needs. Operations Specialists, Systems Administrators, and Business Analysts are often open to high school graduates or those with an associate degree or other short-term credentials. For those with a bachelor's

or master's degree, Project Managers, Software Engineers, and Systems Analysts are commonly sought-after positions, while increasingly common software development and engineering hybrid role Systems Engineers are likely to require a PhD as the field emerges. Required master's degrees often refer as MBAs, are suggested in 706 postings, which reflect a high number of management positions requiring cybersecurity skills.

In addition to needing advanced degrees, workers in Data Management and Cybersecurity often need several years of relevant experience. While CAV is new to many companies, it is growing quickly, and workers must be as seasoned as possible. Cybersecurity specialists often have higher experience requirements than other IT positions. About 36 percent of postings specifying experience requirements were open to entry-level jobseekers, while about half require between three and five years. Again, considering posted job titles, Database Administrators, Enterprise Architects, and Data Architects are the most likely to require six or more years of experience.

Subgroup Hourly Wage Distribution

SOC Code	Occupation	Hourly Earnings				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
11-3021	Computer and Information Systems Managers	$38.86	$49.25	$62.24	$77.08	$96.99
13-1199	Business Operations Specialists, All Other	$17.95	$23.97	$32.69	$45.42	$58.12
15-1121	Computer Systems Analysts	$25.29	$31.63	$39.48	$49.19	$60.09
15-1122	Information Security Analysts	$28.87	$34.26	$44.00	$56.46	$65.65
15-1141	Database Administrators	$24.30	$31.28	$42.38	$53.32	$61.20
15-1142	Network and Computer Systems Administrators	$24.72	$30.52	$37.85	$47.46	$57.27
15-1199	Computer Occupations, All Other	$19.50	$26.03	$36.53	$48.43	$60.02
15-1199	Computer Operators	$11.63	$15.03	$21.07	$27.56	$30.96

In-Demand Skills

In-Demand Degrees

- Computer and Information Sciences, General
- Computer Programming/Programmer, General
- Computer Engineering, General
- Information Science/Studies
- Management Information Systems, General
- Computer and Information Systems Security/ Information Assurance
- Information Technology
- Computer Systems Networking and Telecommunications
- Computer Science
- Operations Management and Supervision

Technical Skills

- Agile Software Development
- Project Management
- Microsoft Access
- SQL
- Automation
- Business Requirements
- Business Process
- Software Development
- Information Systems
- Auditing

Foundational Skills

- Management
- Leadership
- Communications
- Operations
- Innovation
- Problem Solving
- Infrastructure
- Information Technology
- Troubleshooting (Problem Solving)
- Integration

Qualifications

- Certified Information Systems Security Professional
- Project Management Professional Certification
- Certified Information System Auditor (CISA)
- Cisco Certified Network Associate
- GIAC Certifications
- Certified Information Security Manager
- ITIL Certifications
- Microsoft Certified Systems Engineer
- Certified Ethical Hacker
- Cisco Certified Network Professional

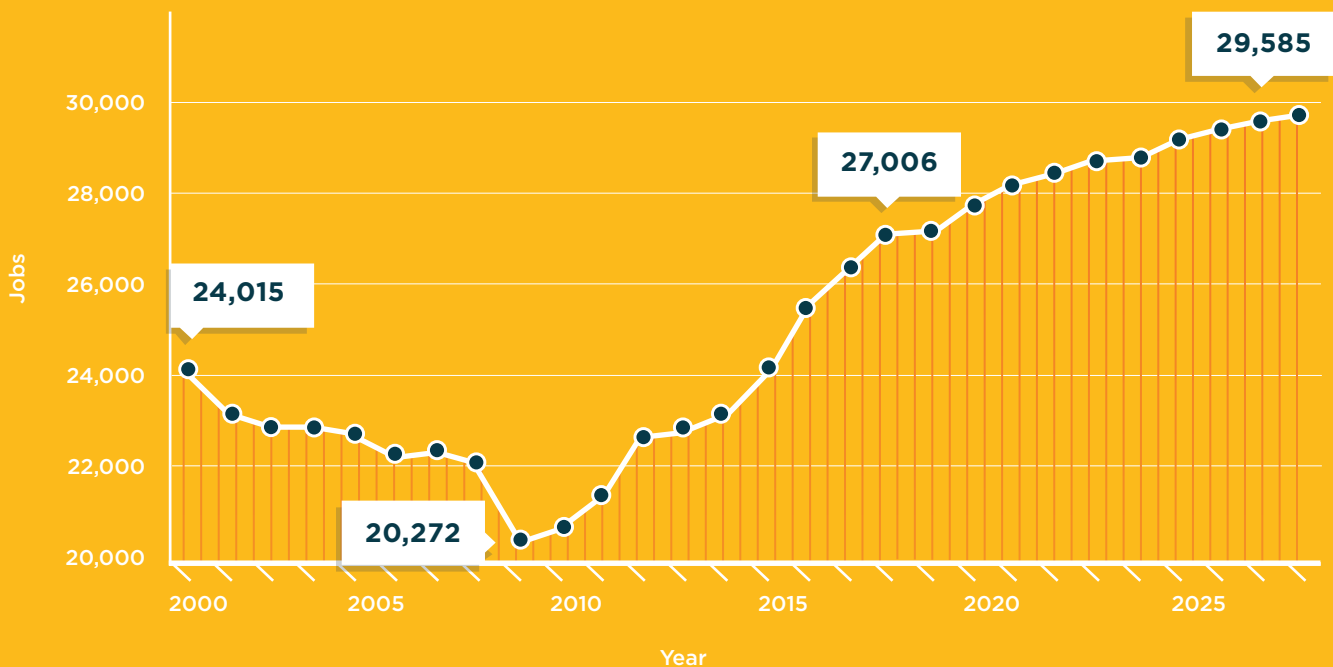# Intelligent Transportation Systems and Infrastructure Design

Employer demand for Intelligent Transportation Systems and Infrastructure Design workers has been strong since the recession in 2008. Skilled and knowledgeable workers found in this industry have been key in the implementation of connected vehicle infrastructure and intelligent transportation systems. Telecommunications specialists and civil engineers work closely with transportation planners and traffic technicians within this sub-group to inform decision making on connected infrastructure and traffic management. Workers in this industry may be employed for state and local departments of transportation or private consulting firms.

Demand Trends

Intelligent Transportation Systems and Infrastructure Design occupations make up 5.7 percent of all connected and automated vehicles jobs. Since 2010, employment in these occupations has been on an upward trend that

is projected to continue to increase by 9.3 percent from 2018 through 2028. Civil Engineers is the highest growing occupation for ITS and infrastructure design, with a 22.1 percent growth rate projected from 2018 through 2028. Between October 2018 and September 2019 there were 10,685 online job postings. The automation index for Urban and Regional Planners, Telecommunications Equipment Installers and Repairers, Except Line Installers, and Telecommunications Line Installers and Repairers are each above 100, so these occupations may be at a higher risk of being automated in the future.

ITS and Infrastructure Design Employment Over Time
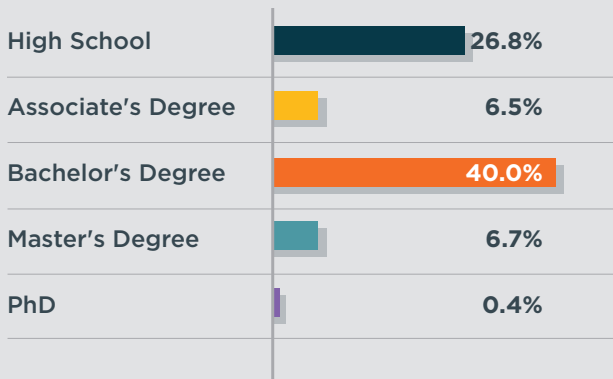
Top Posting Employers

The employers posting the highest number of job openings in ITS and Infrastructure Design are listed below.

- Comcast Corporation

- Army National Guard

- Bennett Truck Transport, LLC

- Dish Network L.L.C.

- Koch Trucking, Inc.

- Xpo Logistics, Inc.

- Roadrunner Transportation Systems, Inc.
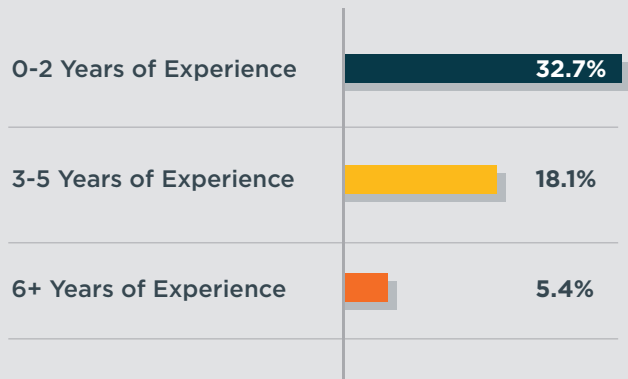
- Ryder System, Inc.

- FCA US LLC

- Aecom

Employment Regional Specialization

ITS and Infrastructure Design workers are needed for city planning and maintenance in municipalities nationwide; nearly all of these occupations have location quotients near or just under one, indicating average concentration. The exception to this is logisticians, who are critical in helping the region's distribution centers. The top posting industries demanding ITS and Infrastructure Design occupations in southeast Michigan are professional, scientific, and technical services, transportation and warehousing, and administrative and support and waste management and remediation services.

Education Required in Postings

High School	26.8%
Associate's Degree	6.5%
Bachelor's Degree	40.0%
Master's Degree	6.7%
PhD	0.4%

Experience Required in Postings

0-2 Years of Experience	32.7%
3-5 Years of Experience	18.1%
6+ Years of Experience	5.4%

Experience and Educational Attainment

Many ITS and Infrastructure Design jobs are attainable with a bachelor's degree (4,275 postings) or three to five years of experience (1,937 postings). Although higher education and experience is desired by employers, entry-level workers are still heavily demanded. Employers indicating a high school diploma (2,868 postings) and zero to two years of experience as a requirement (3,493 postings), make up 59.5 percent of all ITS and Infrastructure Design postings. Three of the occupations, Civil Engineering technicians and Telecommunications Equipment and Line Installers and Repairers, are middle skill, middle wage. The top educational programs in this subgroup are Business Administration and Management, General, Computer and Information Sciences, General and Business/Commerce, General.

Experience plays an important role in determining salary ranges for occupations in this industry. Civil Engineers and Transportation, Storage, and Distribution Managers both are highly demanded for their experience of six plus years. Logisticians with a median wage of $41.59, only require zero to two years of experience. The median salary approximations for these occupations are $51,000 and $83,180 respectively.

Subgroup Hourly Wage Distribution

SOC Code	Occupation	Percentile Wages				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
11-3071	Transportation, Storage, and Distribution Managers	$33.40	$40.84	$50.33	$63.78	$81.17
13-1081	Logisticians	$24.90	$31.64	$41.59	$49.93	$58.59
15-1143	Computer Network Architects	$29.81	$40.00	$53.18	$64.33	$75.48
17-2051	Civil Engineers	$25.25	$29.94	$36.87	$46.77	$59.12
17-3022	Civil Engineering Technicians	$15.41	$20.04	$24.72	$29.17	$32.89
19-3051	Urban and Regional Planners	$22.81	$28.53	$34.28	$39.49	$46.52
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	$16.01	$20.64	$25.93	$29.98	$35.94
49-9052	Telecommunications Line Installers and Repairers	$12.08	$14.30	$18.37	$26.79	$41.12
53-1048	First-line Supervisors of Transportation and Material Moving Workers, Except Aircraft Cargo Handling Supervisors	$14.27	$19.52	$25.50	$34.05	$41.44
53-6041	Traffic Technicians	$15.31	$16.95	$20.07	$24.67	$30.03

In-Demand Skills

In-Demand Degrees

- Computer and Information Sciences, General
- Computer Programming/Programmer, General
- Computer Engineering, General
- Information Science/Studies
- Management Information Systems, General
- Computer and Information Systems Security/ Information Assurance
- Information Technology
- Computer Systems Networking and Telecommunications
- Computer Science
- Network and System Administration/Administrator

Technical Skills

- Warehousing
- Civil Engineering
- Microsoft Access
- Supply Chain Management
- Telecommunications
- Auditing
- Purchasing
- AutoCAD
- Data Warehousing
- Construction Management

Foundational Skills

- Management
- Operations
- Communications
- Customer Service
- Leadership
- Problem Solving
- Innovation
- Valid Driver's License
- Microsoft Excel
- Sales

Qualifications

- Commercial Driver's License (CDL)
- Professional Engineer
- Licensed Professional Engineer
- Certified Forklift Operator
- Cisco Certified Network Associate
- Project Management Professional Certification
- Cisco Certified Network Professional
- Cisco Certified Internetwork Expert
- LEED Accredited Professional (AP)
- American Institute of Certified Planners (AICP) Certification
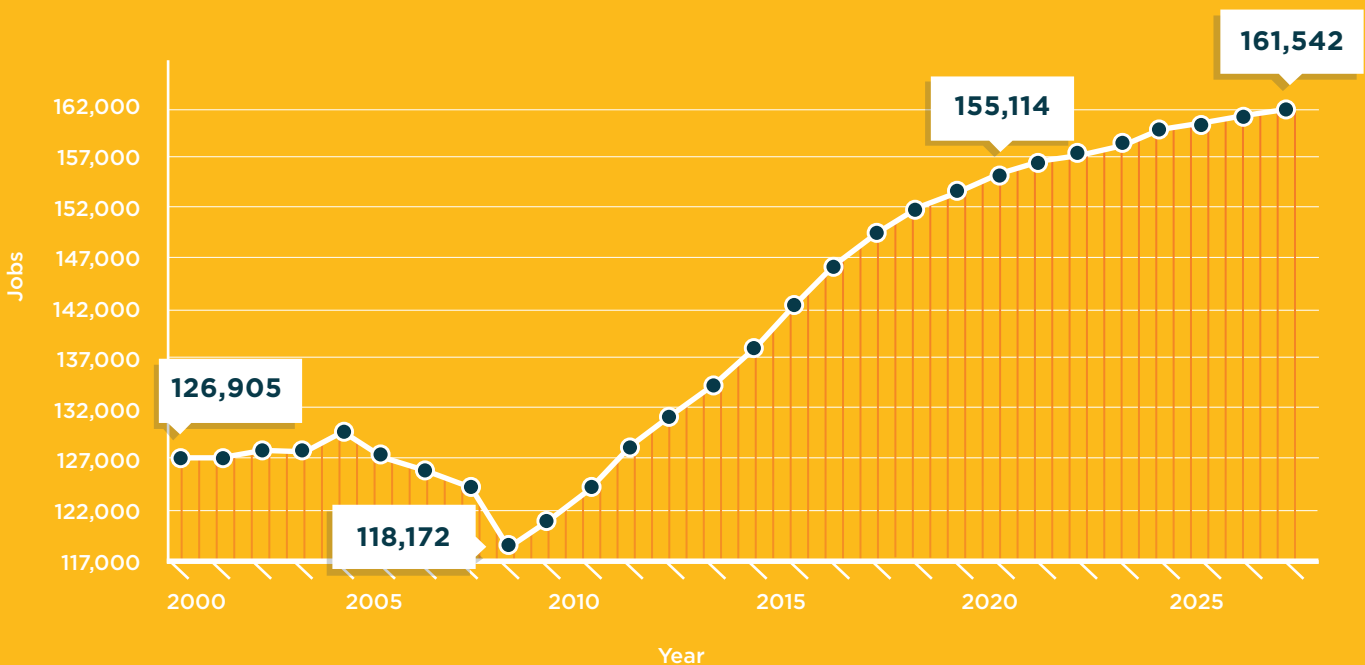
Business, Legal, and Marketing Support

As Connected and Automated Vehicles become more common in everyday life and use, educating the public and working with other businesses and legislators has become an important piece of the puzzle impacting the safety and comfort of commuters. These workers exist already in nearly every type of business and this report will examine the skills needed for marketing, deploying, and insuring CAV.

Demand Trends

Employment in Business, Legal, and Marketing occupations has grown steadily since the recession and is expected to increase through 2028. Since the market high in 2001, employment has grown by 17.7 percent, and another 8.2 percent is predicted over the next ten years. There were about 3,700 online job postings between October 2018 and September 2019 for workers in these occupations in related auto manufacturing firms. Though these workers are not included in the development or creation of automated vehicles, they must be familiar with the technology and able to communicate with both engineers and consumers. Selected occupations in business, legal, and marketing roles make up 3.5 percent of auto manufacturing and research and development industry employment and are projected to increase to 3.6 percent over the next ten years. There are an estimated 14,000 annual openings across all industries. Due to these workers' role in managing the human factors end of the technology, all included occupations are at less risk than average of being automated themselves; ten of the 18 occupations have automation indices below 90, and only one has an average risk of about 100.

Business, Legal, and Marketing Employment Over Time

Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Business, Legal, and Marketing Services are listed below.
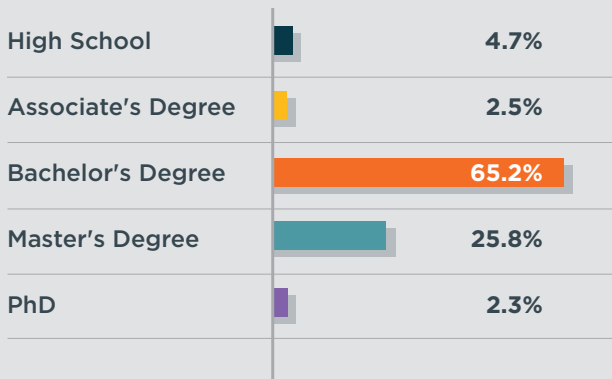
- Ford Motor Company

- FCA US LLC

- General Motors Company

- Robert Bosch LLC

- Nsf International

- Meritor, Inc.

- American Axle & Manufacturing, Inc.

- DELPHI AUTOMOTIVE PLC

- TRW LTD

- Tenneco Inc.

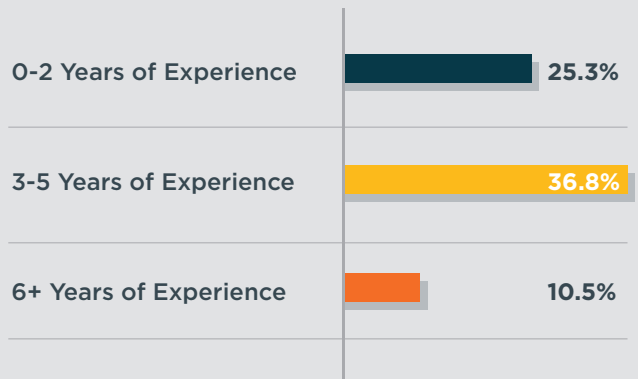## Employment Regional Specialization

Unlike many direct manufacturing-focused roles, business, legal, and marketing occupations have an average concentration in southeast Michigan based on location quotient. However, they report high employment and skills are highly transferrable across different regions. There are a low number of completions compared to openings.

Location quotient is a measurement of regional specialization for certain occupations and industries. Top occupations Buyers and Purchasing Agents, Market Research Analysts and Specialists, and Business Operations Specialists, All Other all have location quotients over 1, indicating unusually high levels of talent in these occupations in southeast Michigan. Among CAV-related industries, Business, Legal, and Marketing workers make up a relatively high portion of staff within Industrial Design Services and R&D Enterprises.

Education Required in Postings

High School	4.7%
Associate's Degree	2.5%
Bachelor's Degree	65.2%
Master's Degree	25.8%
PhD	2.3%

Experience Required in Postings

|	
0-2 Years of Experience	25.3%
3-5 Years of Experience	36.8%
6+ Years of Experience	10.5%

Experience and Educational Attainment

Of the 18 occupations in the Business, Legal, and Marketing group, 14 typically require at least a bachelor's degree for entry according to BLS data. Additionally, about 70 percent of online job postings prefer a college degree, however, another 25 percent of postings present openings for candidates with an advanced degree. Nearly 400 job postings indicated that an MBA is desired. Working as a Marketing Manager or Market Research Analyst is especially likely to require at least a bachelor's degree. Buyers and Purchasing Agents and Sales Managers are more likely to rely on experience. Postings requiring a PhD often request programming skills, while those preferring a bachelor's or master's degree focus on purchasing skills, auto industry knowledge, forecasting, and product development. Job postings seeking candidates with a high school diploma

or associate degree prefer specific vehicle knowledge such as familiarity with powertrains, chassis, and diesel engines along with business skills such as strategic planning and customer service. Given the high levels of preferred education in this subgroup, many of the occupations considered through BLS data to be middle skill are insurance, sales, claims, and appraiser positions.

Though there are positions open in this group for workers at any point in their career, the greatest number of online job postings, about 37 percent, are for individuals with three to five years of related experience. Lawyers and managers tend to need more experience, although Buyers and Purchasing Agents and Market Research Analysts and other analysts are often open to entry level workers. Forecasting and economics skills can assist with career entry, while business related skills are often developed and sought-after over time.

Subgroup Hourly Wage Distribution

SOC Code	Occupation	Hourly Earnings				
		Pct. 10	Pct. 25	Median	Pct. 75	Pct. 90
11-1021	General and Operations Managers	$21.51	$33.42	$52.66	$82.06	$115.71
11-2021	Marketing Managers	$35.71	$45.79	$61.76	$79.43	$118.50
11-2022	Sales Managers	$33.22	$46.89	$64.03	$80.70	$120.11
11-2031	Public Relations and Fundraising Managers	$36.00	$44.16	$56.52	$73.15	$94.72
11-9199	Managers, All Other	$5.80	$13.84	$30.72	$51.86	$70.96
13-1028	Buyers and Purchasing Agents	$19.42	$24.84	$32.98	$43.46	$55.01
13-1031	Claims Adjusters, Examiners, and Investigators	$21.11	$26.48	$32.79	$40.20	$47.58
13-1032	Insurance Appraisers, Auto Damage	$21.93	$25.25	$29.96	$35.74	$40.38
13-1111	Management Analysts	$22.27	$28.87	$39.51	$55.82	$81.88
13-1151	Training and Development Specialists	$15.97	$21.59	$29.93	$38.89	$48.52
13-1161	Market Research Analysts and Marketing Specialists	$16.46	$23.28	$32.16	$45.18	$58.65
13-1199	Business Operations Specialists, All Other	$17.95	$23.97	$32.69	$45.42	$58.12
13-2053	Insurance Underwriters	$23.04	$27.17	$34.41	$44.61	$52.90
15-2031	Operations Research Analysts	$25.04	$33.30	$42.81	$52.56	$61.67
23-1011	Lawyers	$24.07	$30.14	$45.38	$70.93	$96.83
27-3031	Public Relations Specialists	$15.12	$20.25	$27.73	$36.36	$46.62
41-3021	Insurance Sales Agents	$13.84	$18.57	$25.70	$39.23	$63.27
43-9041	Insurance Claims and Policy Processing Clerks	$12.80	$15.91	$19.70	$24.64	$29.32
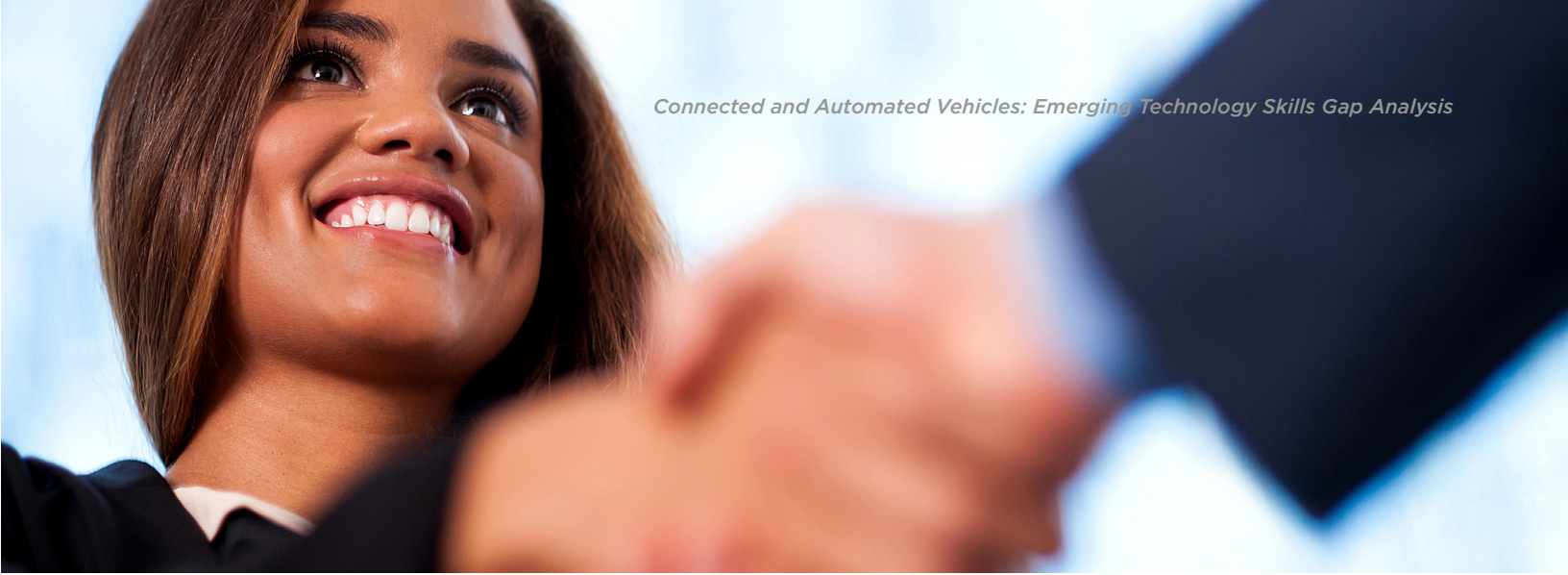
In-Demand Skills

In-Demand Degrees

- Business Administration and Management, General
- Marketing/Marketing Management, General
- Speech Communication and Rhetoric
- Business/Commerce, General
- Law
- Finance, General
- Human Resources Management/Personnel Administration, General
- International Business/Trade/Commerce
- Communication, General
- Business Administration, Management and Operations, Other

Technical Skills

- Purchasing
- Automotive Industry
- New Product Development
- Strategic Planning
- Forecasting
- Project Management
- Supply Chain Management
- Customer Relationship Management
- Powertrain
- Auditing

Foundational Skills

- Management
- Leadership
- Sales
- Communications
- Innovation
- Presentations
- Operations
- Microsoft Excel
- Problem Solving
- Microsoft Office

Qualifications

- Project Management Professional Certification
- Certified in Production and Inventory Management
- Six Sigma Green Belt Certification
- Certified Quality Auditor
- PMI Certified
- Six Sigma Black Belt Certification
- Certified Public Accountant
- Quality Certification
- Certified Business Analysis Professional
- ITIL Certifications

CAV REGULATION & TESTING

ATIONS

CAV REGULATIONS AND TESTING

2017 CAV REPORT REGULATIONS REVIEW

Regulations and policies regarding the testing and deployment of Connected and Automated Vehicles have the ability to speed or slow development. Considerations such as infrastructure design and maintenance and programming rules for autonomous actions and decisions are critical in advancing connected vehicle technology and determining when it is safe to be deployed. Further, when nations and major cities have been more amenable to CAV testing, this can encourage development and, as a result, international competition.

Legislation and Policymakers

Federal Guidance

The 2017 report[7] covered key legislation impacting CAV development as well as major national stakeholders. These codes and organizations still comprise the primary federal guidance for CAV and are summarized here. Emerging trends in CAV and state-by-state legislation are discussed later in the section. The Federal Highway Administration (FHWA) under the United States Department of Transportation (USDOT) and the National Highway Traffic Safety Administration (NHTSA) remain the preeminent sources for federal policy on connected and automated vehicles. USDOT and NHTSA released the Federal Automated Vehicles Policy in September 2016[8] to provide a policy framework at the national level. Professional associations in the world of transportation planning are weighing in on the regulations that should govern connected and automated vehicles as well. The National Association of City Transportation Officials (NACTO), for example, released their policy recommendations on automated vehicles in June 2016[9]. NACTO's recommendations are primarily focused on the potential effects CAV testing and deployment will have on safety, mobility, and land use at the municipal level.

State Guidance

States where development and testing on connected and automated vehicles has begun – some of the highest for CAV job demand explored here, like Michigan and California — have passed laws that are granting rights to first innovators in CAV, rather than prohibiting the ability to test. The National Conference of State Legislatures has published an Autonomous Vehicles State Bill Tracking Database[10] that showcases up-to-date status information on autonomous vehicle bills, both enacted and proposed, by state. The map to the right originates from this database and shows which states have addressed CAV in some manner as of 2018. Other means of; both the US and Michigan Department of Transportation periodically offer mobility challenges to encourage transit automation research and pilot programs.

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[7] *WIN CAV Skills Gap Analysis (2017)*

[8] *National Highway Transportation Safety Administration (2016)*

[9] *National Association of City Transportation Officials (2016)*

[10] *www.ncsl.org/research/transportation/autonomous-vehicles-legislative-database.aspx*

States with Autonomous Vehicles Enacted Legislation and Executive Orders

AS	American Samoa
GU	Guam
MP	Northern Mariana Islands
PR	Puerto Rico
VI	U.S. Virgin Islands

- ● Enacted Legislation
- ● Executive Order
- ● Both
- ● None

KEY STAKEHOLDERS

Mobility Alliances and Industry Stakeholders

Industry and interest groups span the United States, from technology to agriculture. Mobility alliances and manufacturing industry organizations allow employers, policymakers, and educators to convene and develop strategies. Geographically separate alliances are often complementary in that they focus on their region's strengths and unique challenges. Michigan, for instance, has given rise to organizations focused on expanding the horizons of auto manufacturing, while corresponding organizations in coastal hubs may have more interest in using data and vehicle technology to address congestion and smart infrastructure. Still other advanced manufacturing-heavy regions work to strengthen the CAV supply chain.

Southeast Michigan

- Michigan Alliance for Greater Mobility (MAGMA)

- MichAuto

- PTIO

- American Center for Mobility (ACM)

Mobility Alliances across the US

- E4 Mobility Alliance (LA County)

- Eastern Advance Manufacturing Alliance (EAMA)

- National Council for Advanced Manufacturing (DC)

- Manufacturing Renaissance (Chicago)

- Illinois Network for Advanced Manufacturing

- Conexus Indiana

- Regional Transportation Alliance (Research Triangle)

- Urban Manufacturing Alliance (Various)

- Northern Virginia Transportation Alliance

Roadblocks

Perception and Safety

Individuals must be prepared to adopt autonomous vehicles in order to create a strong market for them. As an unfamiliar update to familiar transportation technology, many consumers may experience discomfort. While CAV have the capability, and the goal, to make roadways safer for drivers and pedestrians alike, they will likely need to be significantly safer than traditional vehicles before adoption becomes widespread. Accidents involving autonomous vehicles, like the highly publicized 2018 Uber crash in Tempe, Arizona, or any of several related to Tesla's Autopilot feature[11] between 2016 and 2019, serve to make the public wary of the new technology. Generally, these incidents have occurred during the transition when a partially automated Level 2 or Level 3 vehicle requires the human driver to resume control. Consumer opinion on CAV safety appears to vary by age bracket; just 23.4 percent of individuals age 45-54 stated that they would be comfortable with a fully automated vehicle, while 40.0 percent of individuals age 25-34 felt this way.[12]

Stalling Out: Insurance and Federal Guidance

Questions abound regarding the impact of vehicle automation on car insurance rates and structure. Actuaries, automakers, policymakers and other stakeholders have yet to determine a solution. This will be an impactful topic in future CAV research, and the Business, Legal, and Marketing Services subgroup may witness a growth in automation-related skillsets once the technology becomes more widely utilized. Insurance plans will likely need to be plotted out before widespread implementation. Additionally, federal and state guidance on CAV testing, as well as workforce standards, are still not evolving as quickly as the technology.

Technology

Two approaches are currently being utilized in CAV implementation, and the distinction between them creates a need for manufacturers to prioritize one or the other. The first model is that of the fully autonomous shuttle that operates at low speeds on a set, short-distance route. The second is that of gradually integrating automated features into standard vehicles.

A dichotomy can also be observed in the kinds of wireless network used to connect vehicles to each other and the surrounding infrastructure. Dedicated Short-Range Communications (DSRC), viable sooner and therefore implemented first, involves a dedicated network between vehicles and roadside units. Cellular Vehicle-to-Everything (C-V2X) utilizes existing cellular networks for longer-range transmissions and a greater range of communicable connected devices and sensors. While both have strengths and weaknesses regarding the technology, ensuring that vehicles are able to communicate with each other may require standardization of the network. Automakers must choose which to focus on, and regulators, including the European Union, are currently deciding which to encourage. Even static infrastructure must be prepared for widespread connected vehicle usage; pavement markings must be wide enough to be read by sensors, road surfaces must be smooth, and traffic signals and other devices must be network-connected.

Training

A prepared workforce and sufficiently large talent pool present both an opportunity and a challenge for employers interested in CAV development. Increasingly rare and competitive skillsets and the changing nature of existing occupations require a multifaceted approach to workforce preparation. Current manufacturing workers must be upskilled, new workers must be attracted to the region, and employers may see benefit in reevaluating their degree requirements. See the next section, Training Provider Preparation, and WIN's CAV workforce recommendations in the Conclusion, for a detailed picture of the present and required education and training landscape in southeast Michigan.

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[11]*www.wired.com/story/tesla-autopilot-self-driving-crash-california/*
[12]*Abraham (2016)*

TRAINING PREPARATION

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TRAINING PROVIDER PREPARATION

TRAINING PROVIDER PREPARATION

As technology is advancing in CAV-related occupations, employers are best positioned to determine what skills their workforce will need to meet and maintain the demand of this industry. Therefore, training standards and practices have been primarily employer and industry lead thus far. For example, many auto manufacturers are implementing in-house training to upskill their existing workforce. One such model includes public-private partnerships such as MAGMA and the Michigan Mobility Institute, who offer short courses in CAV-related topics. In anticipation of future needs, regional educational providers are also increasing their offerings for automation, advanced manufacturing, robotics, and cybersecurity-related degree programs.

In addition to these collaborative models, job posting data can provide indicators for the skills and proficiencies needed by CAV workers. Subgroup-specific skill needs are outlined within each section, and to the right are the top posted skills for all CAV occupations employed in manufacturing.

Top In-Demand Skills for All CAV Occupations

1. Microsoft Access
2. Top Secret-Sensitive Compartmented Information (TS/SCI Clearance)
3. New Product Development
4. Agile Software Development
5. Software Development
6. Pharmaceuticals
7. Auditing
8. Software Engineering
9. Automation
10. Systems Engineering
11. Project Management
12. R
13. Electrical Engineering
14. Linux
15. Python
16. Information Systems
17. Java
18. SQL
19. Cyber Security
20. Corrective and Preventive Actions
21. Purchasing
22. Mechanical Engineering
23. C++
24. Biotechnology
25. Operating Systems
26. Business Development
27. Continuous Improvement Process
28. Strategic Planning
29. Quality Control
30. Manufacturing Processes
31. Lean Manufacturing
32. Budgeting
33. Procurement
34. Forecasting
35. C
36. Customer Satisfaction
37. Automotive Industry
38. Life Sciences
39. Technical Support
40. Customer Relationship Management

Current State of Training in Southeast Michigan

Though curricula for CAV-specific workers are still being developed, there are many two- and four-year institutions in the region ready to meet the demand. In total, within southeast Michigan, there are 37 institutions offering programs related to CAV occupations. This includes 195 types of degree and certificate programs, and over 21,000 completions per year. For all workers in these occupations across every industry, however, there are over 45,000 job openings per year. Curricula must also be flexible enough to meet changing demand; employers indicate difficulty finding talent with certain high-demand skillsets. These including emerging skills with non-standardized training, such as mechatronics and robotics, skilled trades roles with aging talent pools such as machinists, and the flexible combination of engineering and programming skills increasingly needed in vehicle software engineering positions.

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CAV represents part of an overall shift in technology adoption throughout everyday life, alongside other connected devices, machine learning, and an increased need for data privacy and cybersecurity measures. Auto manufacturers, transportation planners, and policymakers are still working to expand the frontier of connected vehicles and smart infrastructure. To enable a smooth transition, a skilled workforce at every stage of CAV development is critical.

To the right are the recommendations made in WIN's 2017 CAV Skills Gap Analysis.

2017 CAV Skills Gap Recommendations:

1 Employers must work together to create a common set of requirements for workers in the CAV space.

2 Current workers in CAV-related occupations who lack CAV-related skills must start to cross-training and develop related skills in order to remain competitive.

3 Connections between employers and the talent system, made up of community colleges, workforce boards, universities, and four-year colleges, must be strengthened to enhance the training provided to and received by the current workforce.

4 Regulations must be set in place that allow for more companies to test CAV on roadways in real-life situations.

5 Funding must be provided to develop public-private partnerships to create inclusive, safe intelligent transportation systems. Stakeholders include the public, first responders, the disabled community, and others.

In many ways, these recommendations remain salient as we observe greater advances in CAV technology. While a greater amount of CAV-specific collaboration is taking hold both in the region and the nation, there is still limited regulation related to CAV testing. In keeping with this updated CAV workforce report's focus on talent pipelines in southeast Michigan, WIN provides the following recommendations for continuing cultivation of a robust, innovative skill pool in the region:

2020 Emerging Technology Workforce Recommendations:

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1 Degree requirements should be made flexible when possible, allowing workers without a bachelor's degree to enter the CAV workforce provided the right skills and training. Expansion of middle skill positions has the potential to meet talent demand and strengthen the region's overall economy. At this time, many occupations in technology roles have high degree requirements for positions that could be filled with an individual who had completed short-term training or an apprenticeship in the right skills.

2 Educators, employers, and workforce boards must collaborate in creating robust training pathways to fill both short- and long-term skill needs. In particular, upskilling existing production workers is still a major opportunity.

3 To meet demand and continue transforming the connected vehicle space, employers must focus efforts on attracting technology talent to southeast Michigan.

APPENDICES

Appendix A: Occupation Codes by Subgroup

SOC	OCCUPATION

Design and Testing

SOC	Occupation
17-2071	Electrical Engineers
17-2072	Electronics Engineers, Except Computer
17-2131	Materials Engineers
17-2141	Mechanical Engineers
17-3013	Mechanical Drafters
17-3023	Electrical and Electronics Engineering Technicians
17-3023	Electrical Engineering Technicians
17-3023	Electronics Engineering Technicians
17-3027	Mechanical Engineering Technicians
17-3029	Engineering Technicians, Except Drafters, All Other
27-1021	Commercial and Industrial Designers
17-3024	Electro-Mechanical Technicians

Manufacturing

SOC	Occupation
17-2112	Industrial Engineers
47-2111	Electricians
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers
11-9041	Architectural and Engineering Managers
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors
17-2199	Engineers, All Other
17-3026	Industrial Engineering Technicians
43-5061	Production, Planning, and Expediting Clerks
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers
51-1011	First-Line Supervisors of Production and Operating Workers

IT Design

SOC	Occupation
15-1131	Computer Programmers
15-1132	Software Developers, Applications
15-1133	Software Developers, Systems Software
15-1151	Computer User Support Specialists
15-1152	Computer Network Support Specialists
17-2061	Computer Hardware Engineers
15-1111	Computer and Information Research Scientists

Quality Control

SOC	Occupation
11-3051	Industrial Production Managers
13-1041	Compliance Officers
19-4099	Quality Control Analysts
19-4099	Quality Control Systems Managers
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers

Data Management and Cybersecurity

SOC	Occupation
11-3021	Computer and Information Systems Managers
13-1199	Security Management Specialists
15-1121	Computer Systems Analysts
15-1122	Information Security Analysts
15-1141	Database Administrators
15-1142	Network and Computer Systems Administrators
15-1199	Computer Occupations, All Other
15-1199	Computer Systems Engineers/Architects
15-1199	Data Warehousing Specialists
15-1199	Database Architects
15-1199	Geospatial Information Scientists and Technologists
15-1199	Software Quality Assurance Engineers and Testers
43-9011	Computer Operators

Intelligent Transportation Systems and Infrastructure Design

SOC	Occupation
11-3071	Transportation, Storage, and Distribution Managers
11-3071	Transportation Managers
13-1081	Logisticians
15-1143	Computer Network Architects
17-2051	Civil Engineers
17-2051	Transportation Engineers
17-3022	Civil Engineering Technicians
49-9052	Telecommunications Line Installers and Repairers
53-6041	Traffic Technicians
19-3051	Urban and Regional Planners
53-1048	First-line Supervisors of Transportation and Material Moving Workers, Except Aircraft Cargo Handling Supervisors

Business, Legal, and Marketing Support

SOC	Occupation
11-1021	General and Operations Managers
11-2021	Marketing Managers
11-2022	Sales Managers
11-2031	Public Relations and Fundraising Managers
11-9199	Managers, All Other
13-1028	Buyers and Purchasing Agents
13-1111	Management Analysts
13-1151	Training and Development Specialists
13-1161	Market Research Analysts and Marketing Specialists
13-1199	Business Operations Specialists, All Other
15-2031	Operations Research Analysts
23-1011	Lawyers
27-3031	Public Relations Specialists
13-1031	Claims Adjusters, Examiners, and Investigators
13-1032	Insurance Appraisers, Auto Damage
13-2053	Insurance Underwriters
41-3021	Insurance Sales Agents
43-9041	Insurance Claims and Policy Processing Clerks

Appendix B: CAV Keyword and Industry Data Collection Filters

Industry Filters

336111	Automobile Manufacturing
333618	Other Engine Equipment Manufacturing
333613	Mechanical Power Transmission Equipment Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing
336120	Heavy Duty Truck Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing
336211	Motor Vehicle Body Manufacturing
336370	Motor Vehicle Metal Stamping
336340	Motor Vehicle Brake System Manufacturing
336390	Other Motor Vehicle Parts Manufacturing
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
541380	Testing Laboratories
541420	Industrial Design Services
541715	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)

Keyword Filters

- automation
- forward collision warning
- emergency electronic brake light
- intersection movement assist
- blind spot warning
- verify-all
- advanced driver assistance systems
- integrated safety system
- on board equipment
- do not pass warning
- aftermarket safety device
- left turn across path
- do not pass warning
- curve speed warning
- sensor fusion
- vehicle to vehicle
- vehicle to infrastructure
- pedestrian detection system
- dedicated short range communications
- intelligent transportation system
- signal phasing and timing
- connected vehicle professional
- vehicle software development
- cybersecurity
- wireless integration
- connected vehicles
- automated vehicles
- radar signal processing
- intelligent car
- semi-autonomous systems
- threat assessment
- platooning
- driverless
- platoon
- OMNI Air
- V2I
- V2X
- V2V
- crash avoidance

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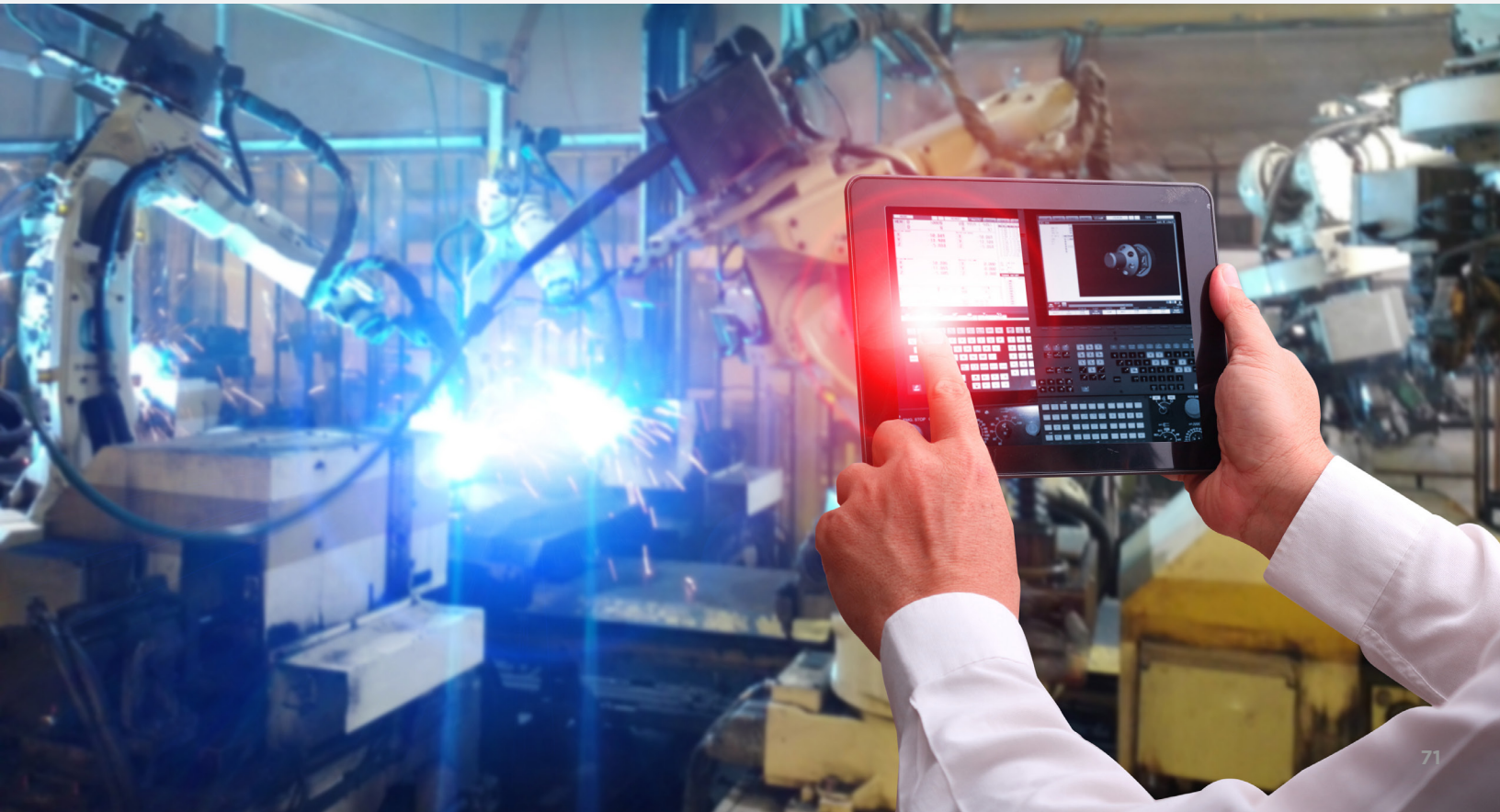
Appendix D: Glossary

Automation Index: Measure for each occupation provided by Emsi:

"The automation index captures an occupation's risk of being affected by automation using four measures:

- % of time spent on high-risk work

- % of time spent on low-risk work

- Number of high-risk jobs in compatible occupations

- Overall industry automation risk

This methodology starts with the underlying work on task content. We use estimated task time shares, derived from O*NET work activities, and regress them for each occupation based on Frey and Osborne's published "computerization probabilities" (2013). This helps us identify which tasks are positively and negatively correlated with automation risk. This classification is then linked with the task time shares to identify the share of each occupation's time spent in high- and low-risk work, from an automation perspective. Then we look at the place of an occupation in the broader context of labor market automation risk. Using occupation compatibility scores, we look at all similar roles (defined as having an O*NET compatibility score over 75) and find the percentage of jobs in those similar roles that are at risk of automation. Finally, using staffing pattern data, we multiply the share of an occupation's jobs in 3-digit NAICS industries by that industry's share of at-risk jobs to calculate the overall industry automation risk. We then standardize all these measures and scale the index so that 100 = the "average worker," defined as the average index across all occupations, weighted by job numbers in 2018. The index has a standard deviation of 15. Note that the share of time spent on low-risk work is a negative contributor to an occupation's index score (making the index score lower) while the other three measures are positive contributors (making the index score higher)."

Bureau of Labor Statistics (BLS): Under the United States Department of Labor, the Bureau of Labor Statistics is the preeminent collector and distributor of labor market and economic data at the federal level.

Certifications: Professional certifications or qualifications required or preferred in online job postings.

Data Management and Cybersecurity: Occupation group that encompasses information technology workers with skills necessary to warehouse and protect data collected by automated vehicles and connected infrastructure on travel behavior. Key occupations include data warehousing specialists, information security analysts, and computer network architects.

Demand Concentration: For the purposes of this analysis, demand concentration refers to the share of CAV-related job postings relative to total job postings at the level of the metropolitan statistical level (MSA).

Education Requirements: This dataset from Emsi overviews the level of educational attainment specified (required or preferred) in online job postings for a particular occupation or job.

Experience: Similar to educational attainment, this information is pulled from job postings to illustrate the level of experience that employers seek from candidates for an open position.

Industry: A category that defines the activities of a business. See also: North American Industry Classification System (NAICS).

Intelligent Transportation Systems/Infrastructure Design: Occupation group primarily concerned with the deployment of the automated vehicle fleet on a fully connected roadway infrastructure. Key occupations include telecommunications professionals, civil engineers, city planners, and traffic technicians.

Internet of Things: A system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Location Quotient: An analytical statistic that measures a region's industrial specialization relative to a larger geographic unit (usually the nation). An LQ is computed as an industry's share of a regional total for some economic statistic (earnings, GDP by metropolitan area, employment, etc.) divided by the industry's share of the national total for the same statistic. For example, an LQ of 1.0 in mining means that the region and the nation are equally specialized in mining; while an LQ of 1.8 means that the region has a higher concentration in mining than the nation.

Job Demand: Approximated by total number of online job postings for a specific occupation in this analysis through the use of job postings data from Emsi.

North American Industry Classification System (NAICS): Adopted in 1997 by the United States Economic Classification Policy Committee (ECPC) and partner departments in Mexico and Canada, the NAICS is a standard system for defining the activities of businesses.

Occupation: A category that defines the knowledge, skills, and functions of a worker. For the purposes of this analysis, defined by some classification system in order to operationalize worker type. See also: O*NET, Standard Occupational Classification System (SOC).

O*NET: Occupational Information Network, maintained by the United States Department of Labor. O*NET catalogs the essential duties, knowledge, and skills required of a certain job, resulting in a set of 8-digit codes delineating distinct occupations. See also: Standard Occupational Classification System (SOC).

Quality Control: Occupation group consisting of quality control systems managers, quality control analysts, and inspectors and testers, integral to the vehicle manufacturing process.

Salary/Wages: Percentile hourly wage data, available at the county level, is provided through the BLS.

Skills, Foundational: Coded from online job postings, Emsi presents these as baseline skills necessary for successful employment in the open position.

Skills, Technical: Coded from online job postings, Emsi present these as the technical skills necessary for successful employment in the open position.

Standard Occupational Classification (SOC): Used by the federal government to define worker type, this classification system features a set of 6-digit codes (aligned with O*NET codes) to delineate distinct occupations. See also: O*NET.

Top Posting Employers: Based on online job postings data from Emsi, these are the employers that posted the most online job ads for an occupation over the analysis period. Online job postings are often seen as an indicator of a company's willingness to hire.

Vehicle Design and Testing: Occupation group of engineers involved in the early design and development of automated vehicles, aftermarket retrofit devices, and connected infrastructure. Key occupations include electrical engineers, mechanical engineers, and commercial and industrial designers.

Vehicle IT Design: Occupation group made up of workers tasked with writing software and designing hardware to govern vehicle automation. Key occupations include computer programmers and software developers.

Vehicle Manufacturing: Occupation group made up of existing manufacturing occupations that will need additional training in order to work on connected and automated vehicle manufacturing processes. Key occupations include industrial engineers, mechatronics and robotics engineers, and team assemblers.

RW

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F O U N D A T I O N

Report compiled by the Workforce Intelligence Network for Southeast
Michigan on behalf of the Ralph C. Wilson, Jr. Foundation

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