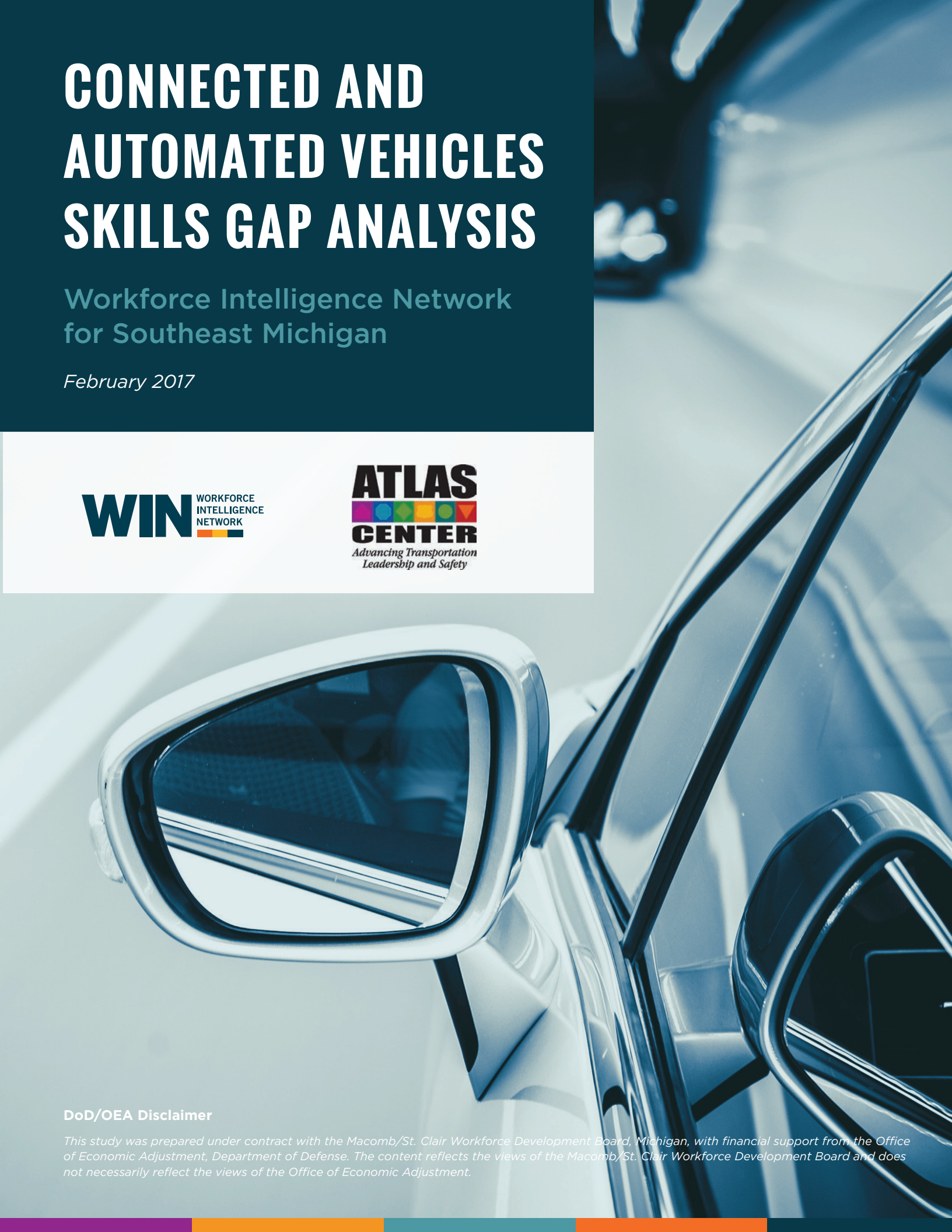
CONNECTED AND AUTOMATED VEHICLES SKILLS GAP ANALYSIS

Workforce Intelligence Network for Southeast Michigan

February 2017

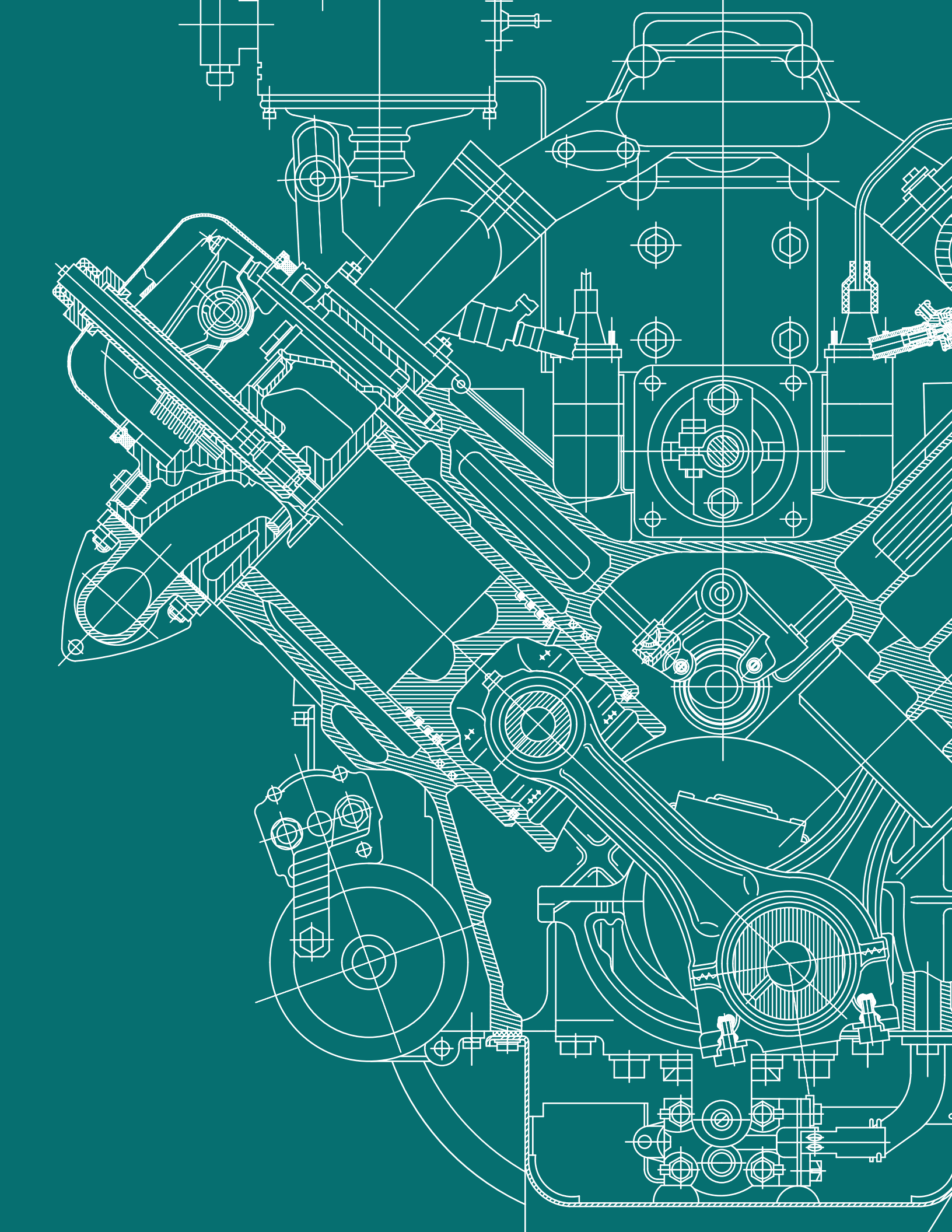
WIN WORKFORCE INTELLIGENCE NETWORK

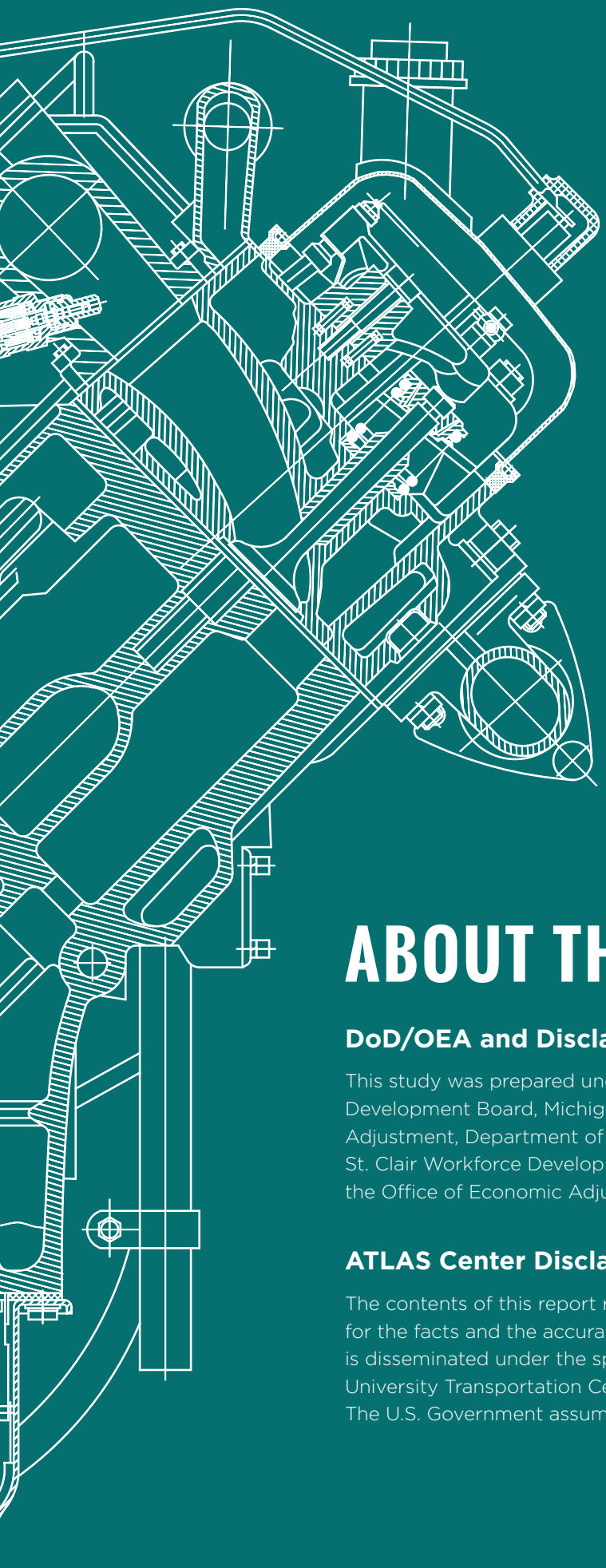
ATLAS CENTER
Advancing Transportation Leadership and Safety



DoD/OEA Disclaimer

This study was prepared under contract with the Macomb/St. Clair Workforce Development Board, Michigan, with financial support from the Office of Economic Adjustment, Department of Defense. The content reflects the views of the Macomb/St. Clair Workforce Development Board and does not necessarily reflect the views of the Office of Economic Adjustment.





ABOUT THE REPORT

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Executive Summary

Connected and automated vehicles (CAV) are the next frontier for transportation. Companies and research institutes are still scratching the surface of what is possible and necessary to make CAV and intelligent transportation systems a reality for travelers. 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 matures. In order to better understand future workforce demands in the CAV space, the Workforce Intelligence Network for Southeast Michigan (WIN) partnered with University of Michigan Transportation Research Institute (UMTRI) to analyze job postings for a broad set of occupations that may be involved in the design, manufacture, and infrastructure development included in the CAV product cycle.

WIN's analysis method often includes categorizing occupations relevant to the problem at hand, in this case, CAV, then analyzing data on that workforce's demographics, employment trends, and demand for workers by local employers. In this case, because of the broad range of occupations – including engineers, software developers, cybersecurity professionals, and transportation planners – that are integral to the rollout of CAV, 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 Burning Glass Technologies for 49 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 2011 to 2016, WIN researchers present analysis on the demand for CAV workers, including the following data points:

- Top employers hiring for CAV projects,
- Geographic concentration of demand for workers with CAV-related skills,
- Specific levels of experience and educational attainment that employers require of workers for CAV projects,
- Salaries advertised for CAV-related positions, and
- Skills, certifications, and degrees demanded by employers for CAV workers.

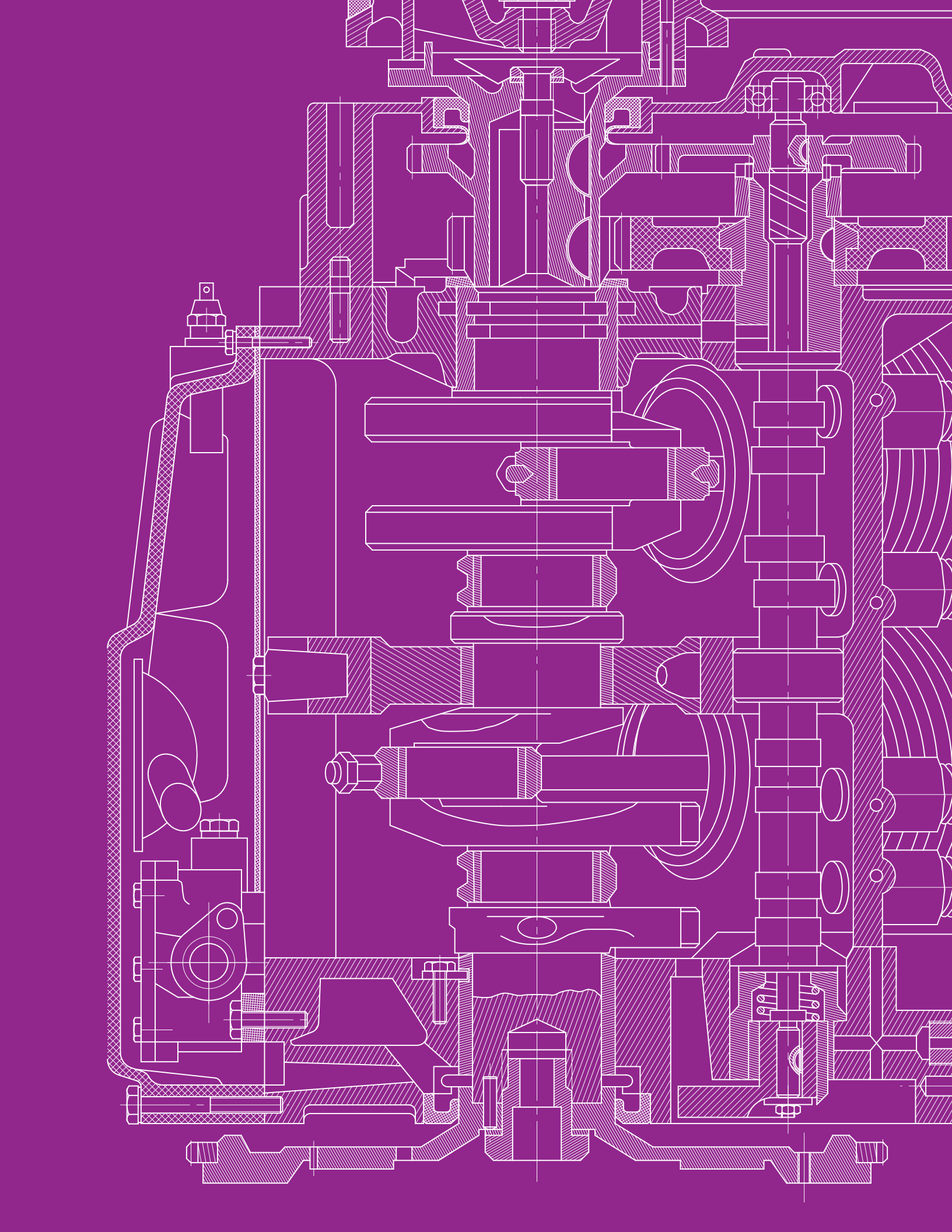
Key findings include:

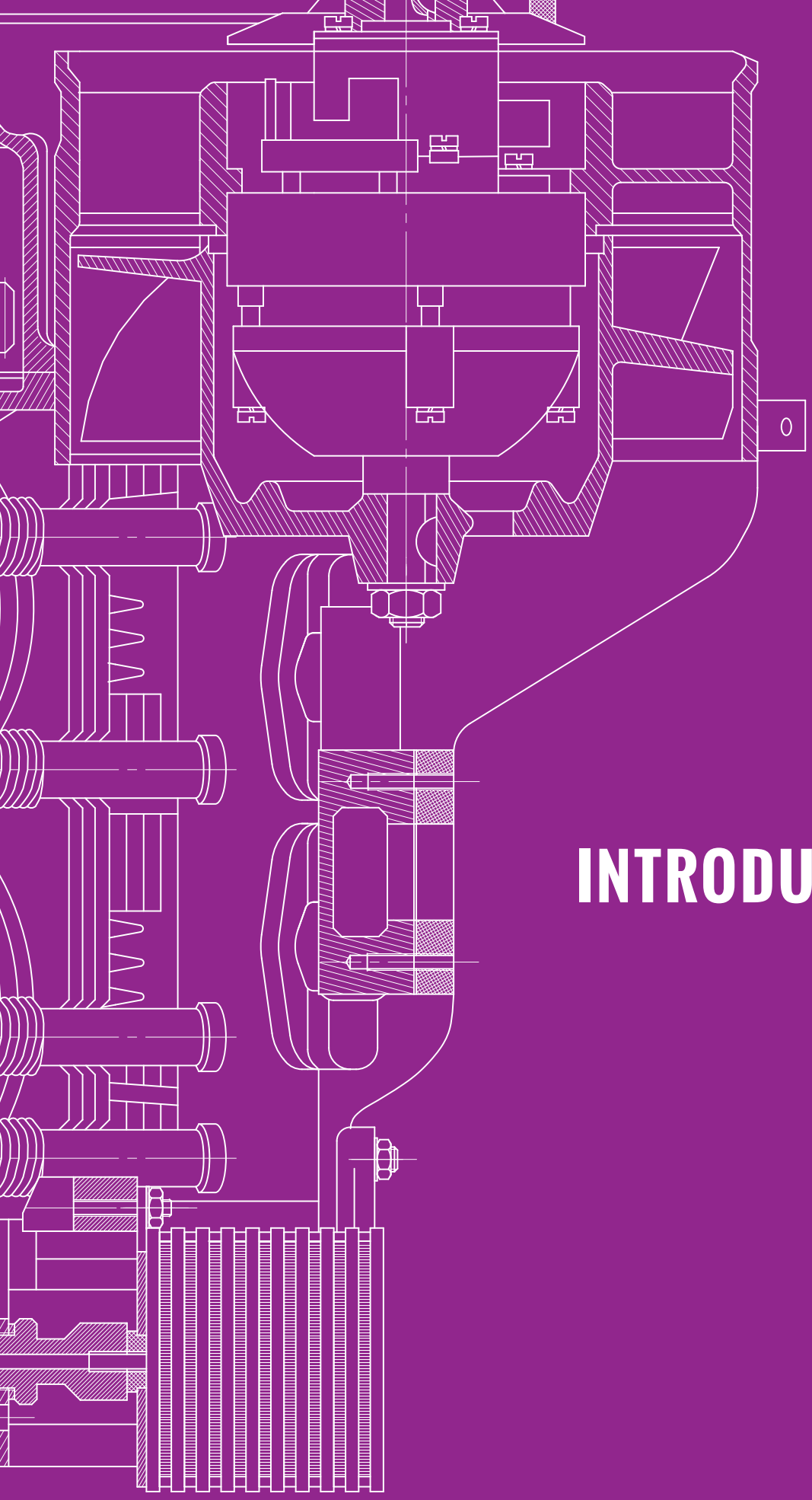
1. Workers related to CAV are from a diverse array of occupations signaling the difficulty in identifying a complete CAV workforce and set of skills for future training.
2. CAV is still in development and no standard government occupation codes have been developed to analyze related workers. Because of this, analysts must rely on more informative, yet less complete, data such as online job ads to better understand employer needs.
3. Between October 2015 and September 2016, the greatest demand for workers with CAV skills was for those in IT, information security, and computer systems.
4. CAV workers must have higher educational attainment at the bachelor's level, at minimum, and many employers seek talent with several years of experience.
5. Talent requirements for workers with a bachelor's degree or higher opens new opportunity for community colleges to provide the baseline training or upskilling necessary for workers in CAV.
6. A federal-level security clearance is one of the most sought-after certifications for CAV workers, making the requirements even more stringent on who can join this workforce.
7. Select cities across the U.S. show more CAV activity than others in terms of employer demand for workers. These locations include Washington, D.C., Detroit, Boston, and Baltimore.

For the workforce side of connected and automated vehicles to move forward, WIN makes the following 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-train 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 4-year colleges, must be strengthened to enhance the training provided to and received by the current and future workforce. Community colleges are the best place for upskilling current workers and preparing new workers for CAV jobs. This includes transfer programs and early training.
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 intelligent transportation systems. Roadways and vehicles can be connected but without the proper inclusion of the public, first responders, the disabled community, and other stakeholders, their potential safety benefits may not be realized.

CONTENTS





INTRODUCTION

Introduction to Connected and Automated Vehicles

Connected and automated vehicles (CAV) are the next frontier for transportation. Companies and research institutes are still scratching the surface of what is possible and necessary to make CAV and intelligent transportation systems a reality for travelers. 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 matures.

In order to better understand future workforce demands in the CAV space, the Workforce Intelligence Network for Southeast Michigan (WIN) partnered with University of Michigan Transportation Research Institute (UMTRI) to analyze job postings for a broad set of occupations that may be involved in the design, manufacture, and infrastructure development included in the CAV product cycle. This follows a successful partnership between WIN and the ATLAS Center at UMTRI on an analysis of the transportation safety-related workforce in Michigan.

Why does this matter? CAV is the new frontier of transportation for personal vehicles, public transportation, and first responders. Not only will CAV make roadways and travel more efficient but it will also increase the safety of roads for drivers and pedestrians alike. CAV development is happening all over the nation. Thus, this analysis includes data for the entire United States.

Workers related to CAV include software developers and other computer scientists developing the code for vehicles to communicate with each other and with surrounding infrastructure; engineers and skilled trade workers designing and building the vehicles; cybersecurity workers developing safe systems for CAV and infrastructure to work safely; quality control ensuring vehicle safety; and civil engineers and planners developing new systems to make CAV most useful and efficient on roadways. The implications and possibilities for CAV are endless with many stakeholders involved in the processes.

This report is organized into five parts. The table of contents provides page numbers indicating the location of each section.

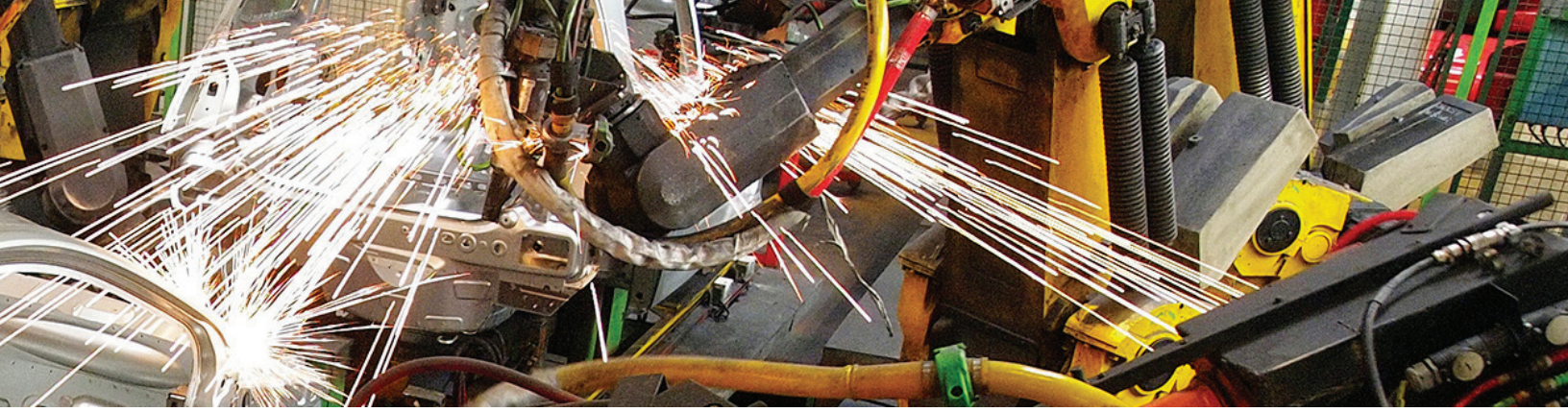
1. Findings that follow this introduction present the major highlights of WIN's research
2. A Methodology section provides detail on WIN's analysis methods
3. The Workforce Overview sheds light on all CAV occupations along with detailed analysis of each occupation group
4. Conclusions and Next Steps outline the potential of what is to come for the CAV workforce
5. Thorough Appendices provide lists, tables, and relevant background data

Findings

1. **Workers related to CAV are from a diverse array of occupations signaling the difficulty in identifying a complete CAV workforce and set of skills for future training.**

   Forty-nine occupations across a variety of skillsets have been identified as directly related to CAV. It is these workers who will contribute to the new frontier of transportation in the United States. Workers related to the design and manufacture of connected and automated vehicles (CAV) include those in IT, cybersecurity, civil engineering, mechanical engineering, transportation systems design, and others. Because these occupations are so diverse, training workers in CAV-specific skills requires adding to the training plans for many different academic and industry-based programs. See page 10 for more detail and Appendix A for a list of related occupations.

2. **CAV is still in development and no standard government occupation codes have been developed to analyze related workers. Because of this, analysts must rely on more informative, yet less complete, data such as online job ads to better understand employer needs.**



While WIN developed a list of related occupations using government codes, the codes do not include the nuance to truly understand CAV workers' skills. To combat this data issue, WIN looked to keyword analysis in online job postings to better understand the needs of employers. While this data is useful, it is incomplete and does not allow analysis of the current workforce but instead the needs for the future workforce. See the Methodology section for more details.

3. **Between October 2015 and September 2016, the greatest demand for workers with CAV skills was for those in IT, information security, and computer systems.**

   Most CAV jobs currently are focused on the IT design and development because much of CAV work is still in the research and development phase with little mass manufacturing occurring. Job postings related to manufacturing, infrastructure, and quality control will likely increase as CAV becomes more prevalent and available for wide-spread public use. See page 16 for more detail.

4. **CAV workers must have higher educational attainment at the bachelor's level, at minimum, and many employers seek talent with several years of experience.**

   CAV-related work is complex and requires workers to have a deep understanding of engineering, mathematics, and IT. In addition, because the current work is so focused on IT design and development, employers are most interested in workers with a track record of experience in their field. These workers may be difficult to find because CAV is still so new for many companies and it is difficult for a worker to have several years of experience on a relatively new technology. However, workers with proven experience in their occupation overall are likely good candidates to shift their focus to CAV. This could have implications for employers seeking similar workers as competition for talent is already fierce. See pages 35 and 36 for more detail.

5. **Talent requirements for workers with a bachelor's degree or higher opens new opportunity for community colleges to provide the base-line training or upskilling necessary for workers in CAV.**

   Workers with a bachelor's degree are in-demand for CAV employers. There is, however, opportunity for community colleges to work hand-in-hand with employers to develop programming customized for upskilling current industry employees and to develop entry-level training for future workers to move into employer training or a bachelor's program.

6. **A federal-level security clearance is one of the most sought-after certifications for CAV workers, making the requirements even more stringent on who can join this workforce.**

   Much of CAV work is IT-related and therefore requires a considerable amount of cybersecurity knowledge. Also, a substantial amount of CAV work conducted or regulated by the federal government and government contractors. A federal-level security clearance is required by many employers due to this circumstance. This has several implications as CAV becomes more prevalent and workers more in-demand. Many IT workers in the U.S. are working under an H1B visa that allows foreign workers to legally be employed in the U.S. Non-U.S. citizens cannot hold a federal-level security clearance and thus are limited to IT jobs that do not require this. A federal-level security clearance requires a stringent vetting process and is not an easy credential to obtain. With IT employers already competing for workers, this requirement will make the landscape even more difficult moving forward.

7. **Select cities across the U.S. show more CAV activity than others in terms of employer demand for workers.**

   Employers seeking to hire workers with CAV skills are most concentrated in Washington, D.C., Detroit, Boston, and Baltimore. Those in the Washington, D.C. area are most commonly interested in workers in IT. In terms of overall activity, Washington, D.C. and Detroit have the strongest current demand for CAV-related workers relative to overall employer demand in these areas. See pages 18 for more detail.

Methodology

This report was compiled using data on employer demand (job postings) from Burning Glass Technologies and employment data from Bureau of Labor Statistics (BLS) and Economic Modeling Specialists International (EMSI). The data is national unless otherwise noted. All data are 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.

WIN's analysis method often includes categorizing occupations relevant to a particular area then analyzing data on that workforce's demographics, employment trends, and demand for workers by local employers. In this case, because CAV is still so new that typical occupation codes are not nuanced enough to truly capture CAV workers, WIN has relied more on job posting data that includes more information about the workers that employers need with CAV-related skills. WIN's method uses standard occupation codes (SOC) which are government-defined occupation codes. As these codes are not yet refined to separate CAV workers from other similar workers, WIN's researchers created a list of keywords to better catalog job postings that may be for CAV-related workers. Combining the list of occupations that likely align with CAV with CAV keywords allowed WIN to analyze the data about different areas of CAV workers in depth.

The first step in the research process was a literature review that resulted in a list of keywords commonly associated with the growing field of connected and automated vehicles (CAV). Using the keywords, WIN researchers searched online job postings from Burning Glass Technologies to define 49 occupations that have knowledge and skillsets applicable to the growing demand for connected and autonomous vehicles. This list was validated by employers and other WIN collaborators working in the CAV space. Please see the subsequent section on Occupation Groups to learn more about the categories used in this report. See Appendix B for a list of all documents used for the literature review, Appendix C for a list of the keywords used, and Appendix D for list of CAV "buzzwords" and frequently used job titles that are included and were considered in this analysis but may not be listed in standard occupation classification codes.

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. To focus this report on CAV-related positions only, WIN researchers used the aforementioned keywords and several industries as filters in data collection. In collecting job posting data from Burning Glass Technologies, 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 postings data collection.

This analysis focuses mainly on data collected from job postings. Data pertaining to employment and company-specific workers is scarce and many companies are just starting to expand their CAV-related operations. Job postings allowed WIN researchers to see what companies are looking for and get an idea of what is to come for workers in CAV.

Data on in-demand degrees, certifications, and skills presented in this report was limited to the top 10 to 15 in each list. For some occupation groups, the lists of in-demand degrees, certifications, and skills was much longer but was truncated for the purposes of this report.

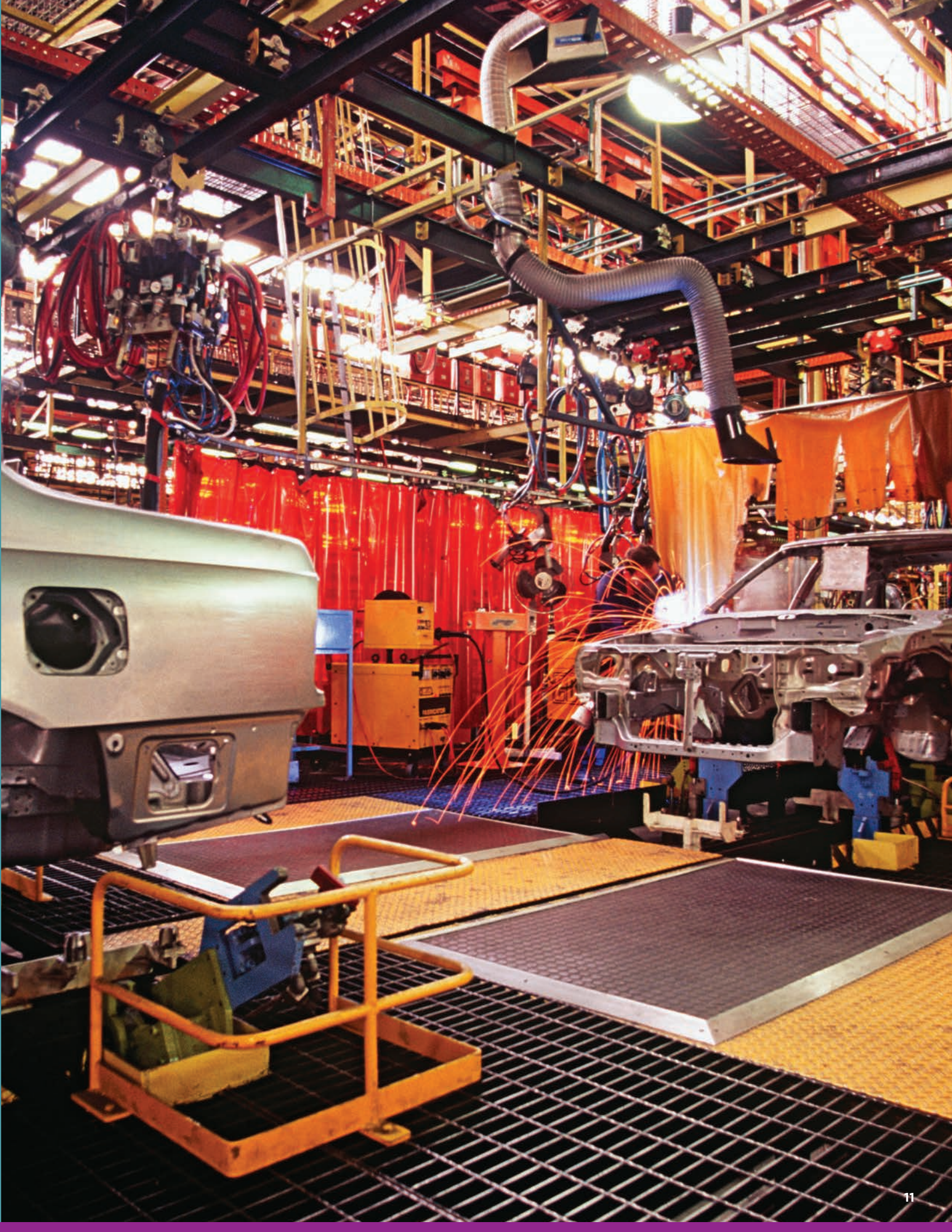
Top employer data reflects the number of job postings and is arranged in order of the employers posting the most job openings. Top employers were limited to the top 10-15 employers in each list. This data is not inclusive of the number of CAV workers employed within organizations. The possibility exists that other employers may currently employ more CAV workers than those listed but lack current job openings.

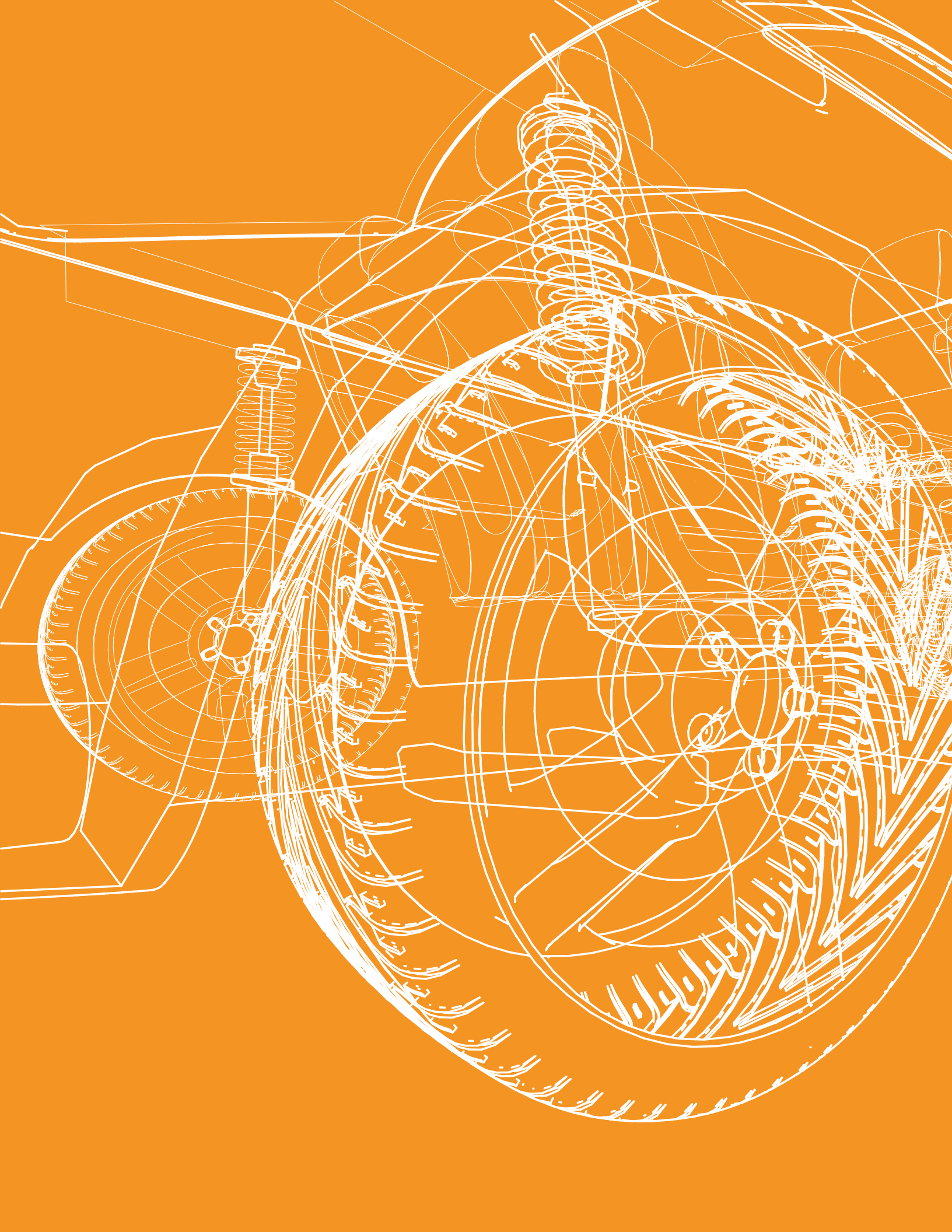
With such a large number of occupations working on a diverse set of problems in the connected and automated vehicles realm, occupational analysis is more easily undertaken and better understood if occupations are grouped into categories. **The 49 CAV-related occupations used in this analysis are categorized into the following six sub-groups:**

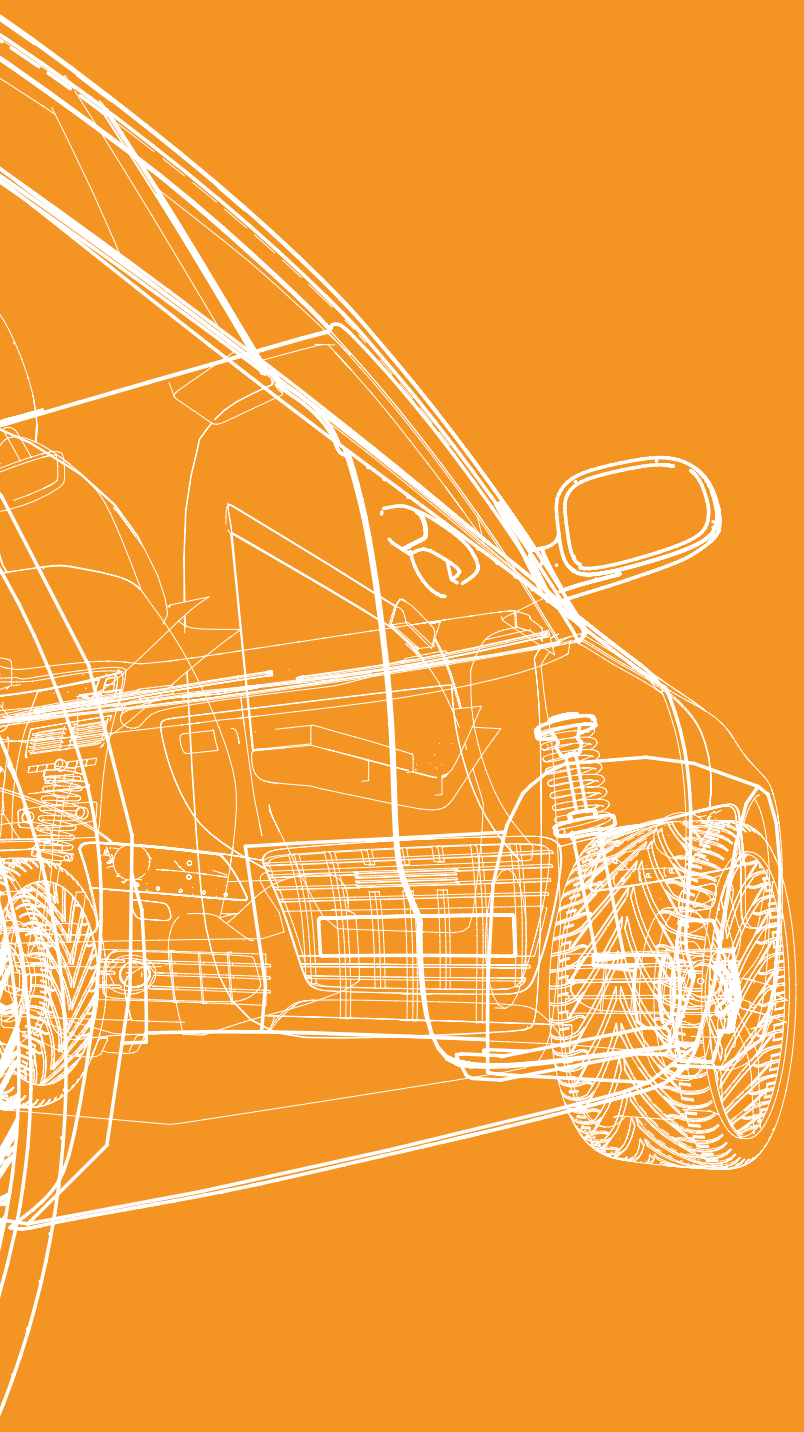
1. **Connected and automated vehicle design & testing;**
2. **Connected and automated vehicle manufacturing;**
3. **Connected and automated vehicle IT design;**
4. **Quality control;**
5. **Data management & cybersecurity; and**
6. **Intelligent transportation systems & infrastructure design.**

Unless otherwise noted, all data included in this report is reported at the national level and includes data available for the entire United States.

The list of occupations in Appendix A provides detail on each group.







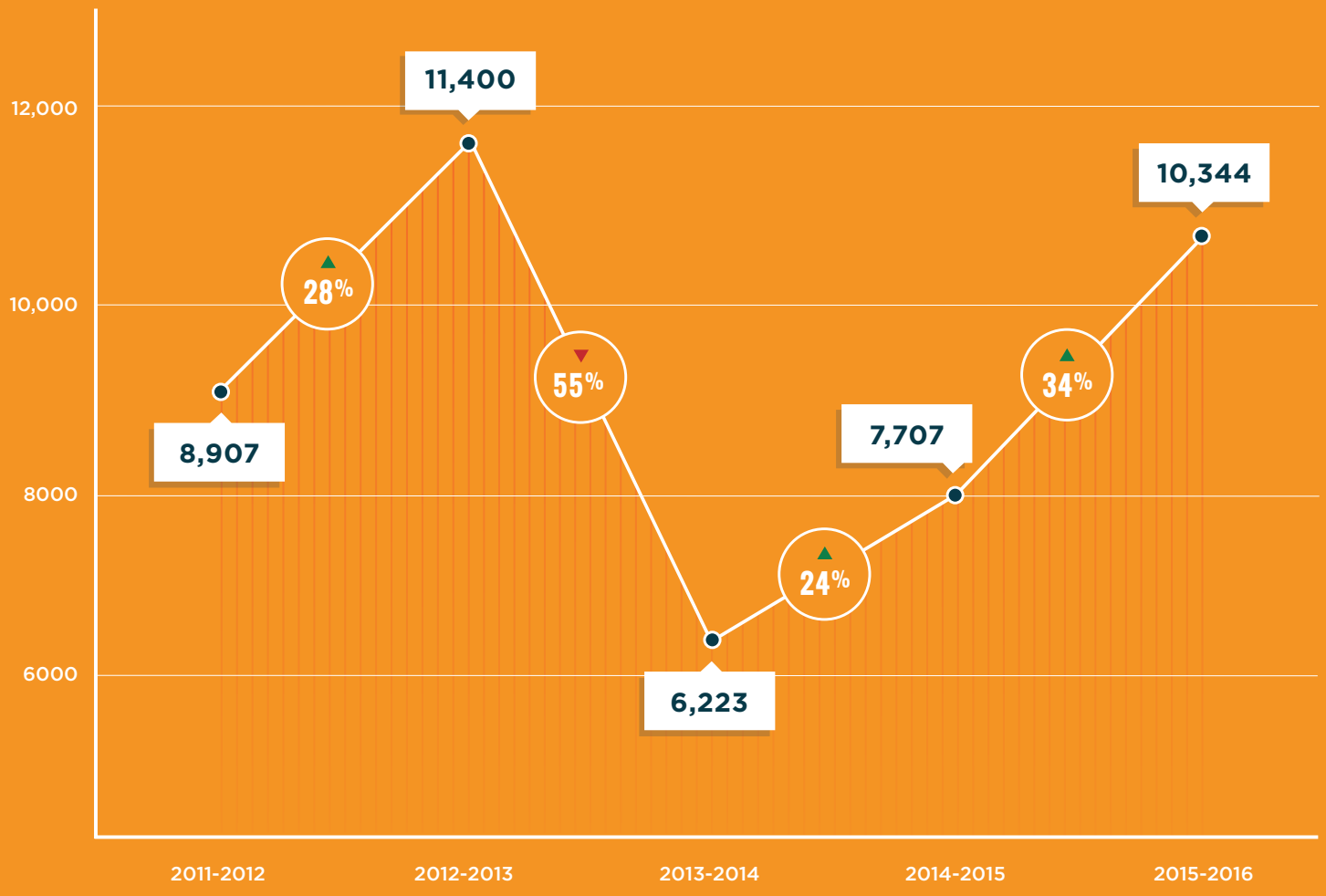
CONNECTED AND AUTOMATED VEHICLE IN-DEMAND WORKFORCE OVERVIEW

Worker Demand Trends

As CAV technologies have become more prevalent, demand for workers with related skills has also grown. Demand for workers with CAV capabilities increased between 2011-2012 and 2015-2016. The peak In-Demand for these workers was 2012-2013 with 11,400 job ads nationally.

Note: Job posting data during the third quarter of 2013 was very high relative to other years. This is an unexplained anomaly in the data.

CAV Occupation Online Job Ads



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

Top Posting Jobs

The most in-demand jobs with CAV skills posted in the United States between October 2015 and September 2016 are IT-related. The top three, software developers, information security analysts, and computer systems engineers, are associated with cybersecurity, IT design, and managing the data related to connected transportation systems. Demand for these three occupations represents 61% of all CAV-related demand in the nation.

Software developers are routinely one of the top in-demand jobs overall in the nation. During the October 2015 to September 2016 timeframe, employers in the U.S. posted nearly 800,000 (793,230 postings) software development jobs. Ads that listed CAV skills (2,546 postings total) represent only 0.3% of all software development postings. Employers looking to hire workers with CAV-related skill sets are competing for workers in the one of the most in-demand fields, in addition to needing workers with highly specialized skills.

Top 25 In-Demand with CAV Skills

= 100 Job Postings

Software Developers, Applications	2,546
Information Security Analysts	2,133
Computer systems Engineers/ Architects	1,672
Electrical Engineers	636
Computer Systems Analysts	385
Network and Computer Systems Administrators	349
Computer Network Architects	287
Computer User Support Specialists	263
Mechanical Engineers	251
Software Quality Assurance Engineers and Testers	238
Civil Engineers	144
Geospatial Information Scientists and Technologists	132
Database Administrators	124
Computer Hardware Engineers	110
Security Management Specialists	107
Electronics Engineers, Except Computer	106
Computer Programmers	100
Computer and Information Systems Managers	90
Electronics Engineering Technicians	80
Computer Occupations, All Other	76
Data Warehousing Specialists	53
Validations Engineers	50
Software Developers, Systems Software	40
Industrial Engineers	37
Commercials and Industrial Designers	36

Distribution of Demand Across Sectors

More than 50 percent of employer demand related to CAV is for workers in data management, cybersecurity, and IT. Fewer postings, relative to the total, are for Vehicle Manufacturing, Quality Control, and Intelligent Transportation Systems and Infrastructure. This is likely not due to an absence in the overall need for these professions in CAV work, but rather the current workforce is sufficient for current needs. As the prevalence of CAV grows, the demand for workers in these fields further down the R&D supply chain is expected to increase.

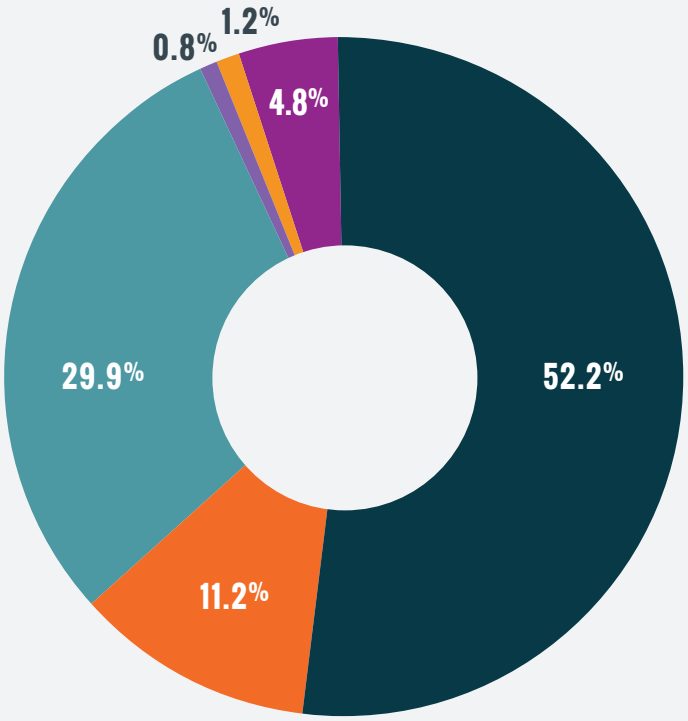
Salary Analysis

Economic theory indicates that as demand for something increases, with an unchanged or lower supply, the price of that thing will also increase. This follows for workers as well. As demand for workers with certain skills increases, if the number of workers with related skills does not also increase, salaries (the price) will also increase. This has been the case for workers with CAV skills. Another way for the average advertised salary to increase for a wide array of jobs, like all CAV jobs in this analysis, is for there to be more openings in higher skill, higher education-required jobs overall, resulting in more competition for highly skilled workers across many industries.

In the case of CAV jobs, both aforementioned situations are working to increase wages offered for workers with CAV skills. Demand is strong, supply cannot keep up, and an increasing number of jobs are for those with higher level skills and higher education attainment.

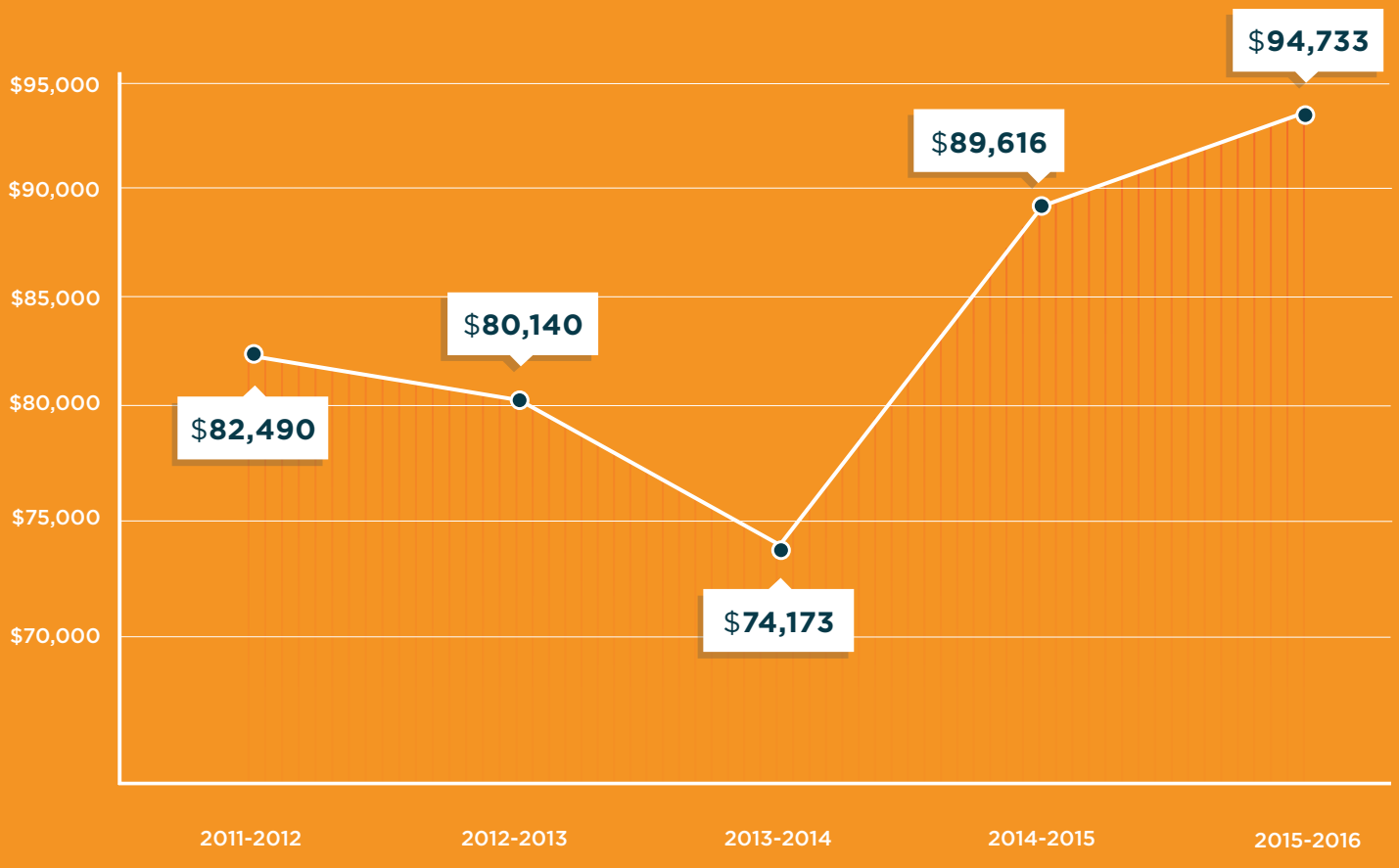
Distribution of CAV Ads by Occupation Group

United States, October 2015 - September 2016



Occupation Group	Number of Ads 2015-2016
Data Management & Cybersecurity	5,400
Design & Testing	1,154
IT Design	3,089
Quality Control	84
Vehicle Manufacturing	121
Intelligent Transportation Systems & Infrastructure	496
Total Job Ads Directly Related to CAV Jobs	**10,344**

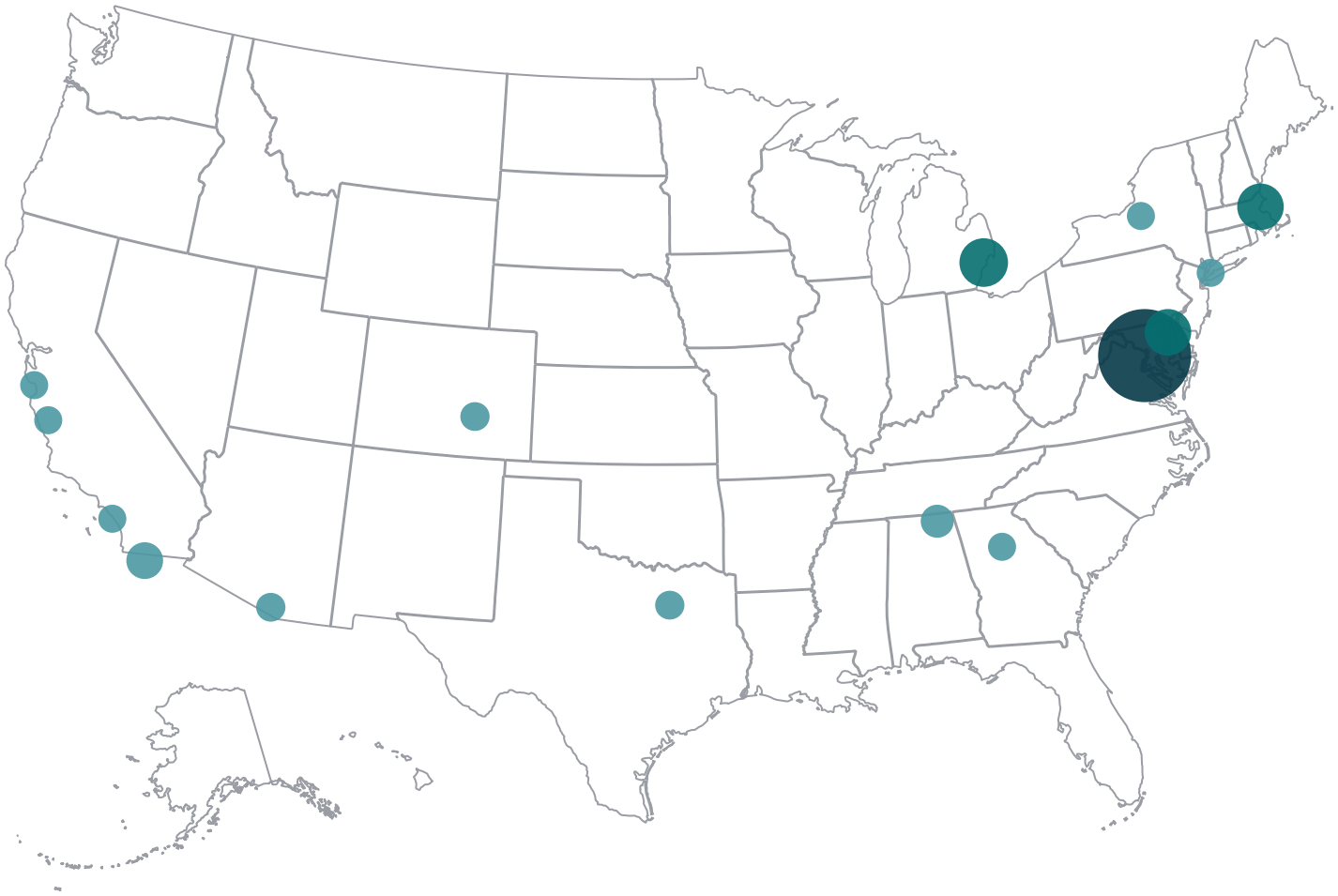
CAV Occupational Advertised Average Salary in Job Ads



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

Worker Demand Concentration

Employers seeking to hire workers with CAV skills are most concentrated in Washington, D.C., Detroit, Boston, and Baltimore. By far the most jobs are posted in Washington, D.C. and these are dominated by those in cybersecurity. The jobs posted in Detroit are most closely related to engineering and IT.



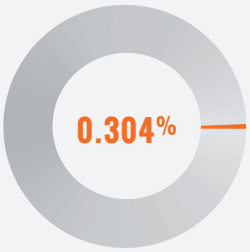
Metro Area	**CAV Job Postings** *United States 2015*
Washington-Arlington-Alexandria, DC-VA-MD-WV (Metropolitan Statistical Area)	2,472
Detroit-Warren-Dearborn, MI (Metropolitan Statistical Area)	878
Boston-Cambridge-Nashua, MA-NH (Metropolitan NECTA)	667
Baltimore-Columbia-Towson, MD (Metropolitan Statistical Area)	559

Posting Concentration Compared to Volume

When comparing connected and automated vehicle related postings to total postings in different MSAs, CAV made up a small percentage of postings in any given area. Of the areas with high volumes of CAV postings, the Washington, D.C. area had the strongest percentage of postings, followed by the Detroit metropolitan area.

CAV Postings in Metropolitan Statistical Areas

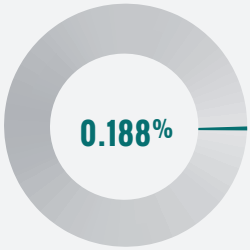
Washington-Arlington-Alexandria, DC-VA-MD-WV



Total Postings
812,265

CAV Related Postings
2,472

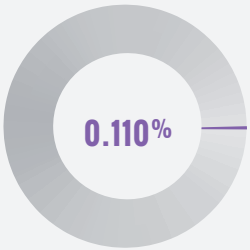
Detroit-Warren-Dearborn, MI



Total Postings
471,387

CAV Related Postings
878

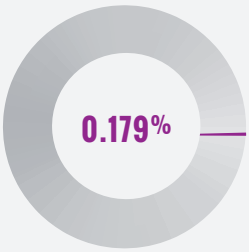
Boston-Cambridge-Nashua, MA-NH



Total Postings
608,092

CAV Related Postings
667

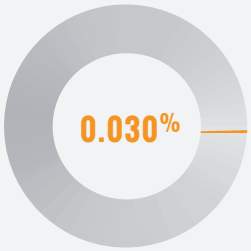
Baltimore-Columbia-Towson, MD



Total Postings
311,574

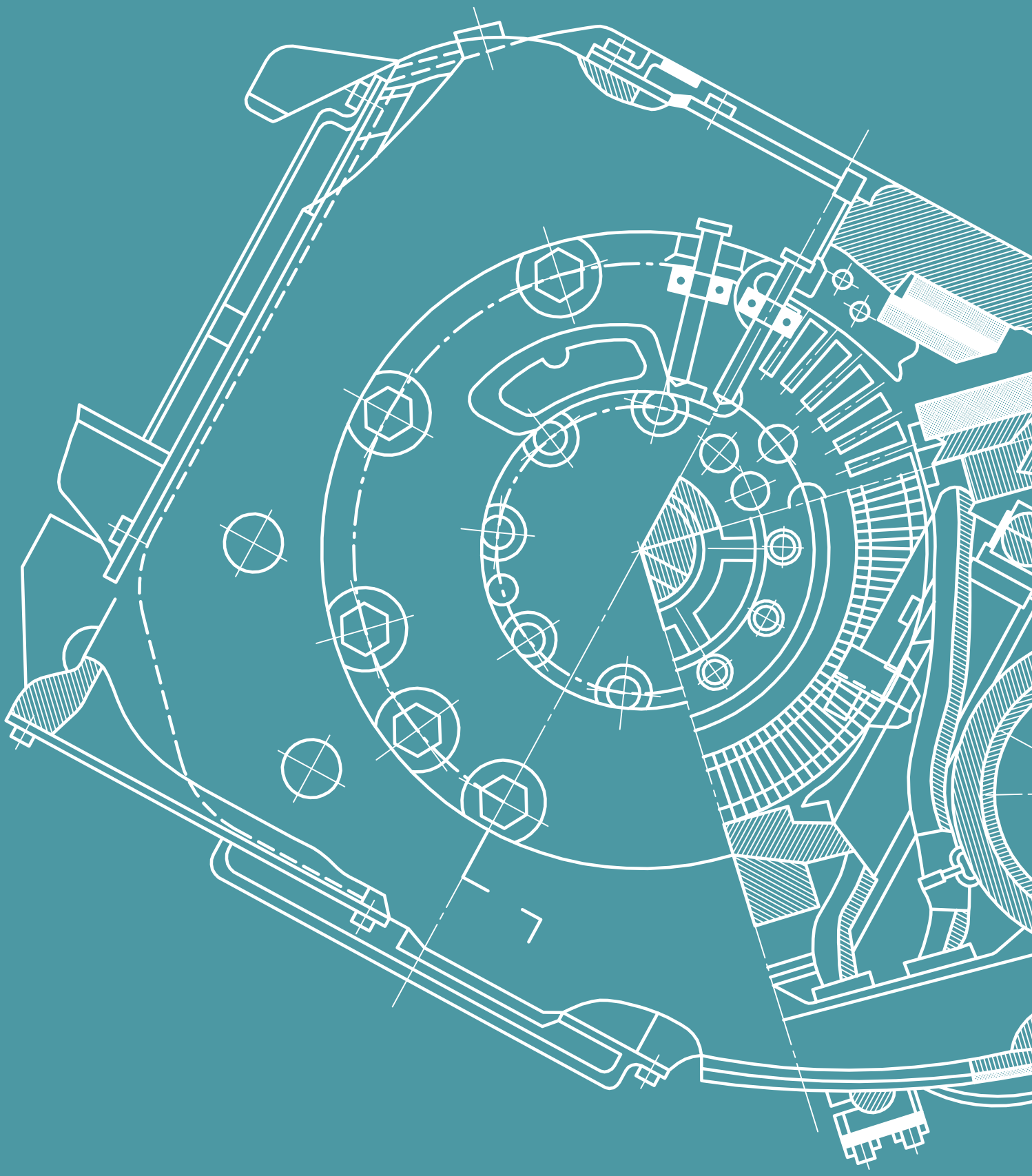
CAV Related Postings
559

Los Angeles-Long Beach-Anaheim, CA



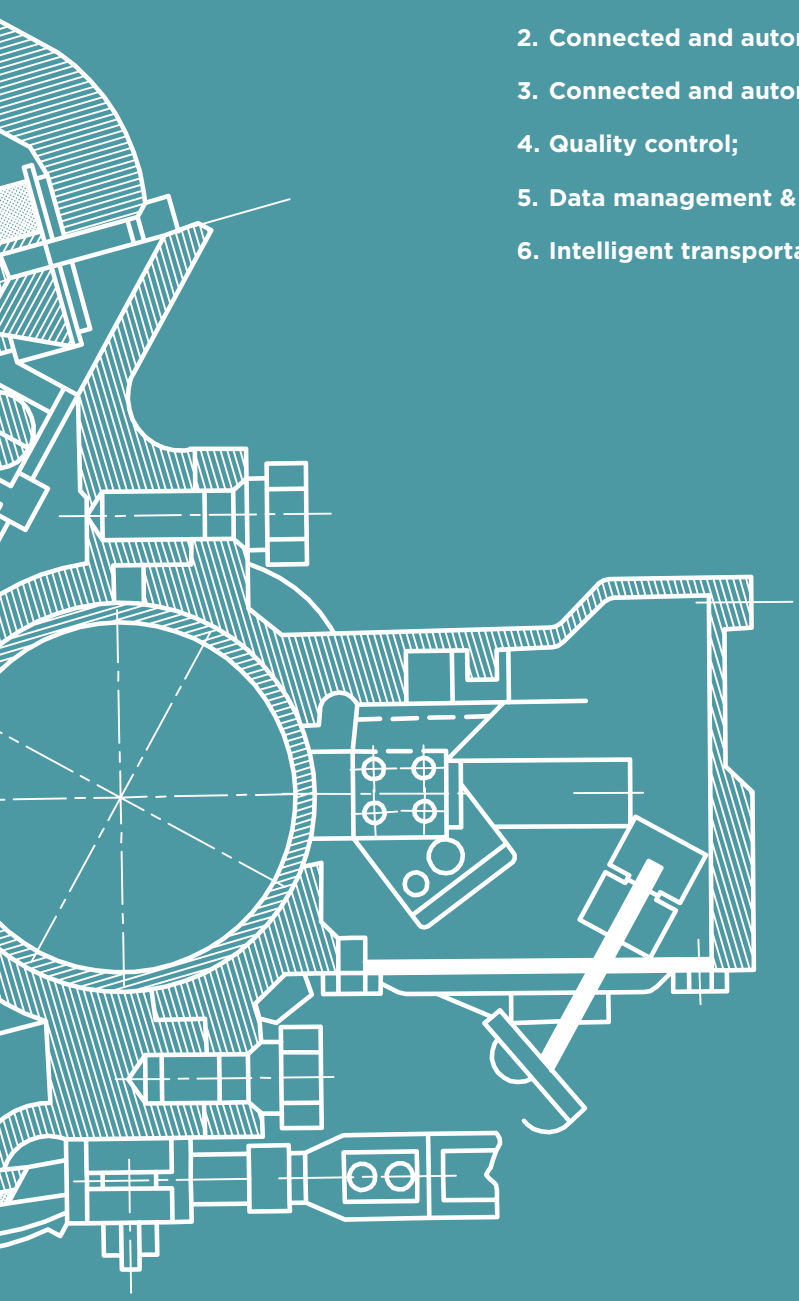
Total Postings
1,193,130

CAV Related Postings
49



CAV-RELATED OCCUPATION SUB-GROUPS

1. Connected and automated vehicle design & testing;
2. Connected and automated vehicle manufacturing;
3. Connected and automated vehicle IT design;
4. Quality control;
5. Data management & cybersecurity; and
6. Intelligent transportation systems & infrastructure design.



Vehicle Design & Testing

The Connected & Automated Vehicle Design & Testing sub-group employs many engineers involved in the ongoing research, design, and testing of CAV projects. The sub-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.

Demand Trends

Online job postings for Design & Testing occupations related to connected and automated vehicles reached a historic high in the 2015-2016 cycle with 1,150 ads. This represented a 15% increase over the 1,000 ads posted during 2014-2015. Since 2011, employer demand for occupations in this group has nearly doubled.

Design & Testing Postings Over Time

October 2015 - September 2016

Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

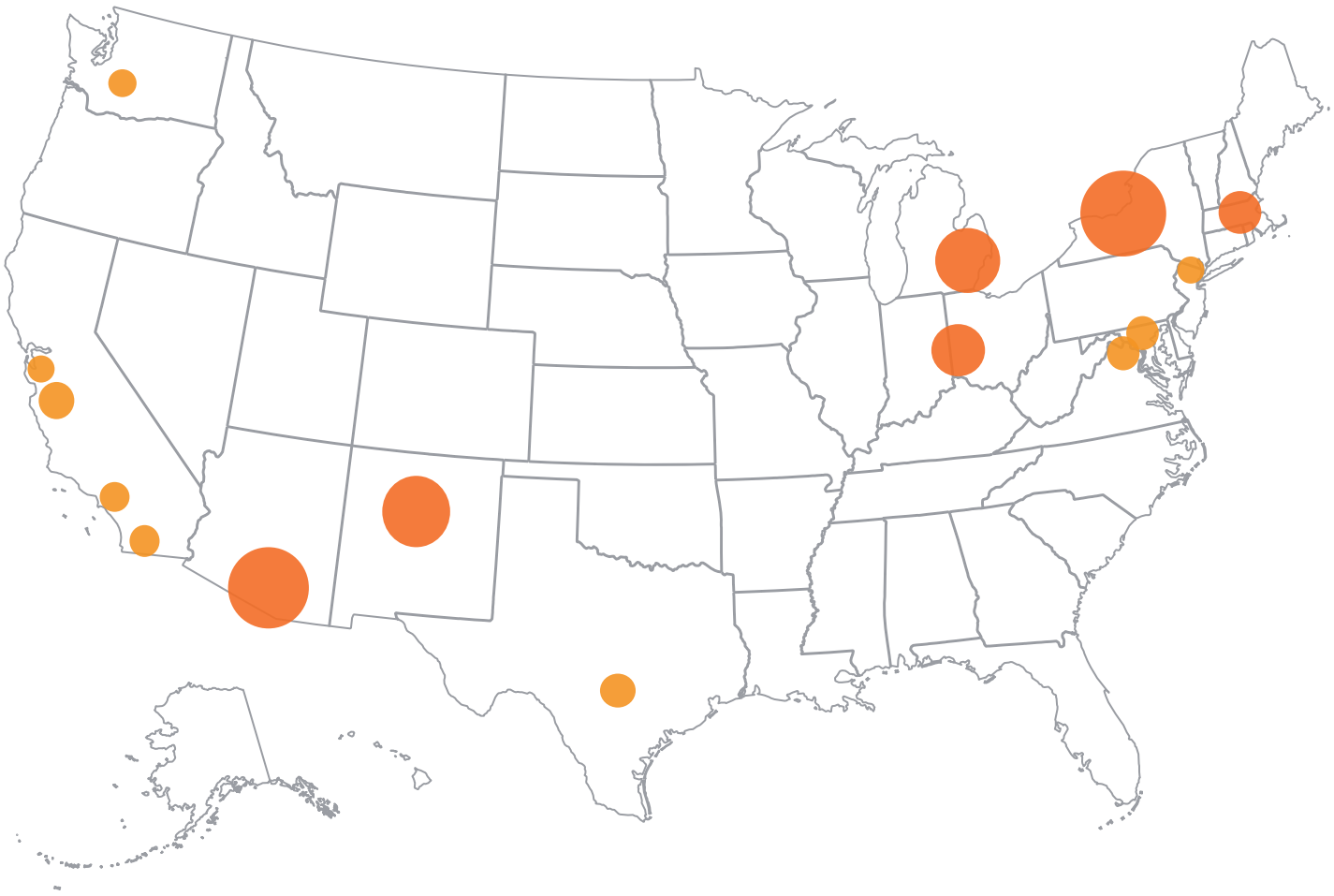
Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Vehicle Design and Testing are listed below.

- Raytheon
- Ford Motor Company
- Parsons Brinckerhoff
- SRC and SRCTec
- TRW Automotive
- Continental Automotive Systems USA
- Syracuse Research Corporation
- Sandia Corporation
- ManTech International Corp.
- Booz Allen Hamilton Inc.
- Apple Inc.
- Sotera Defense Solutions
- Delphi Automotive
- Southwest Research Institute
- General Motors

Worker Demand Concentration

The Detroit metropolitan area led the nation with nearly 200 online postings for occupations in the Design & Testing group during 2015. Other high demand areas included the Washington, D.C. and Boston metros with over 100 postings.



Posting Concentration Compared to Volume

Although the Detroit area had the largest volume of Design & Testing related postings, these postings made up only .04% of the total posting in the area. Of the top five areas with the highest volume of Design & Testing postings, the Syracuse area had the highest percentage of postings with .105%.

Postings in Metropolitan Statistical Areas

Washington-Arlington-Alexandria, DC-VA-MD-WV

Total Postings
812,265

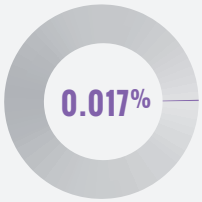
CAV Related Postings
102

Detroit-Warren-Dearborn, MI

Total Postings
471,387

CAV Related Postings
188

Boston-Cambridge-Nashua, MA-NH



Total Postings
608,092

CAV Related Postings
101

Tucson, AZ

Total Postings
81,298

CAV Related Postings
55

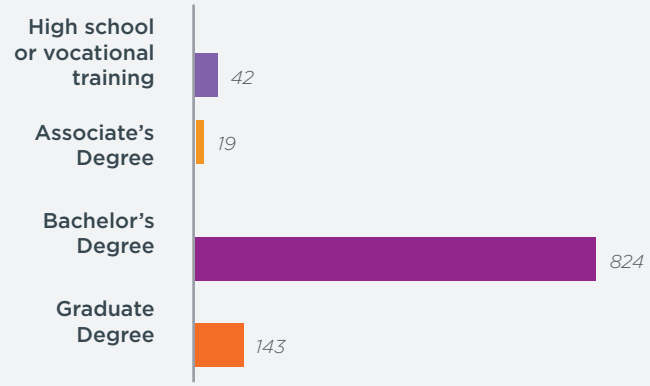
Syracuse, NY

Total Postings
46,513

CAV Related Postings
49

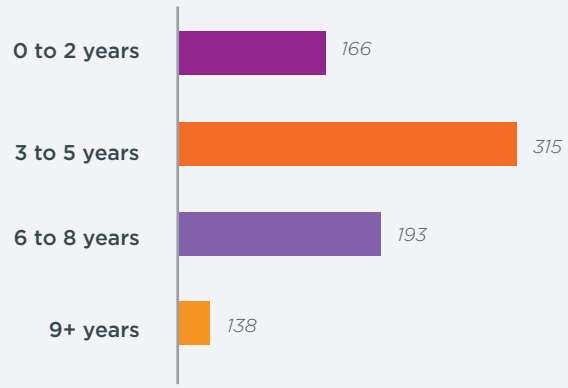
Design & Testing Education

October 2015 - September 2016



Design & Testing Experience

October 2015 - September 2016



Data: Burning Glass Technologies | Analysis: Workforce Intelligence Network

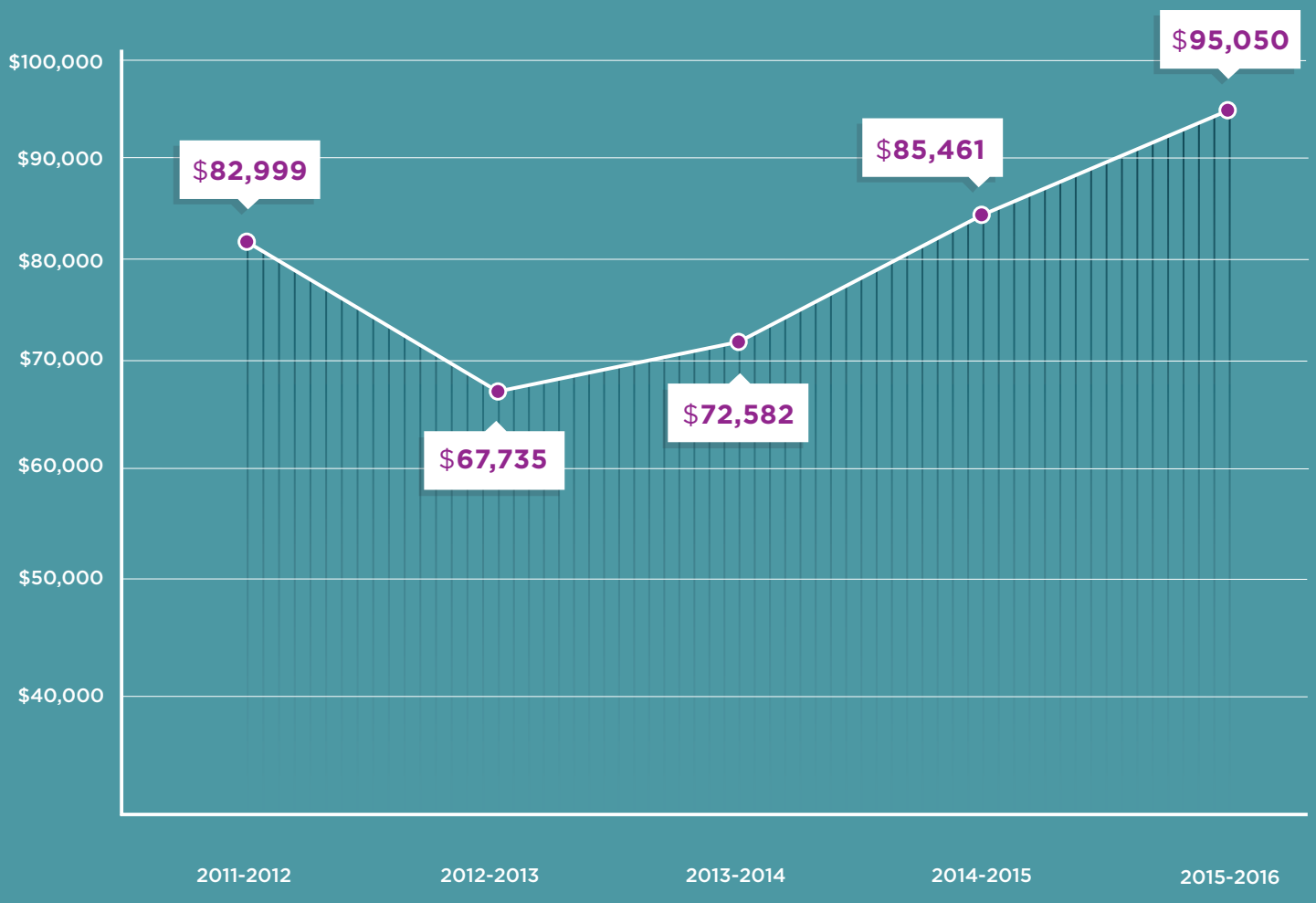
Experience and Educational Attainment

An overwhelming majority (80%) of Design & Testing postings advertising minimum education requirements asked for candidates with a bachelor's degree. In addition, 14% of postings with education listed asked that candidates have education beyond a bachelor's degree. In total, 94% of Design & Testing ads with education requirements preferred candidates with at least a bachelor's degree.

In addition to needing advanced degrees, workers in Design & Testing often need years of relevant experience. Just one out of every five postings advertising experience asked for candidates with minimal experience (less than two years). Meanwhile, 39% of ads wanted workers with three to five years of experience while an additional 41% requested very experienced candidates with six or more years of experience.

Design & Testing Advertised Average Salary in Job Ads

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

Salary/Wages

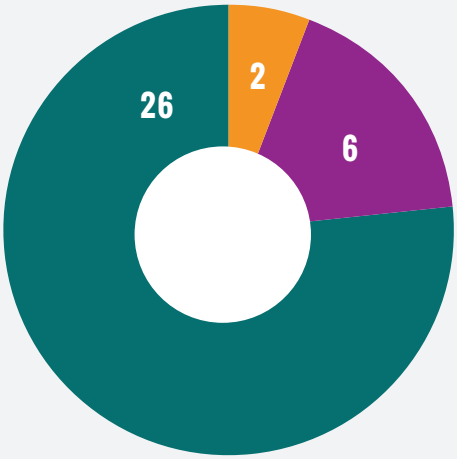
Average advertised salaries for Design & Testing occupations have increased annually since 2012, most recently reaching a historic high of $95,000 from October 2015 through September 2016. The overwhelming majority of postings with wage information advertised annual salaries of over $75,000. With demand for Design & Testing workers doubling in the last five years and high levels of education and experience requirements, wages will remain high for this group in order to entice prospective students and candidates.

In-Demand Skills

Design & Testing occupations require specialized, industry-specific skills. In addition to having an engineering background, these workers often need to know specific computer languages. Employers of Design & Testing occupations typically want well-rounded workers with the ability to research, communicate, and solve problems with teams on projects.

2015-2016 Advertised Salary

October 2015 - September 2016



- Less than $35,000
- $50,00 to $74,000
- More than $75,000

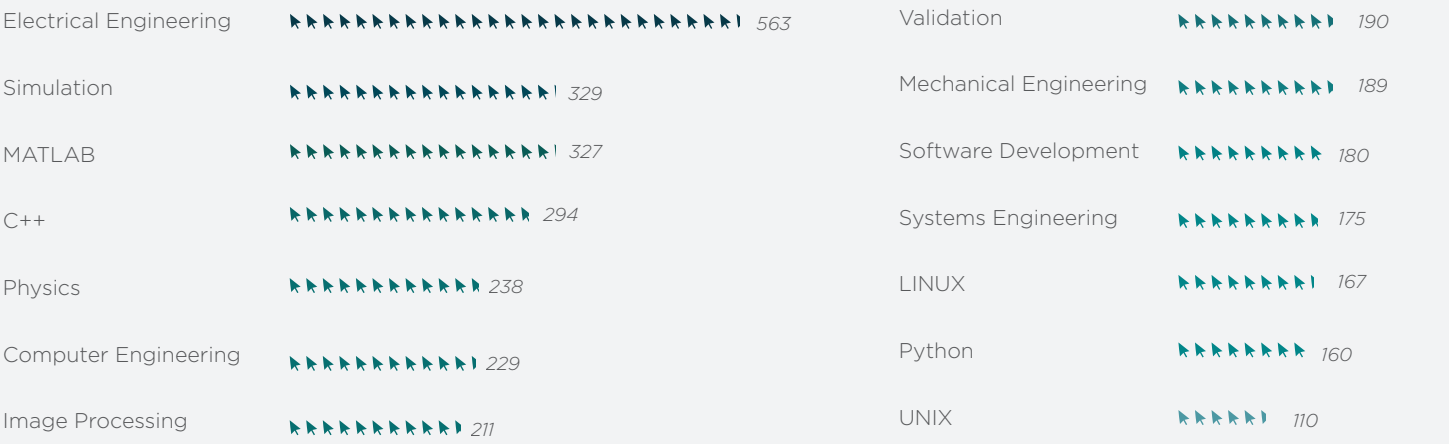
In-Demand Degrees

= 20 Job Postings

Engineering, General	556	Physics	118
Electrical And Electronic Engineering Technologies/ Technicians, Other	425	Aerospace, Aeronautical And Astronautical Engineering	39
Computer Science	230	Mechatronics, Robotics, And Automation Engineering	23
Computer Engineering	178	Engineering Technology, General	17
Mechanical Engineering	156	Applied Mathematics	13

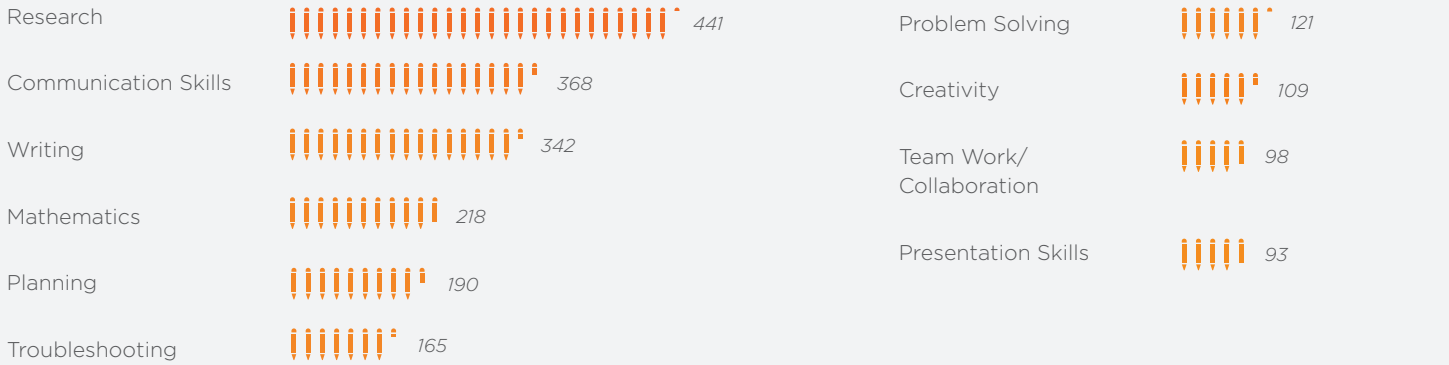
Technical Skills

= 20 Job Postings



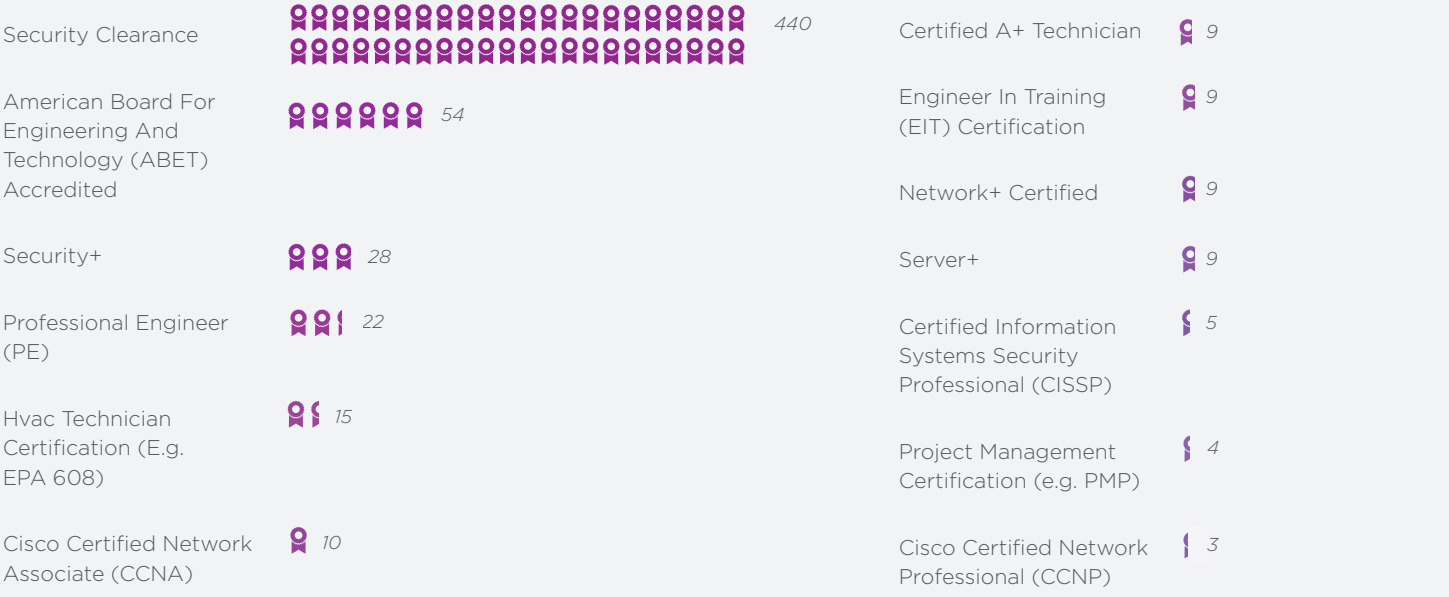
Employability Skills

= 20 Job Postings



In-Demand Certifications

= 20 Job Postings



Vehicle Manufacturing

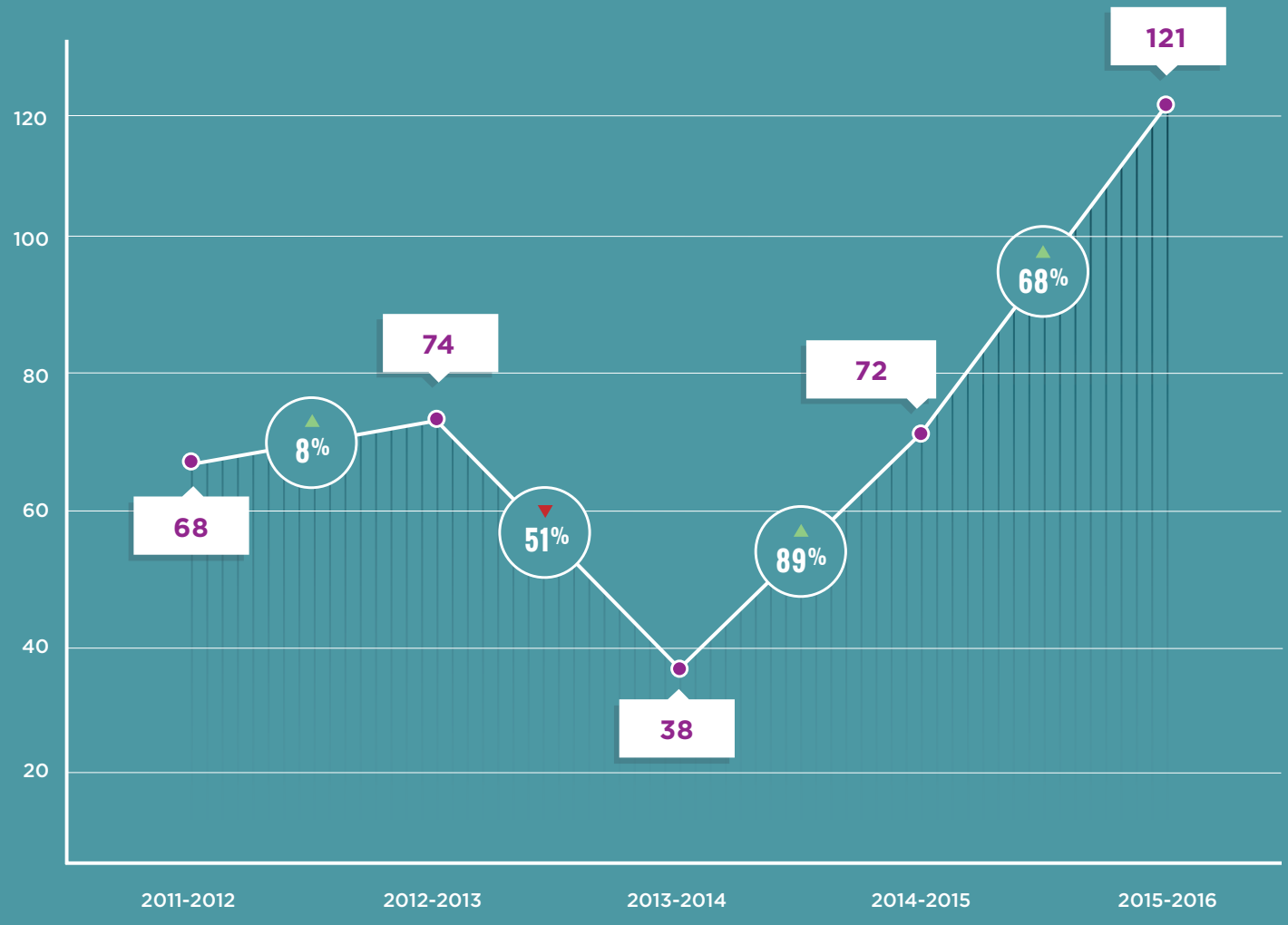
The occupations analyzed in the Connected & Automated Vehicle Manufacturing sub-group are positions that already exist at original equipment manufacturers (OEMs). Workers in this sub-group include industrial engineers, mechatronics and robotics engineers, and team assemblers – workers needed generally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

Demand Trends

Online job postings for Vehicle Manufacturing occupations related to connected and automated vehicles reached a record high in the 2015-2016 cycle with 121 ads. This represented a 68% increase over the 72 ads posted during 2014-2015. Since 2011, employer demand for occupations in this group has nearly doubled.

Vehicle Manufacturing Online Job Ads

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

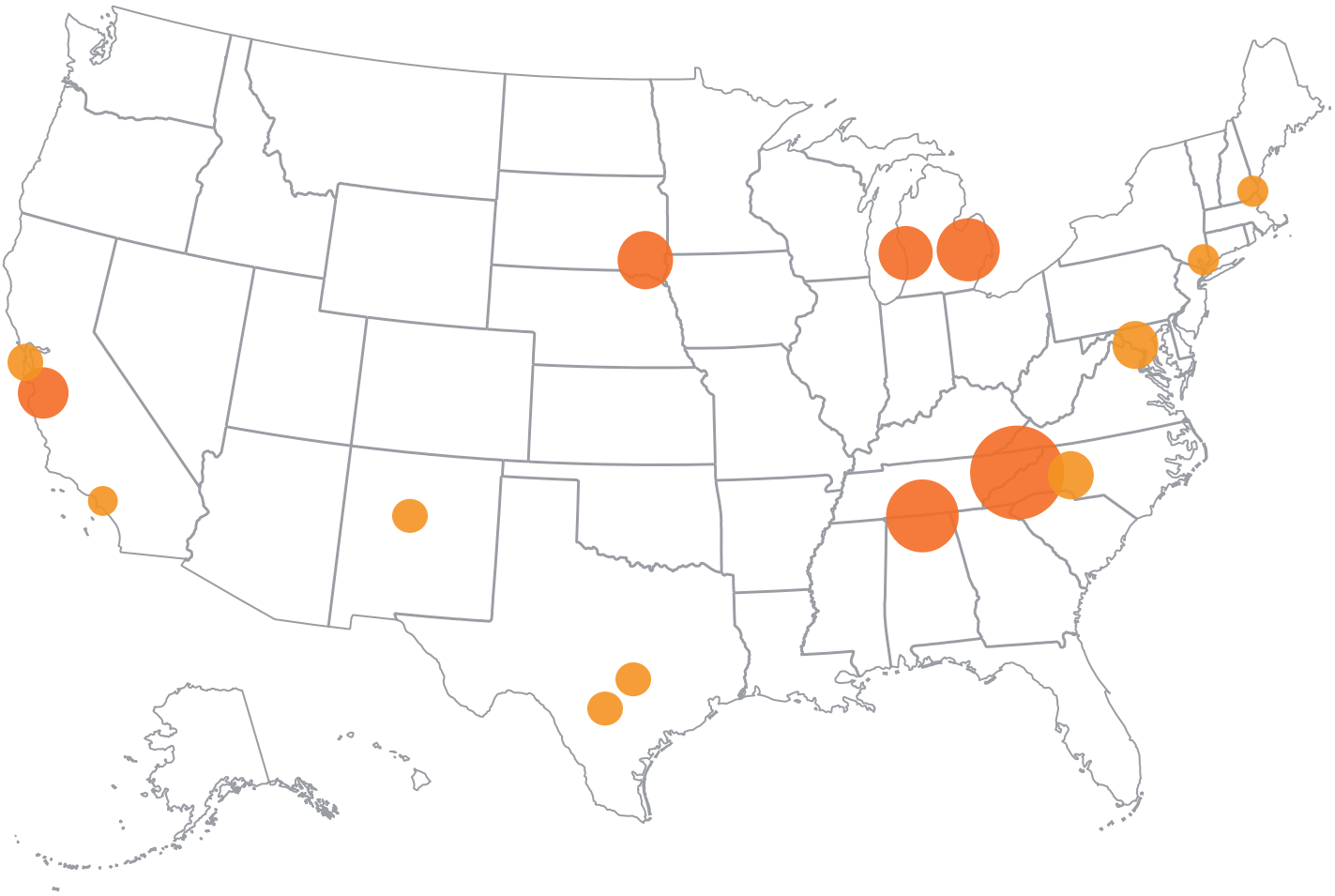
Top Posting Employers

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

- General Motors
- Booz Allen Hamilton Inc.
- Apple Inc.
- Johnson Controls Incorporated
- Continental Automotive Systems USA
- Parsons Brinckerhoff
- Schaeffler Group
- Raytheon
- Macaulay Brown Incorporated
- University of Texas

Worker Demand Concentration

The Detroit metropolitan area led the nation with 30 online postings for occupations in the Vehicle Manufacturing group in the past year. Other high demand metro areas included Washington, D.C. (20 ads) and San Jose (11 ads).



Posting Concentration Compared to Volume

Although the Detroit area had the highest volume of Vehicle Manufacturing postings in the nation, these postings only account for .006% of the area's total postings. Of the top five highest vehicle manufacturing related posting volume, the Asheville metropolitan area had the highest percentage of postings related to total postings with .029%.

Postings in Metropolitan Statistical Areas

Washington-Arlington-Alexandria, DC-VA-MD-WV

Total Postings
812,265

CAV Related Postings
20

Detroit-Warren-Dearborn, MI

Total Postings
471,387

CAV Related Postings
30

San Jose-Sunnyvale-Santa Clara, CA

Total Postings
307,306

CAV Related Postings
11

Grand Rapids-Wyoming, MI

Total Postings
81,728

CAV Related Postings
7

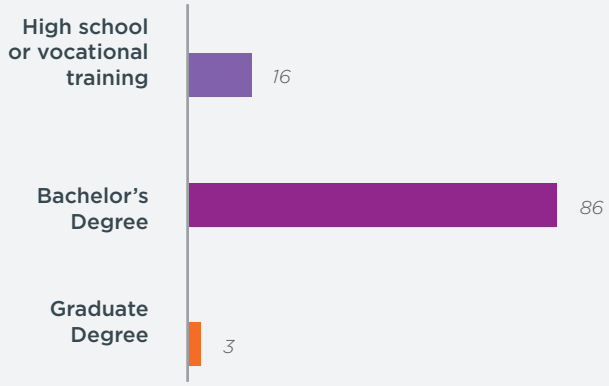
Asheville, NC

Total Postings
24,526

CAV Related Postings
7

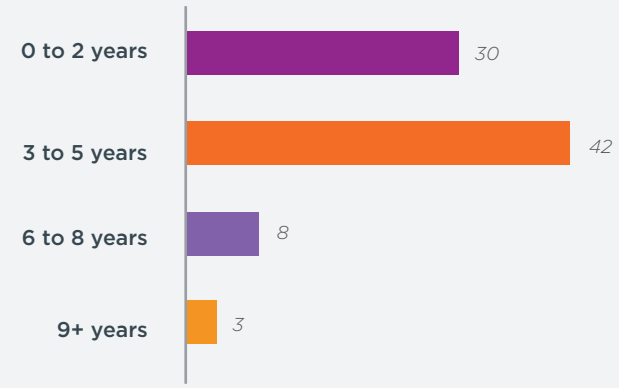
Vehicle Manufacturing Education

October 2015 - September 2016



Vehicle Manufacturing Experience

October 2015 - September 2016



Data: Burning Glass Technologies | Analysis: Workforce Intelligence Network

Experience and Educational Attainment

An overwhelming majority (82%) of Vehicle Manufacturing postings advertising minimum education requirements asked for candidates with a bachelor's degree. An additional 15% of postings required prospective candidates to have a high school degree (or equivalent) or vocational training.

While employers of Vehicle Manufacturing occupations most often advertised a desire for candidates with three to five years of experience (51% of applicable ads), over one-third of online ads advertising minimum experience desired for candidates with minimal experience (less than two years). This indicates that entry-level opportunities likely exist for jobs in this group.

Salary/Wages

Minimal wage data was available for Vehicle Manufacturing talent. In many cases, especially for skilled trade and assembly jobs, wages are negotiated by a union contract. For engineering positions, wages are typically high (above $75,000) but not always advertised in postings.

In-Demand Skills

Vehicle Manufacturing occupations require specialized, industry-specific skills. In addition to having an engineering background, these workers often need to know specific computer languages. Employers of Vehicle Manufacturing occupations typically want well-rounded workers with the ability to research, communicate, and solve problems with teams on projects.

In-Demand Degrees

Technical Skills

= 1 Job Posting

Validation	32
Microsoft Excel	25
Electrical Engineering	24
Inspection	20
MATLAB	19
Microsoft Office	19
Repair	18
Systems Engineering	18
Industrial Engineering Industry Expertise	17
Computer Engineering	16
Image Processing	16
C++	15
Calibration	14
Legal Compliance	14
Electrical Work	13
Embedded Systems	13

Employability Skills

= 2 Job Postings

Communication Skills	57
Problem Solving	38
Writing	38
Organizational Skills	23
Planning	21
Mathematics	20
Research	19
Troubleshooting	16
Quality Assurance and Control	14
Computer Skills	13

In-Demand Certifications

= 1 Job Posting

Security Clearance	15
Auditor Certification	10
Six Sigma Black Belt	10
Six Sigma Certification	10
Certified Quality Engineer	8
Quality System Certification	8
American Society For Quality (ASQ) Certification	6
Automation Certification	4
Certified Control Systems Technician	4
Commercial Driver's License (CDL)	3
Certified Information Systems Security Professional (CISSP)	1
Cisco Certified Design Professional (CCDP)	1
Electrical Certification (e.g. Electrical Installation Certification)	1
Master Electrician License	1
Six Sigma Green BelT	1

Vehicle IT Design

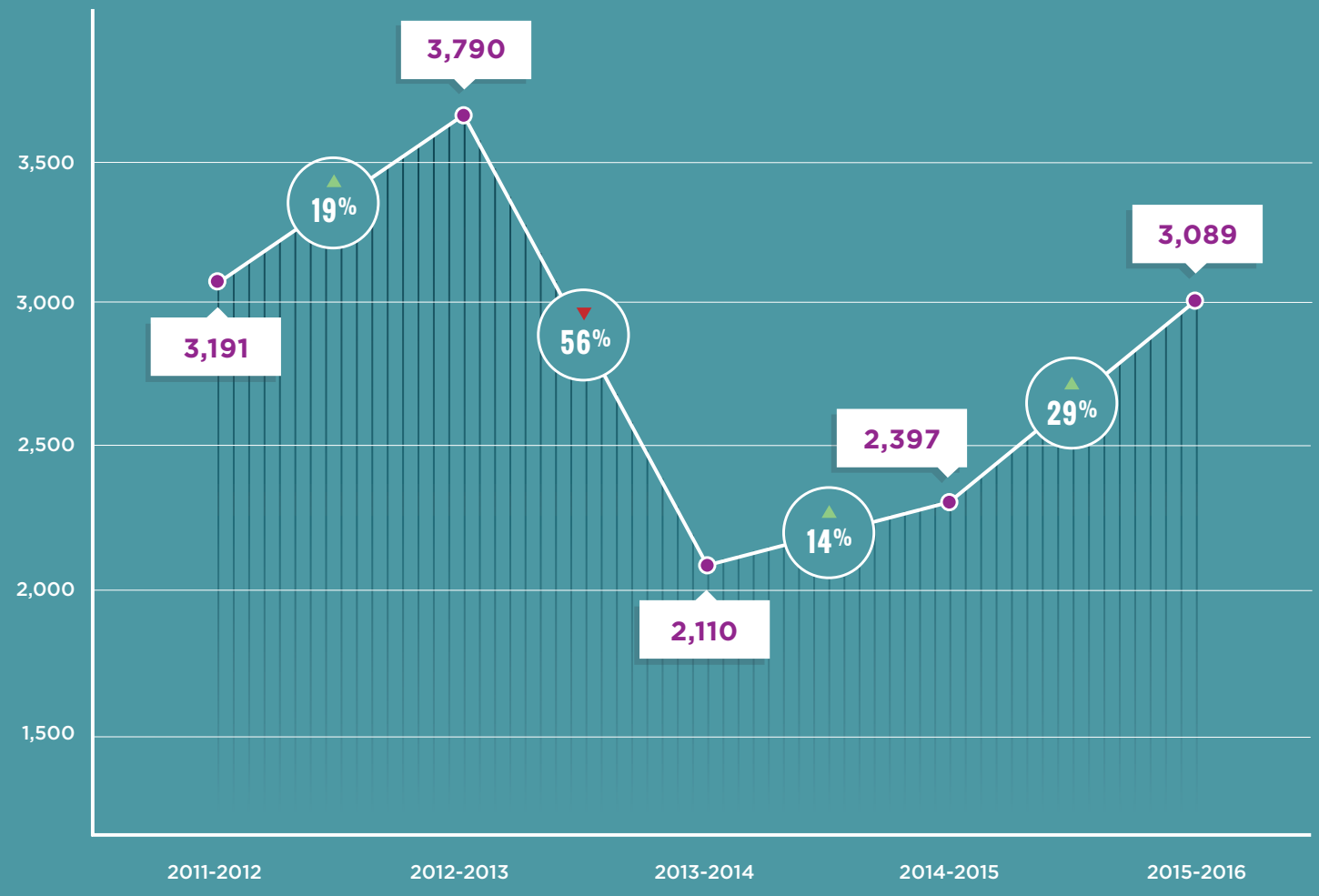
Workers in the Connected & Automated Vehicle IT Design sub-group are tasked with developing hardware and writing software for use in connected and automated vehicles. Computer hardware engineers working on connected and automated vehicle projects are developing hardware for fully automated vehicles as 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 jobs related to connected and automated vehicles peaked between 2012 and 2013 with 3,790 job postings. The following year, postings fell by 44% to 2,110 postings between 2013 and 2014. Since this low point, postings have increased by 46% to 3,089 postings between 2015 and 2016.

Design & Testing Postings Over Time

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

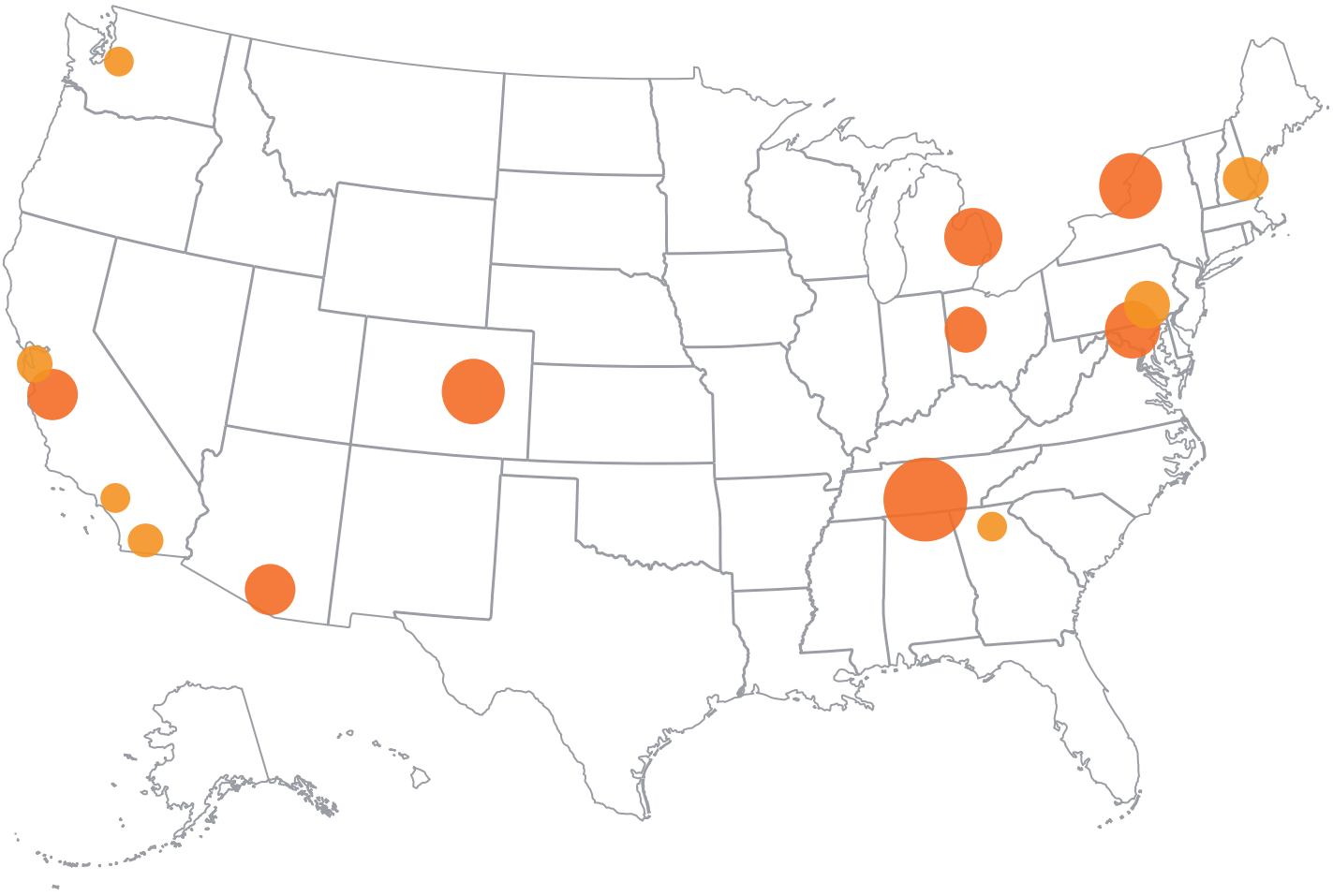
Top Posting Employers

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

- Raytheon
- Booz Allen Hamilton Inc.
- General Motors
- Parsons Brinckerhoff
- Ford Motor Company
- SRC and SRCTec
- Apple Inc.
- Continental Automotive Systems USA
- MITRE Corporation
- Leidos

Worker Demand Concentration

The Washington, D.C. metropolitan area saw the highest demand for IT Design related jobs with 574 job postings in 2015. The Detroit metropolitan area had the second highest demand for IT Design occupations with 347 postings. Both these areas had much higher demand than the national average making them prime areas for CAV development.



Posting Concentration Compared to Volume

Of the top five areas with the largest volume of Vehicle IT Design related postings, the Detroit area had the largest share of CAV related postings compared to total postings in the area. Although the Washington area had a large volume of IT Design postings, they only accounted for .071% of the total postings in this area, slightly less than the percentage found around Detroit.

Postings in Metropolitan Statistical Areas

Washington-Arlington-Alexandria, DC-VA-MD-WV

Total Postings
812,265

CAV Related Postings
574

Detroit-Warren-Dearborn, MI

Total Postings
471,387

CAV Related Postings
347

Boston-Cambridge-Nashua, MA-NH

Total Postings
608,092

CAV Related Postings
243

Baltimore-Columbia-Towson, MD

Total Postings
311,574

CAV Related Postings
168

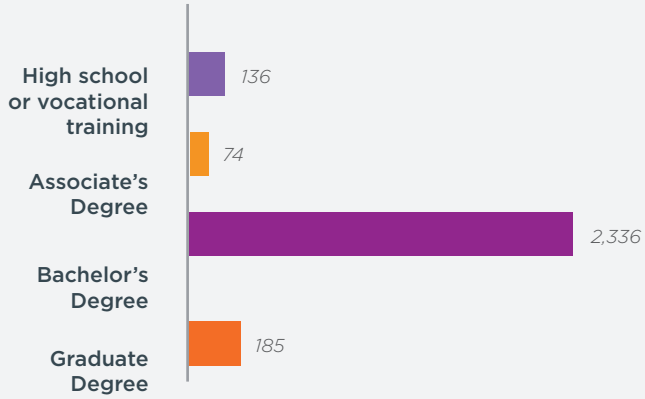
San Jose-Sunnyvale-Santa Clara, CA

Total Postings
307,306

CAV Related Postings
156

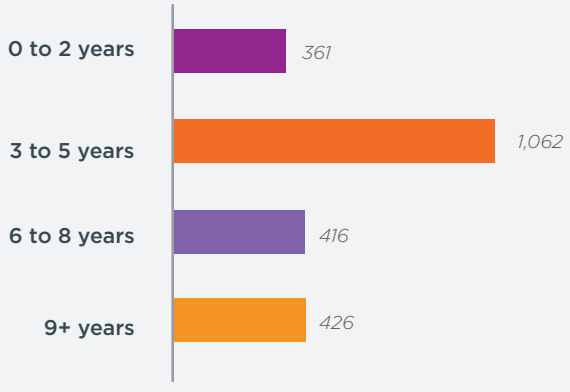
IT Design Education

October 2015 - September 2016



IT Design Experience

October 2015 - September 2016



Data: Burning Glass Technologies | Analysis: Workforce Intelligence Network

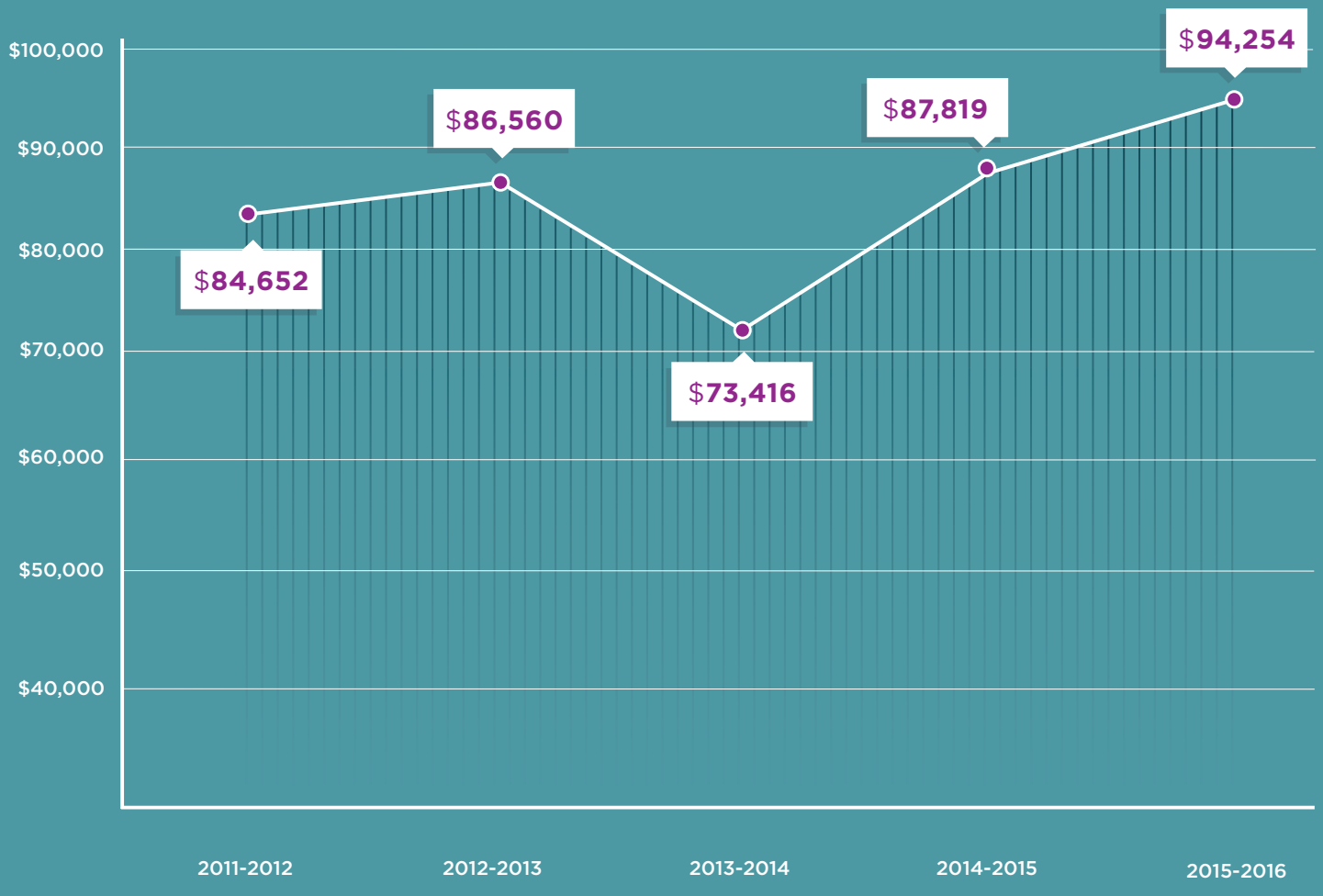
Experience and Educational Attainment

A majority of IT Design jobs are attainable with a bachelor's degree (2,336 postings). Although higher education is desired by employers, workers willing to make the necessary investment will not struggle to find employment with the large amount of job postings in recent years.

Most postings that provided required experience indicated that employers would like workers to have three to five years of experience. Some opportunities do exist for workers with less experience but the majority of employers want workers with experience to work on CAV development.

IT Design Salaries Posted

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

Salary/Wages

Over the past five years, the average advertised salary for IT Designers has increased by 11% from $84,652 between 2011 to 2012 to $94,254 between 2015 to 2016. This presents a lucrative opportunity for job seekers willing to obtain the educational requirements, as wages have reach their highest point for IT Design jobs during this past year.

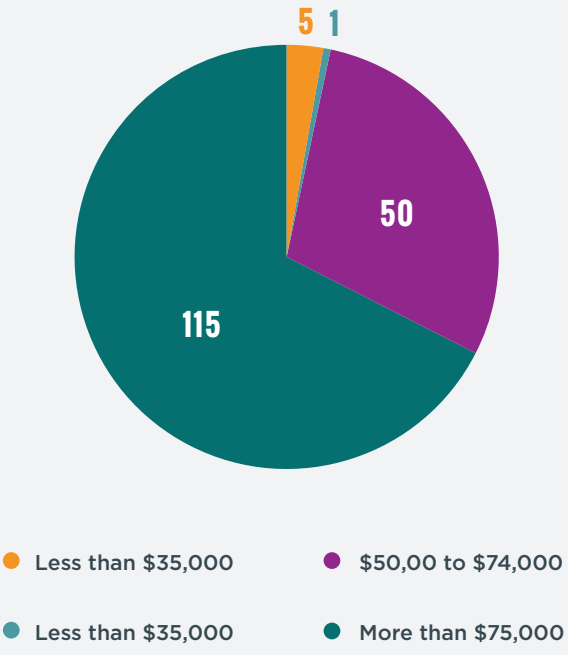
Most postings related to IT Design occupations advertised salaries over $75,000 a year with an average of $94,254 a year. Very few occupations advertised salaries under $50,000 a year, further solidifying the experience and education needed.

In-Demand Skills

IT Design occupations require extremely specialized, industry-specific skills. Skills In-Demand specific to IT include JAVA, software development, C++, and LINUX. Employers hiring IT workers often post employability skills like communication skills, writing, troubleshooting/problem solving, research, and project management.

IT Design Advertised Salary

October 2015 - September 2016



In-Demand Degrees

= 50 Job Postings

Computer Science	1,349	Management Information Systems, General	112
Engineering, General	921	Mechanical Engineering	79
Computer Engineering	518	Systems Engineering	62
Electrical And Electronic Engineering Technologies/ Technicians, Other	474	Information Technology	56
Physics	118	Business Administration And Management, General	50

Technical Skills

= 50 Job Postings

Software Development	1,264
Software Engineering	1,204
C++	1,029
LINUX	850
JAVA	798
Computer Engineering	681
Python	591
Image Processing	586
MATLAB	572
Electrical Engineering	557
UNIX	472
Systems Engineering	451
Software Architecture	388
Information Assurance	380
Information Systems	374

Employability Skills

= 50 Job Postings

Communication Skills	1,216
Writing	1,045
Research	865
Planning	560
Problem Solving	539
Mathematics	482
Team Work/ Collaboration	399
Troubleshooting	394
Creativity	216
Organizational Skills	200
Leadership	180
Detail-Oriented	173
Multi-Tasking	158
Presentation Skills	146

In-Demand Certifications

=50 Job Postings

Security Clearance	1,201
Certified Information Systems Security Professional (CISSP)	311
Security+	160
Sans/Giac Certification	131
Certified Information Security Manager (CISM)	70
Cisco Certified Network Associate (CCNA)	50
Certified Information Systems Auditor (CISA)	45
Project Management Certification (e.g. PMP)	37
Certified Financial Planner	36
Network+ Certified	35

Quality Control

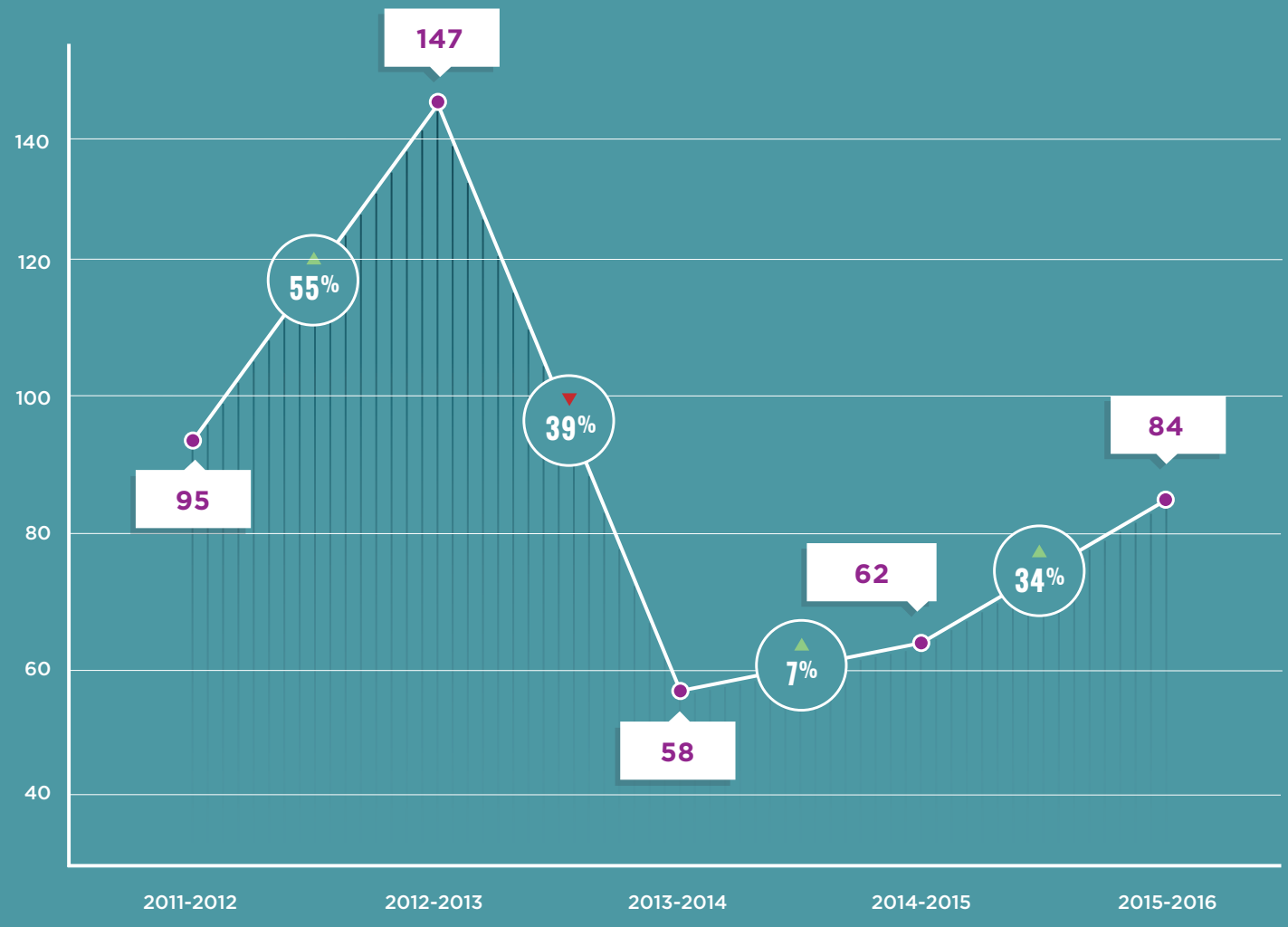
The Quality Control sub-group is a small one made up of quality control systems managers, quality control analysts, and inspectors and testers. The workers employed in this sub-group are integral to the vehicle manufacturing process. Positions for these types of workers already exist at vehicle manufacturers,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

Demand Trends

Quality Control job postings related to connected and automated vehicles peaked in between 2012 and 2013 with 147 ads. The following year, postings fell by 61% to 58 postings between 2013 and 2014. Since this low point, postings have increased by 45% to 84 postings between 2015 and 2016. Demand is rising, but is not as strong as demand for workers in other CAV areas.

Quality Control Postings Over Time

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

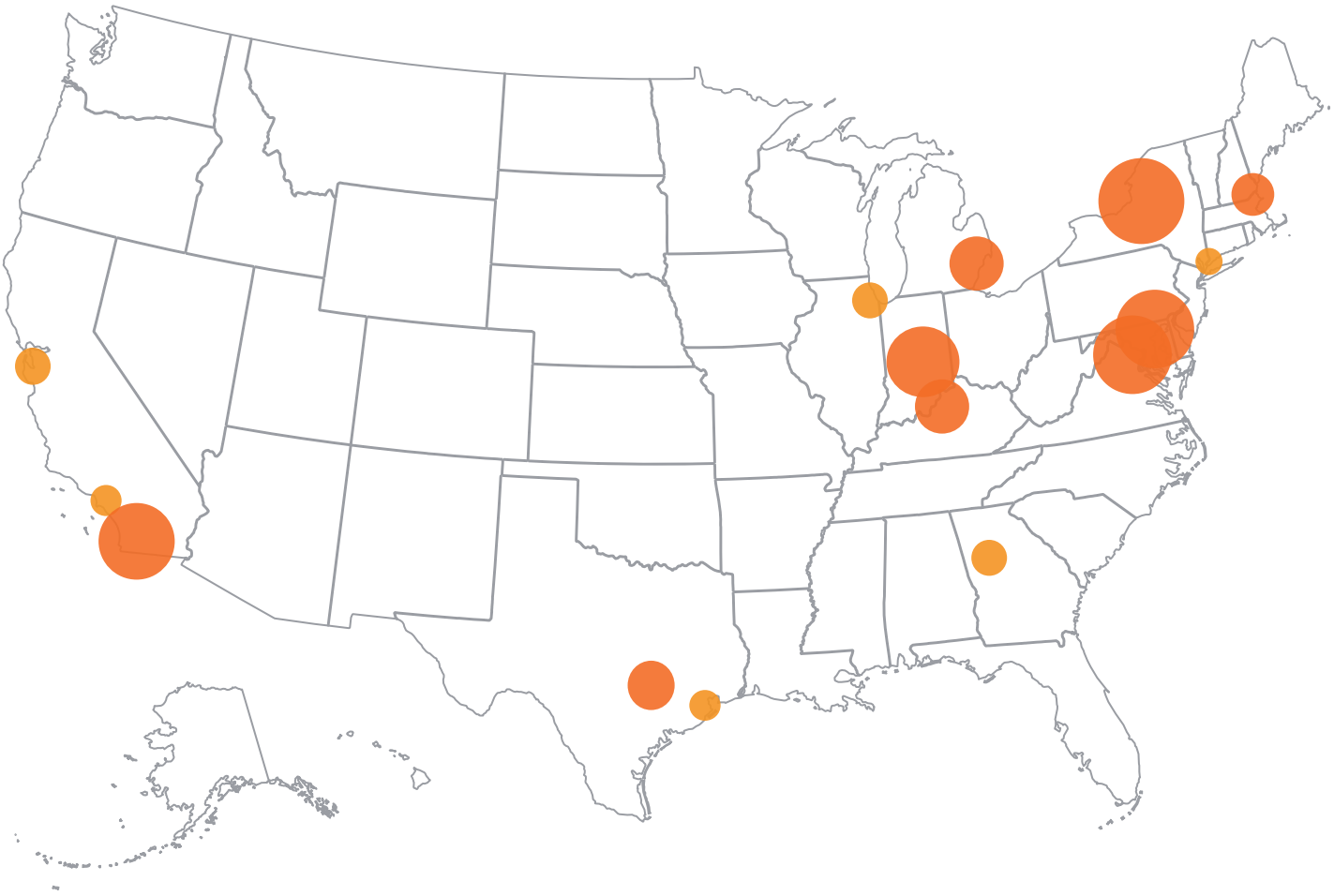
Top Posting Employers

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

- Parsons Brinckerhoff
- Booz Allen Hamilton Inc.
- Raytheon
- ManTech International Corp.
- CGI Group
- AECOM Technology Corporation
- Electronic Arts Incorporated
- General Motors
- Ke`Aki Technologies
- Technology Consulting Incorporated

Worker Demand Concentration

Like many other areas, the Washington, D.C. metropolitan area saw the highest demand for quality control related jobs with 19 job postings in 2015. Southern California was another area with high demand for quality control occupations with 13 postings between the San Diego and Los Angeles metropolitan areas. The Detroit metropolitan area saw 3 postings related to Quality Control, low relative to the demand for other CAV workers.



Posting Concentration Compared to Volume

Of the top five areas with high volumes of Quality Control related postings, three metropolitan areas saw .002% of their total postings representing quality control. This includes the Washington, D.C. area who had the largest volume of Quality Control postings.

Postings in Metropolitan Statistical Areas

Washington-Arlington-Alexandria, DC-VA-MD-WV

Total Postings
812,265

CAV Related Postings
19

Los Angeles-Long Beach-Anaheim, CA

Total Postings
1,193,130

CAV Related Postings
6

Boston-Cambridge-Nashua, MA-NH

Total Postings
608,092

CAV Related Postings
5

Baltimore-Columbia-Towson, MD

Total Postings
311,574

CAV Related Postings
7

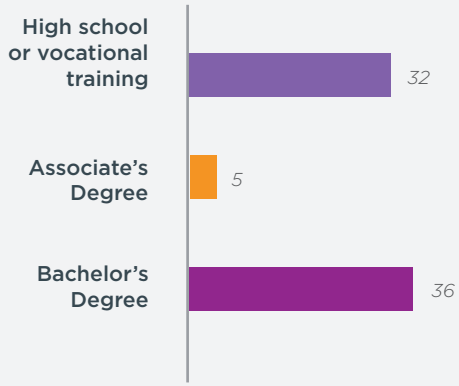
San Diego-Carlsbad, CA

Total Postings
335,788

CAV Related Postings
7

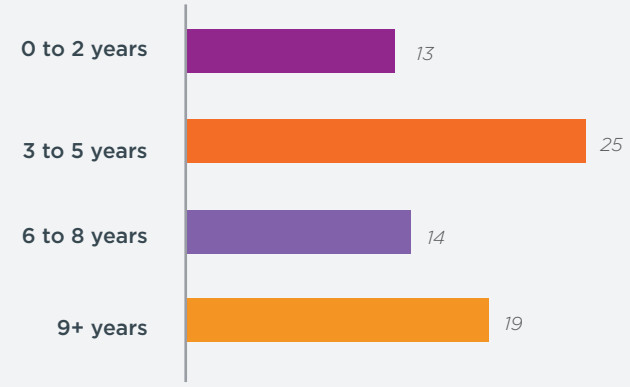
Quality Control Education

October 2015 - September 2016



Quality Control Experience

October 2015 - September 2016



Data: Burning Glass Technologies | Analysis: Workforce Intelligence Network

Experience and Educational Attainment

Almost all jobs in Quality Control are attainable with either vocational training post-high school (32 postings) or a bachelor's degree (36 postings). Supervisory and advanced positions are most likely represented in the postings searching for candidates with a bachelor's degree.

The data show that most Quality Control jobs related to automated and connected vehicles are within reach for workers with fewer than 5 years of experience (38 postings between 2015 and 2016). Those jobs requiring more experience, 6 years and beyond, are likely for some management occupations included in this group.

Salary/Wages

Too few job postings for Quality Control CAV jobs listed salaries offered. Because of this, data is not available.

In-Demand Skills

The occupations related to Quality Control require a wide array of technical skills, like inspection, software development, and computer skills. These job postings listed required knowledge or experience in LINUX, Cisco, and Microsoft Office. Employers are also seeking foundational skills like communication skills and planning.

In-Demand Degrees

 = 2 Job Postings


Engineering, General 22


Computer Science 9


Chemistry 7


Telecommunications Technology/ Technician 5


Business Administration And Management, General 3


Computer Engineering 2


Mechanical Engineering 2

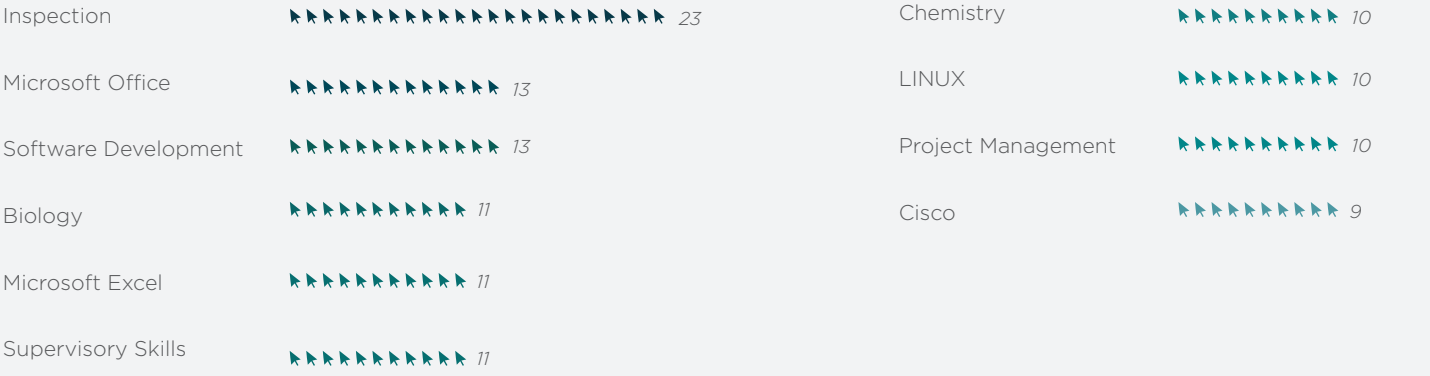

Quality Control Technology/ Technician 1


Electrical And Electronic Engineering Technologies/ Technicians, Other 1


Engineering/Industrial Management 1

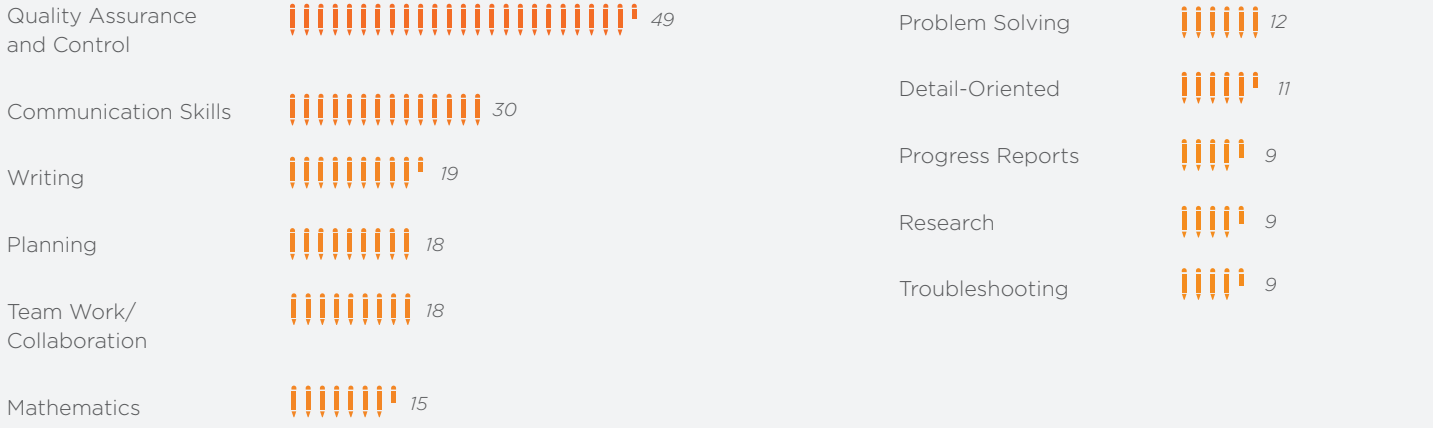
Technical Skills

= 1 Job Posting



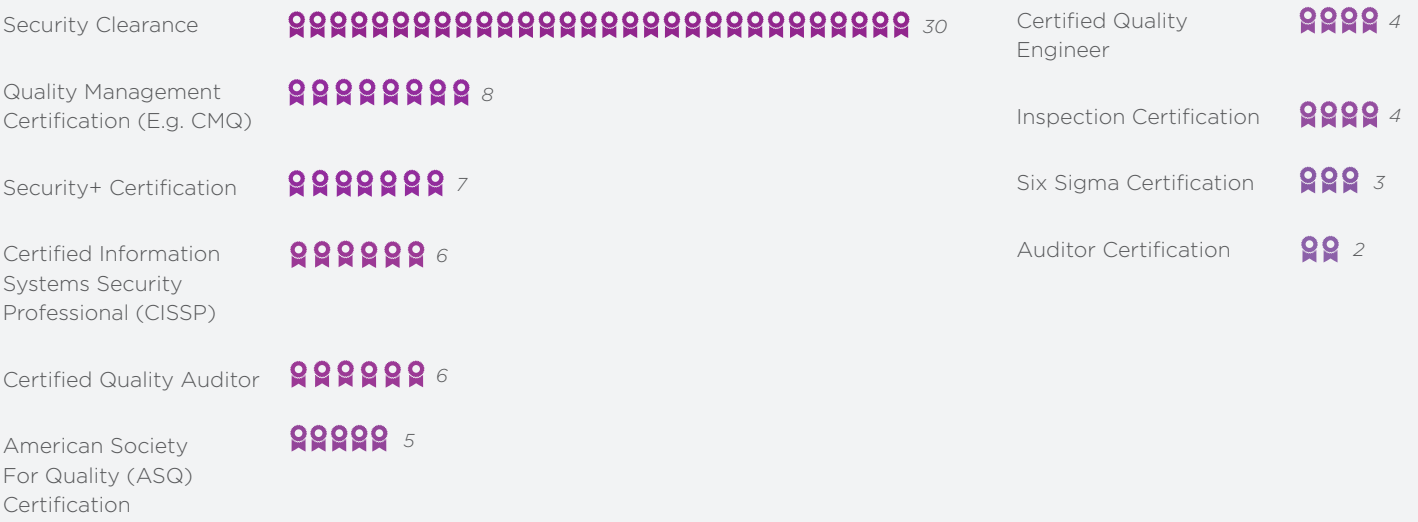
Employability Skills

= 2 Job Postings



In-Demand Certifications

= 1 Job Posting



Data Management & Cybersecurity

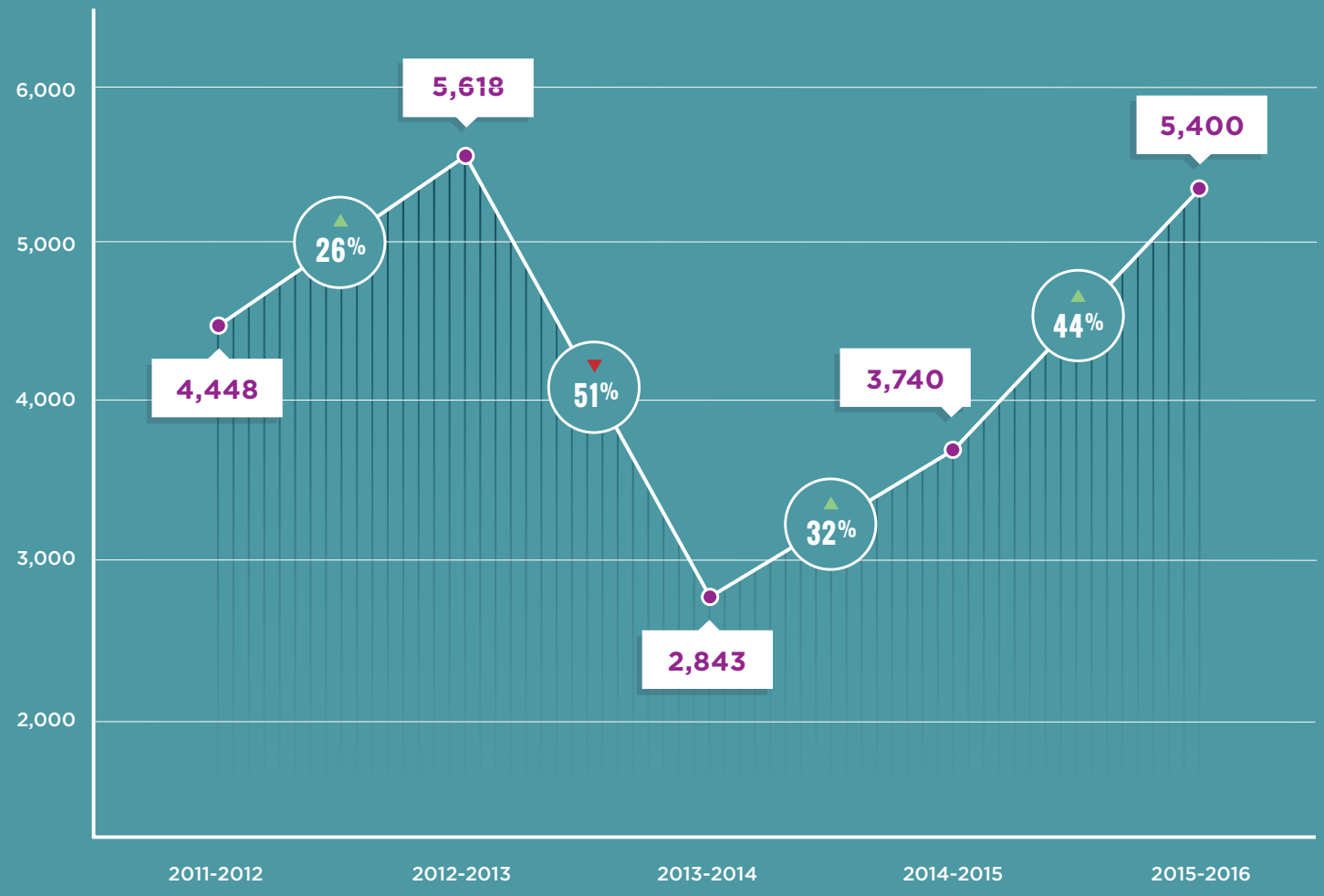
Data Management & Cybersecurity is a large and important sub-group for connected and automated vehicles occupations. The data warehousing specialists, information security analysts, and other computer- and network-related occupations in this sub-group work on projects that protect data being collected 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

Online job postings for Data Management & Cybersecurity occupations related to CAV grew to 5,400 during October 2015 to September 2016 indicating growing demand and need. This represents 21% growth compared to the 4,448 postings during 2011-2012 and 90% percent growth compared to 2013-2014.

Design & Testing Postings Over Time

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

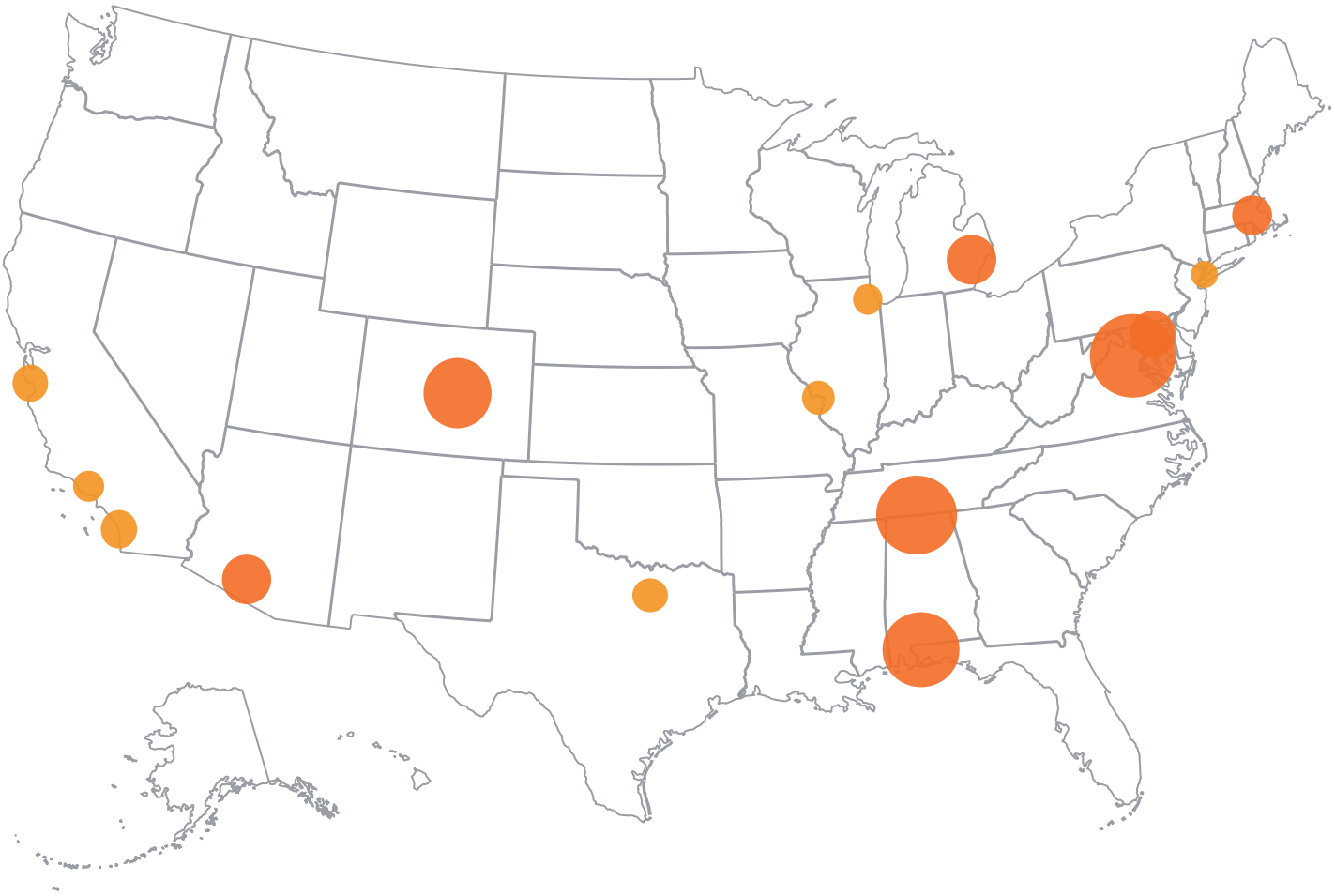
Top Posting Employers

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

- Booz Allen Hamilton Inc.
- Raytheon
- Parsons Brinckerhoff
- General Motors
- Cisco Systems Incorporated
- ManTech International Corp.
- MITRE Corporation
- Leidos
- Microsoft Corporation
- Hewlett-Packard
- CACI
- Jacobs Engineering Group Incorporated
- CGI Group
- SRC and SRCTec
- Unisys

Worker Demand Concentration

In 2015, employers in Washington, D.C. led the nation in postings for workers in Data Management & Cybersecurity. Baltimore, Boston, and Detroit also had strong posting levels. Demand in Colorado, Alabama, and Florida is not strong in volume but high relative to the populations of those metropolitan areas.



Posting Concentration Compared to Volume

The Washington, D.C. area reported the highest volume of Data Management & Cybersecurity and when compared to the total postings in the metropolitan area, these CAV related postings make up .201% of the postings. The Detroit area had the third highest percentage comparing total posting to Data Management & Cybersecurity related postings in the area.

Postings in Metropolitan Statistical Areas

Washington-Arlington-Alexandria, DC-VA-MD-WV

Total Postings
812,265

CAV Related Postings
1,636

Detroit-Warren-Dearborn, MI

Total Postings
471,387

CAV Related Postings
288

Boston-Cambridge-Nashua, MA-NH

Total Postings
608,092

CAV Related Postings
293

Baltimore-Columbia-Towson, MD

Total Postings
311,574

CAV Related Postings
306

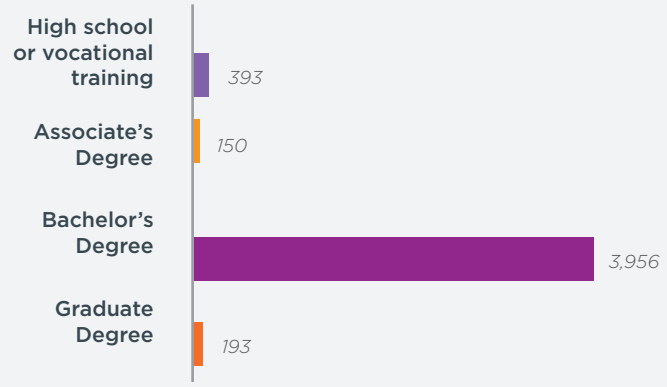
Los Angeles-Long Beach-Anaheim,

Total Postings
1,193,130

CAV Related Postings
176

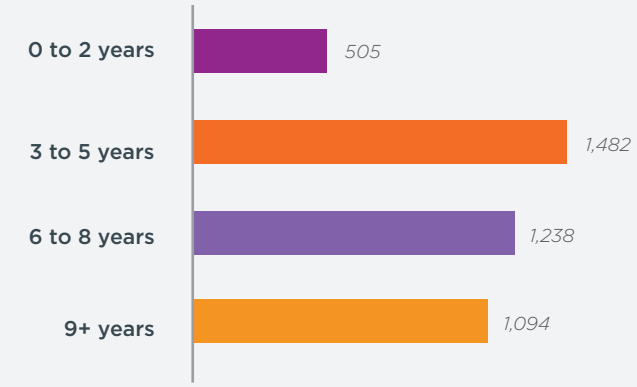
Data Management & Cybersecurity Education

October 2015 - September 2016



Data Management & Cybersecurity Experience

October 2015 - September 2016



Data: Burning Glass Technologies | Analysis: Workforce Intelligence Network

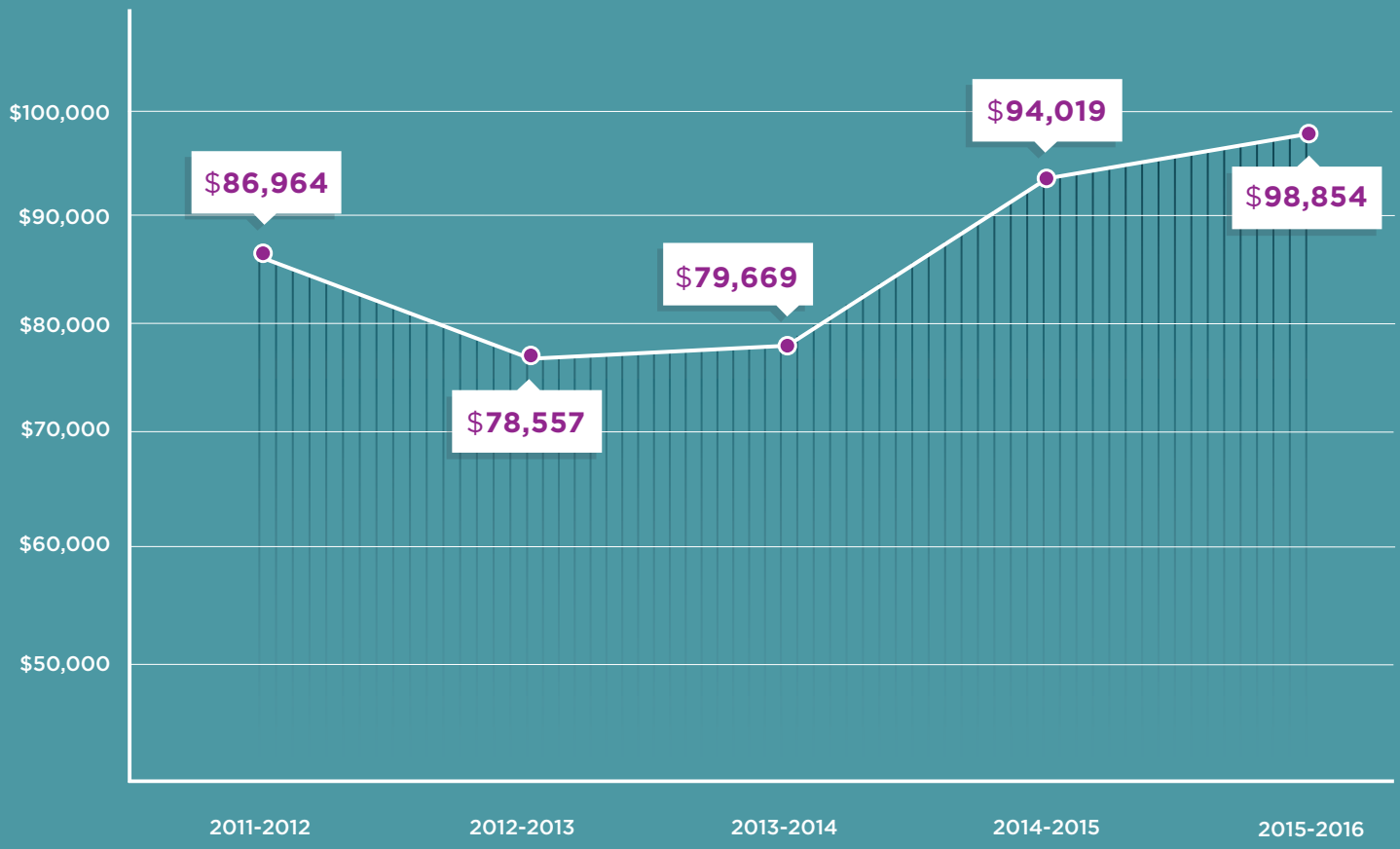
Experience and Educational Attainment

An overwhelming majority (84.3%) of Data Management & Cybersecurity postings advertising minimum education requirements asked for candidates with a bachelor's. An additional 4.1% of postings with education listed asked that candidates have education beyond a bachelor's. Higher education is necessary for workers in CAV-related cybersecurity.

In addition to needing advanced degrees, workers in Data Management & 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. Just one out of every eight postings advertising experience asked for candidates with minimal experience (0-2 years). Meanwhile, 54% of ads desired workers with six or more years of experience.

Data Management and Cybersecurity Advertised Salary in Job Ads

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

Salary/Wages

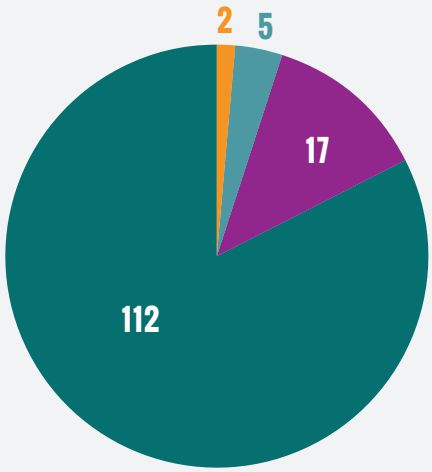
Average advertised salaries for Data Management & Cybersecurity occupations have increased annually since 2012, most recently reaching a historic high of $98,854 from October 2015 through September 2016. The overwhelming majority of postings with wage information advertised annual salaries of over $75,000. With demand for workers doubling in the last three years and high levels of education and experience requirements, wages will likely remain high for this group to entice prospective students and candidates.

In-Demand Skills

Data Management & Cybersecurity occupations require specialized, industry-specific skills. In addition to having an engineering background, these workers often need to know specific computer languages. Employers of Data Management & Cybersecurity occupations typically want well-rounded workers with the ability to research, communicate, and solve problems with teams on projects. Many cybersecurity workers are required to have a Federal-level security clearance due to the sensitive nature of their work.

Data Management & Cybersecurity Advertised Salary

October 2015 - September 2016



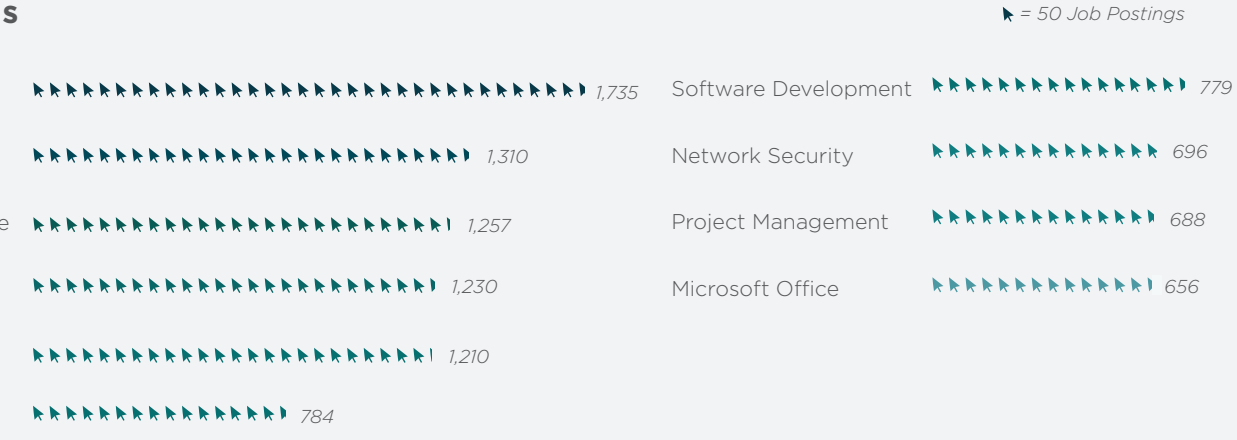
- Less than $35,000
- $50,00 to $74,000
- Less than $35,000
- More than $75,000

In-Demand Degrees

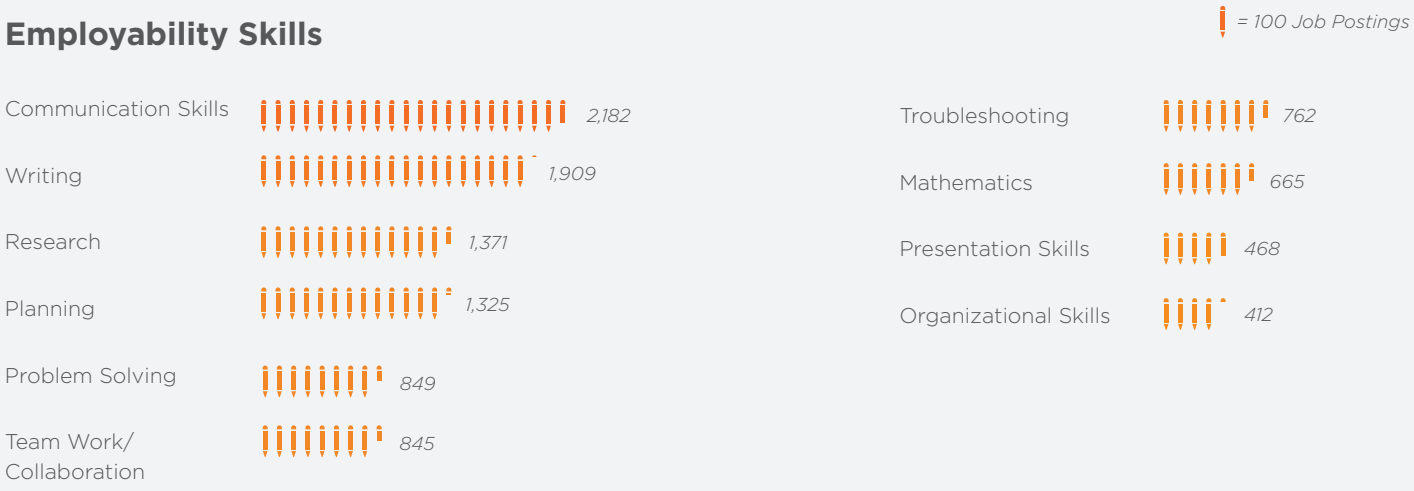
= 50 Job Postings

Computer Science	1,673	Information Technology	236
Engineering, General	1,173	Systems Engineering	221
Computer Engineering	444	Business Administration And Management, General	175
Electrical And Electronic Engineering Technologies/Technicians, Other	366	Physics	144
Management Information Systems, General	261	Mechanical Engineering	116

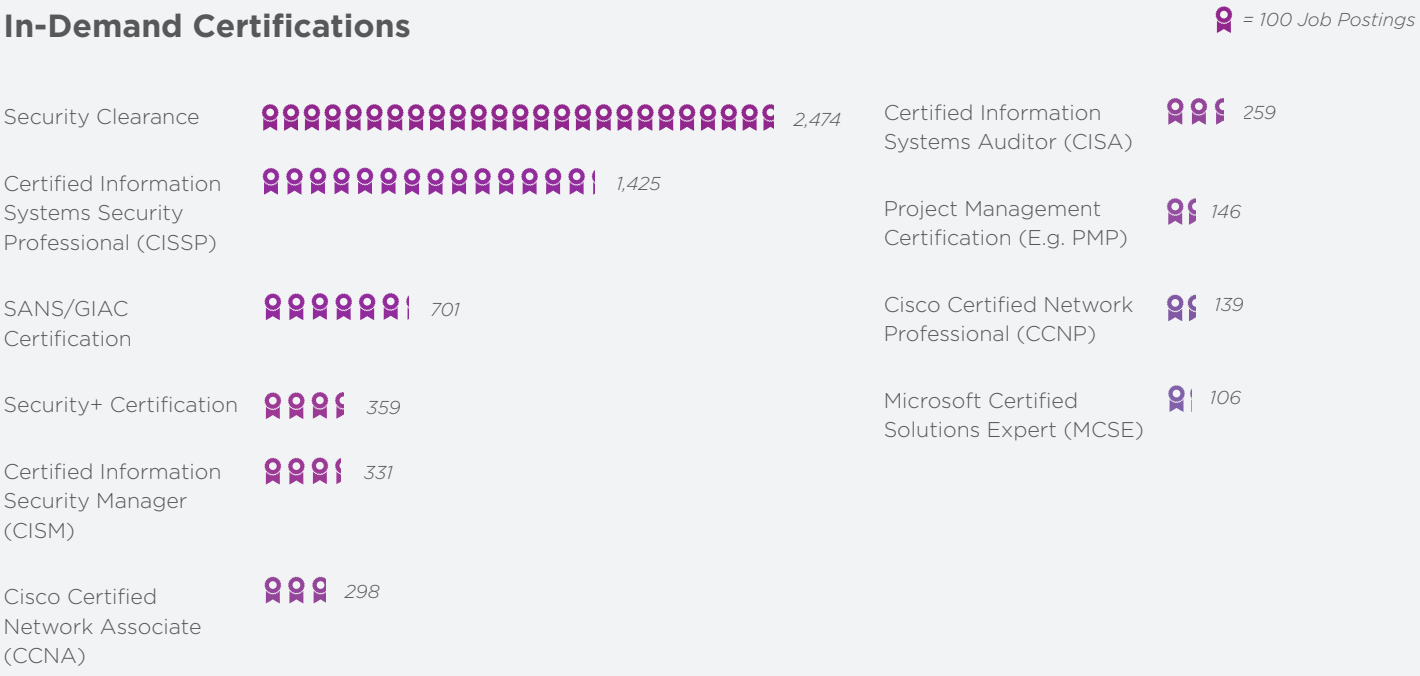
Technical Skills



Employability Skills



In-Demand Certifications



Intelligent Transportation Systems & Infrastructure Design

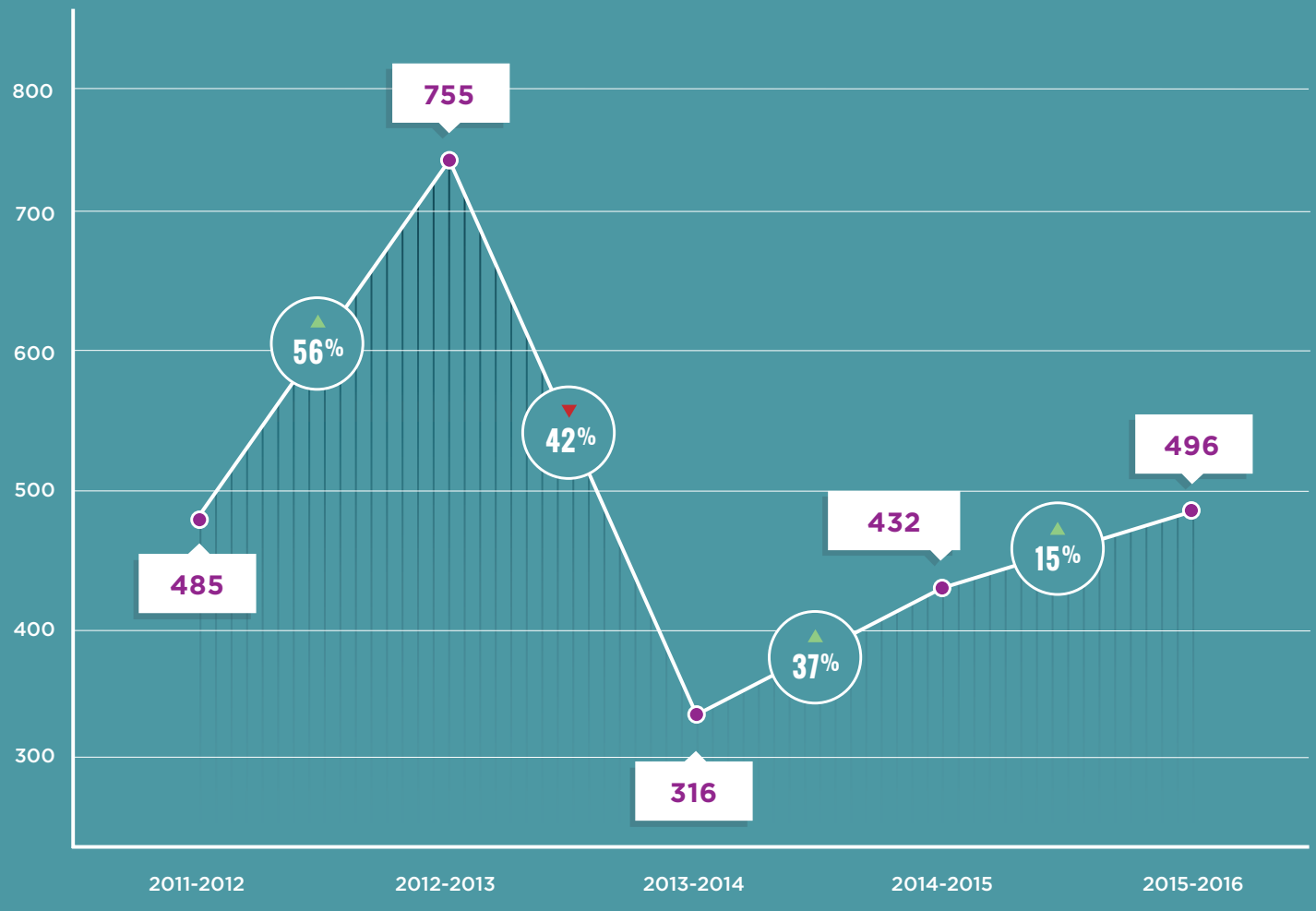
Employer demand for Intelligent Transportation Systems & Infrastructure workers peaked in 2012-2013. Skilled and knowledgeable workers like these will be key in the implementation of connected vehicle infrastructure and intelligent transportation systems. Telecommunications specialists and civil engineers will also work closely with transportation planners and engineers and traffic technicians within this sub-group to inform decision making on connected infrastructure and traffic management. Therefore, workers in this sub-group may work for state and local departments of transportation or private consulting firms.

Demand Trends

Employer demand for Intelligent transportation systems and infrastructure workers peaked in 2012-2013. Online job ads have increased nationally over the past three years but demand is not growing as quickly as in other areas of CAV. This may be because intelligent and connected transportation systems are further in the future than vehicle and IT design.

Transportation Systems & Infrastructure Online Job Ads

October 2015 - September 2016



Data: Burning Glass Technologies
Analysis: Workforce Intelligence Network

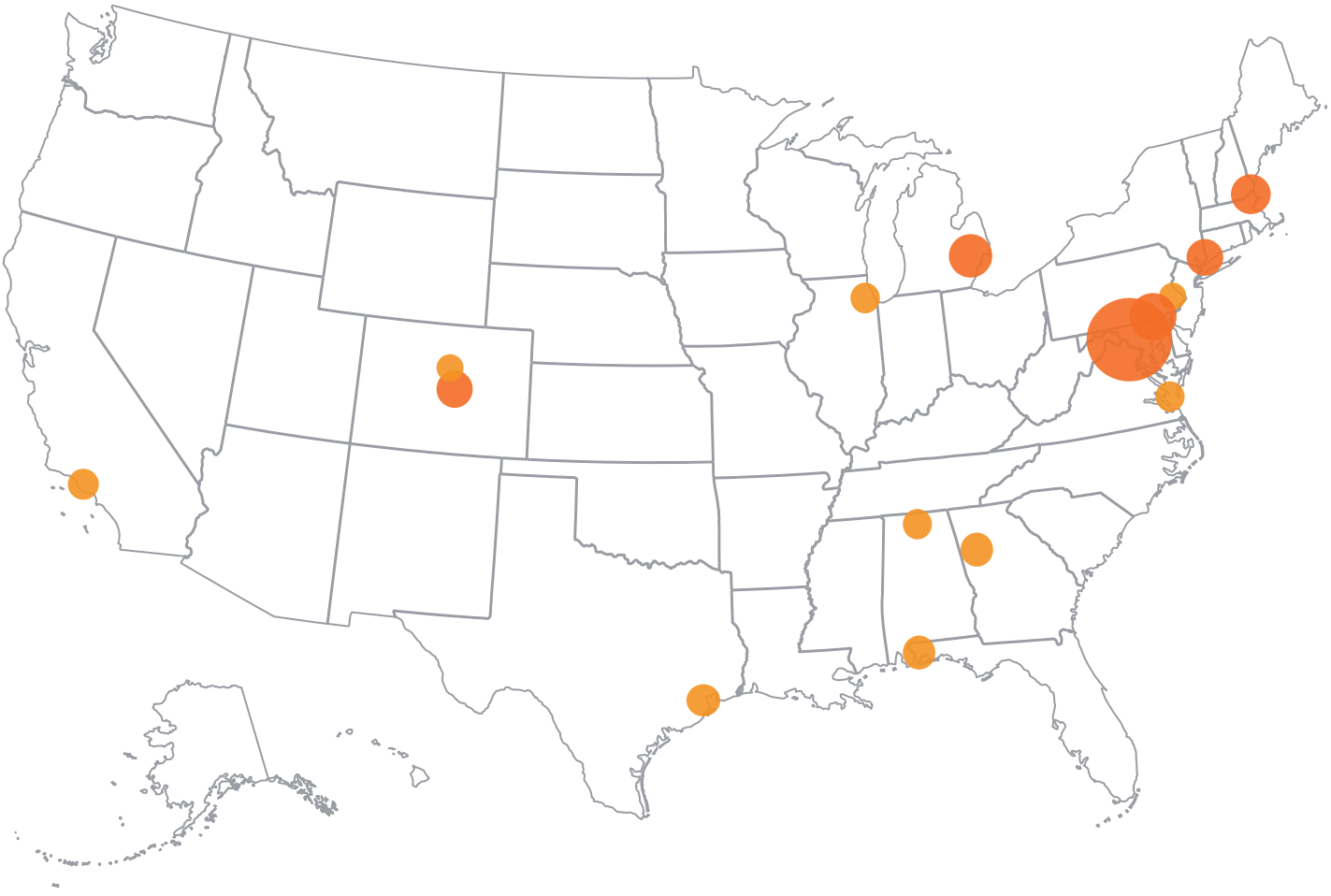
Top Posting Employers

The employers posting the highest number of job openings in the area of CAV Intelligent Transportation Systems and Infrastructure are listed below.

- Parsons Brinckerhoff
- Booz Allen Hamilton Inc.
- Raytheon
- Arcadis
- Qualis Corporation
- Battelle Memorial Institute
- SAIC
- CACI
- Continental Automotive Systems USA
- MITRE Corporation
- Ford Motor Company
- General Motors
- HNTB
- Jacobs Engineering Group Incorporated
- Unisys

Worker Demand Concentration

The majority of job ads across the nation for Intelligent Transportation Systems & Infrastructure Design are for jobs located in Washington, D.C. This is similar to many other CAV occupation groups where the center of job demand is in this area. Other metro regions with strong demand include Baltimore, Atlanta, Colorado, Boston, Detroit, and Los Angeles.



Posting Concentration Compared to Volume

Although the Washington, D.C. metropolitan area had the largest volume of Transportation System & Infrastructure Design, it only had the third largest percentage of total postings. The largest percentage of total postings in area related to Transportation & Infrastructure Design was in Colorado Springs, Colorado with .046%.

Postings in Metropolitan Statistical Areas

Washington-Arlington-Alexandria, DC-VA-MD-WV

Total Postings
812,265

CAV Related Postings
121

Atlanta-Sandy Springs-Roswell, GA

Total Postings
578,370

CAV Related Postings
29

Boston-Cambridge-Nashua, MA-NH

Total Postings
608,092

CAV Related Postings
29323

Baltimore-Columbia-Towson, MD

Total Postings
311,574

CAV Related Postings
52

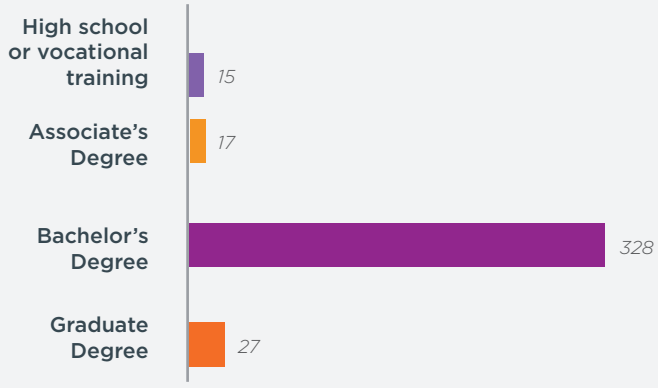
Colorado Springs, CO

Total Postings
54,185

CAV Related Postings
25

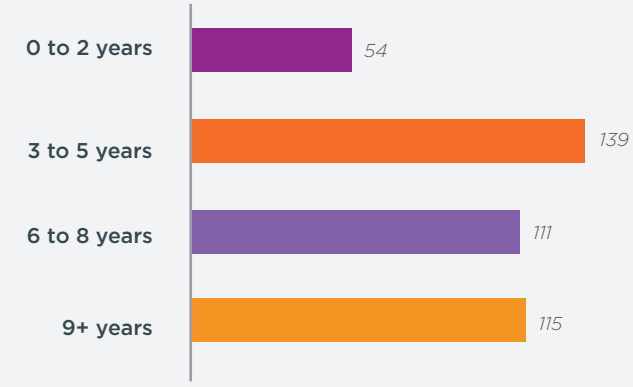
Transportation System & Infrastructure Design Education

October 2015 - September 2016



Transportation System & Infrastructure Design Experience

October 2015 - September 2016



Data: Burning Glass Technologies | Analysis: Workforce Intelligence Network

Experience and Educational Attainment

Intelligent Transportation Systems & Infrastructure Design jobs require, at minimum, a bachelor's degree. The descriptions for many of these jobs list deep understanding of civil engineering principles as a necessity. While some opportunity exists for entry-level workers, most employers are interested in hiring candidates with greater than three years of experience.

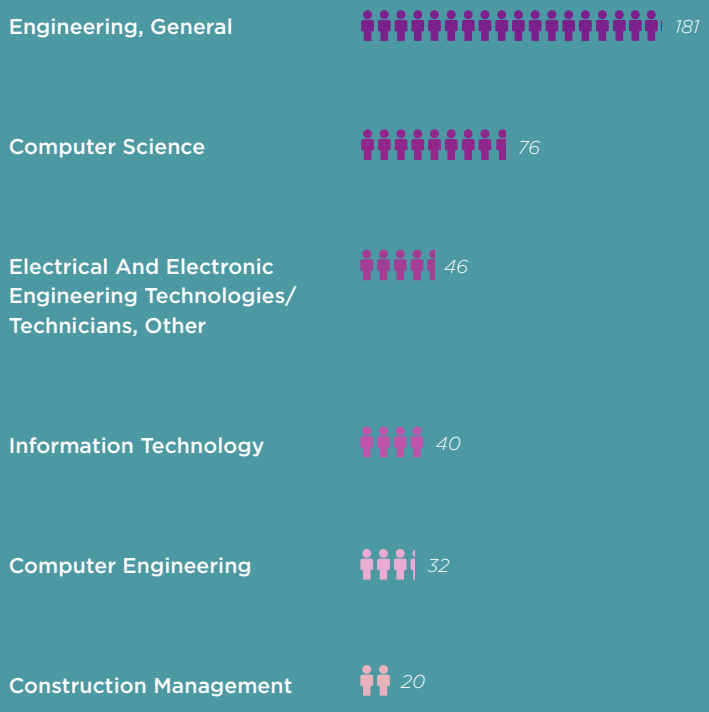
Salary/Wages

Too little data exists from job postings on advertised salaries and wages. Because of this, the data is not presented or analyzed for this occupation group.

In-Demand Skills

Employers hiring Intelligent Transportation Systems & Infrastructure Design workers are interested in talent with deep understanding of engineering, IT, and networks. In addition, they are interested in workers who can work well on a team, have strong math skills, and are detail-oriented. Many of these jobs are located in Washington, D.C. and may involve internet security resulting in a need for a Federal-level security clearance.

In-Demand Degrees

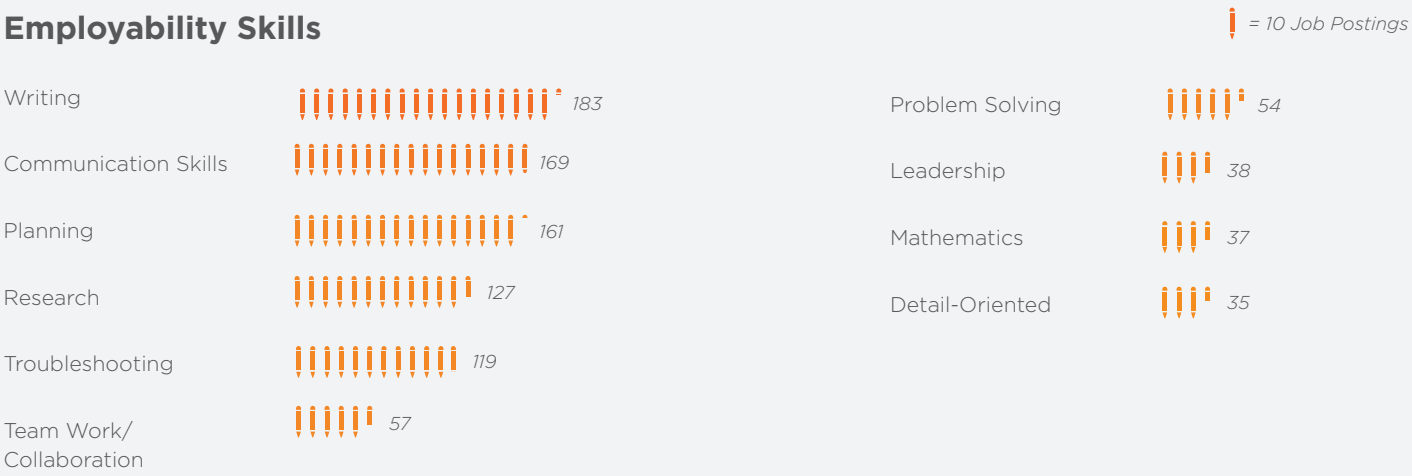


Technical Skills

= 10 Job Postings

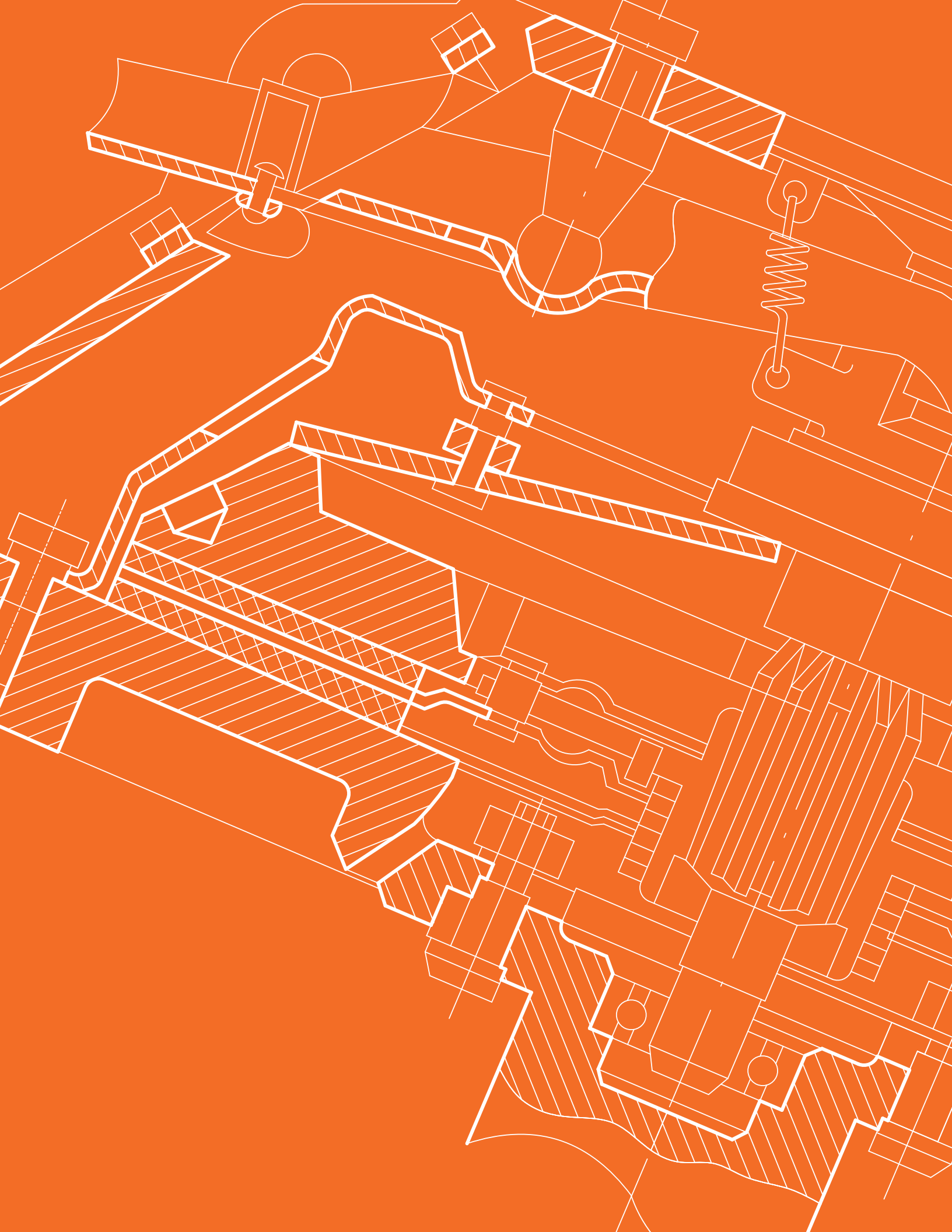
Employability Skills

= 10 Job Postings

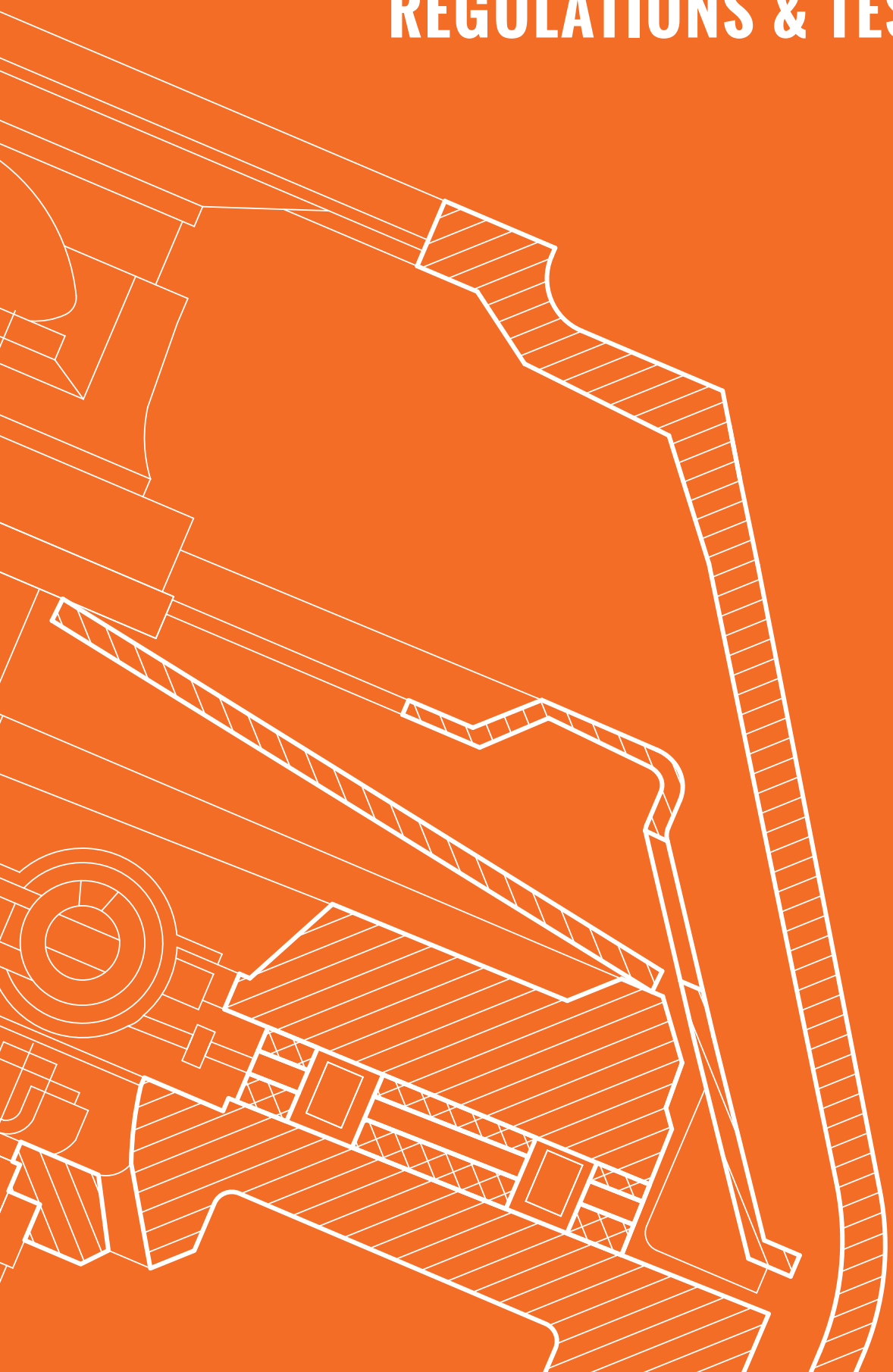


In-Demand Certifications

= 10 Job Postings



REGULATIONS & TESTING

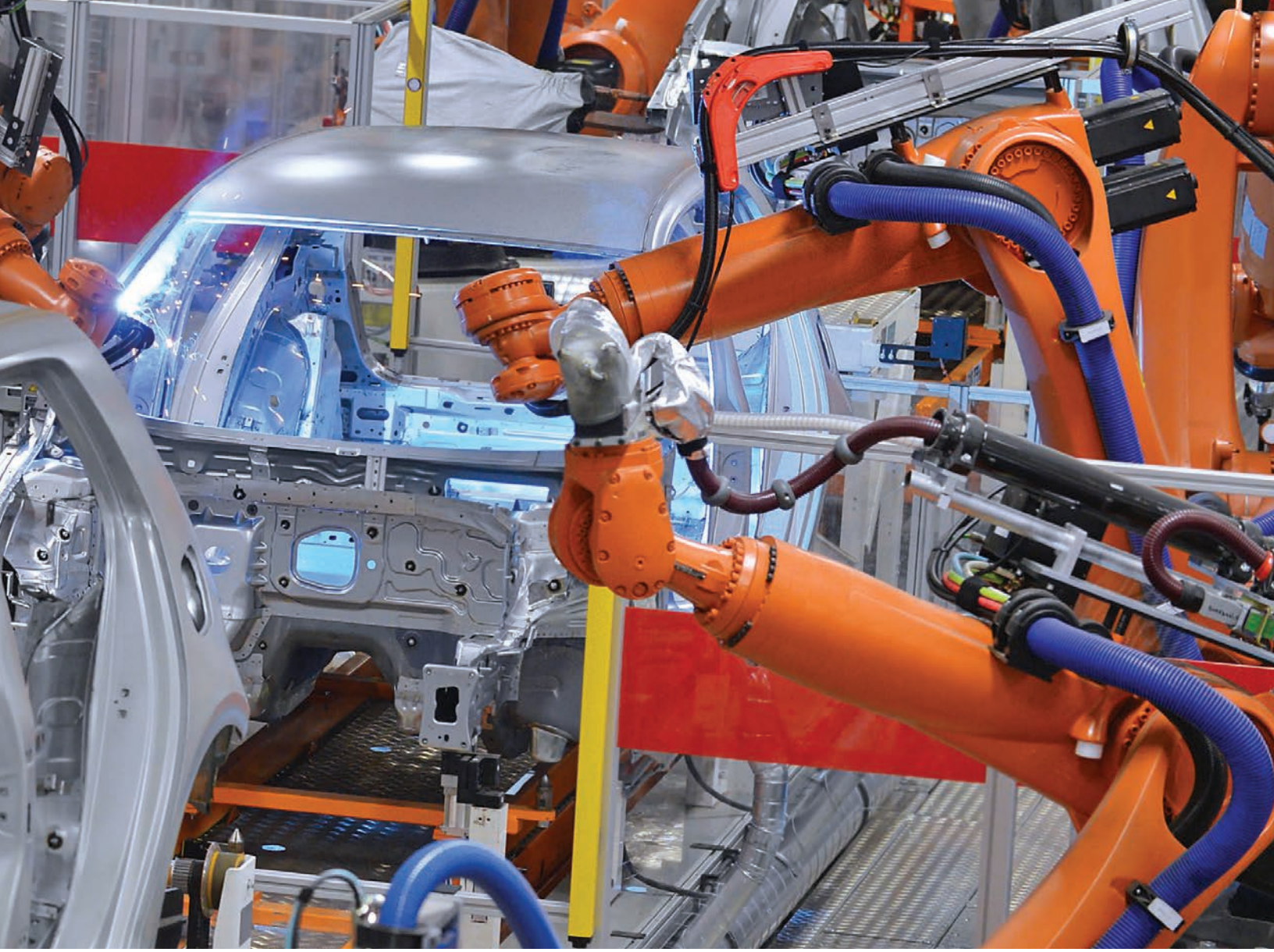


In addition to the occupations and their related job duties outlined in this analysis, many workers will be tasked with providing input to the testing process and new regulations needed to govern the emergence of connected and automated vehicles. Experts in their respective fields will be invited to serve as key stakeholders as government agencies and lawmakers write standards and laws for each phase of the CAV product cycle.

Government agencies like the Federal Highway Administration (FHWA) under the United States Department of Transportation (USDOT) and the National Highway Traffic Safety Administration (NHTSA) are the preeminent sources for federal policy on connected and automated vehicles. USDOT and NHTSA released Federal Automated Vehicles Policy in September 2016 to provide a policy framework at the national level to "translate [Department] aspirations and knowledge into early guidance" (p. 3).[1] Transportation industry experts, including transportation engineers, at USDOT are continually seeking to answer the myriad of questions that a future with automated vehicles poses.

Many state governments are arguably a step ahead of federal transportation agencies like FHWA. 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. States passing legislation over connected and automated vehicles hesitate to pass overly restrictive laws that would impede progress on development of this disruptive technology.

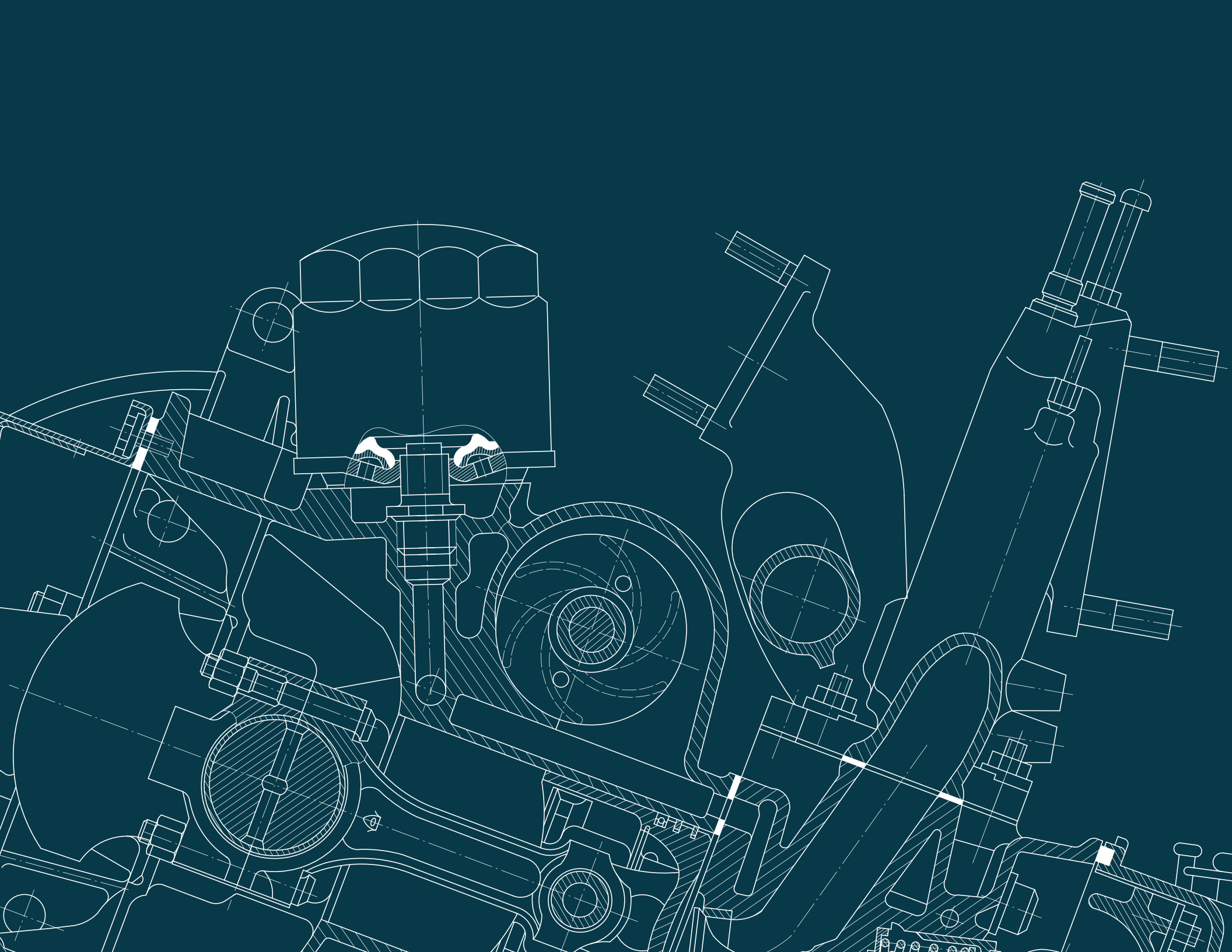
[1] *National Highway Transportation Safety Administration. (2016, September). Federal Automated Vehicles Policy: Accelerating the next revolution in roadway safety. Retrieved from <https://www.transportation.gov/sites/dot.gov/files/docs/AV%20policy%20guidance%20PDF.pdf>.*

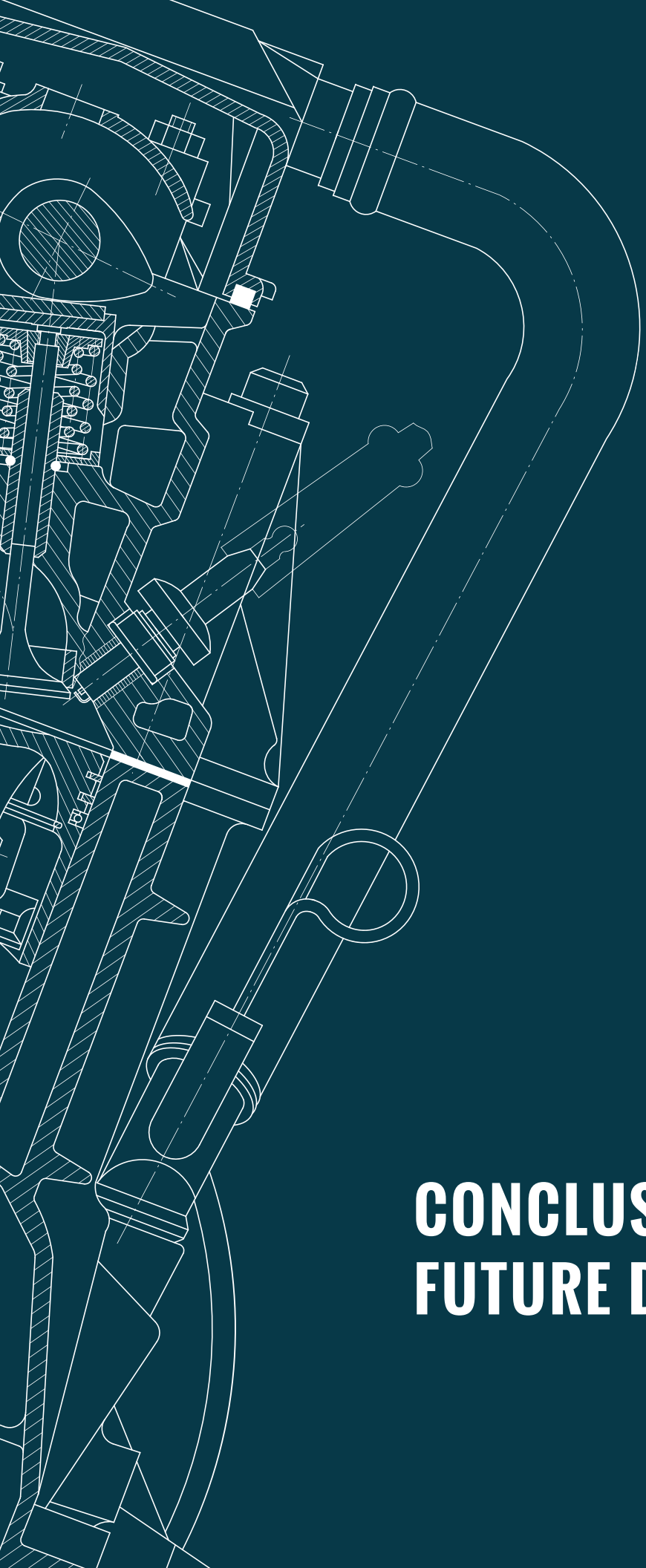


Passing legislation regulating CAV requires action by progressive policymakers, analysis by legal experts, and input from researchers in industry and academia.

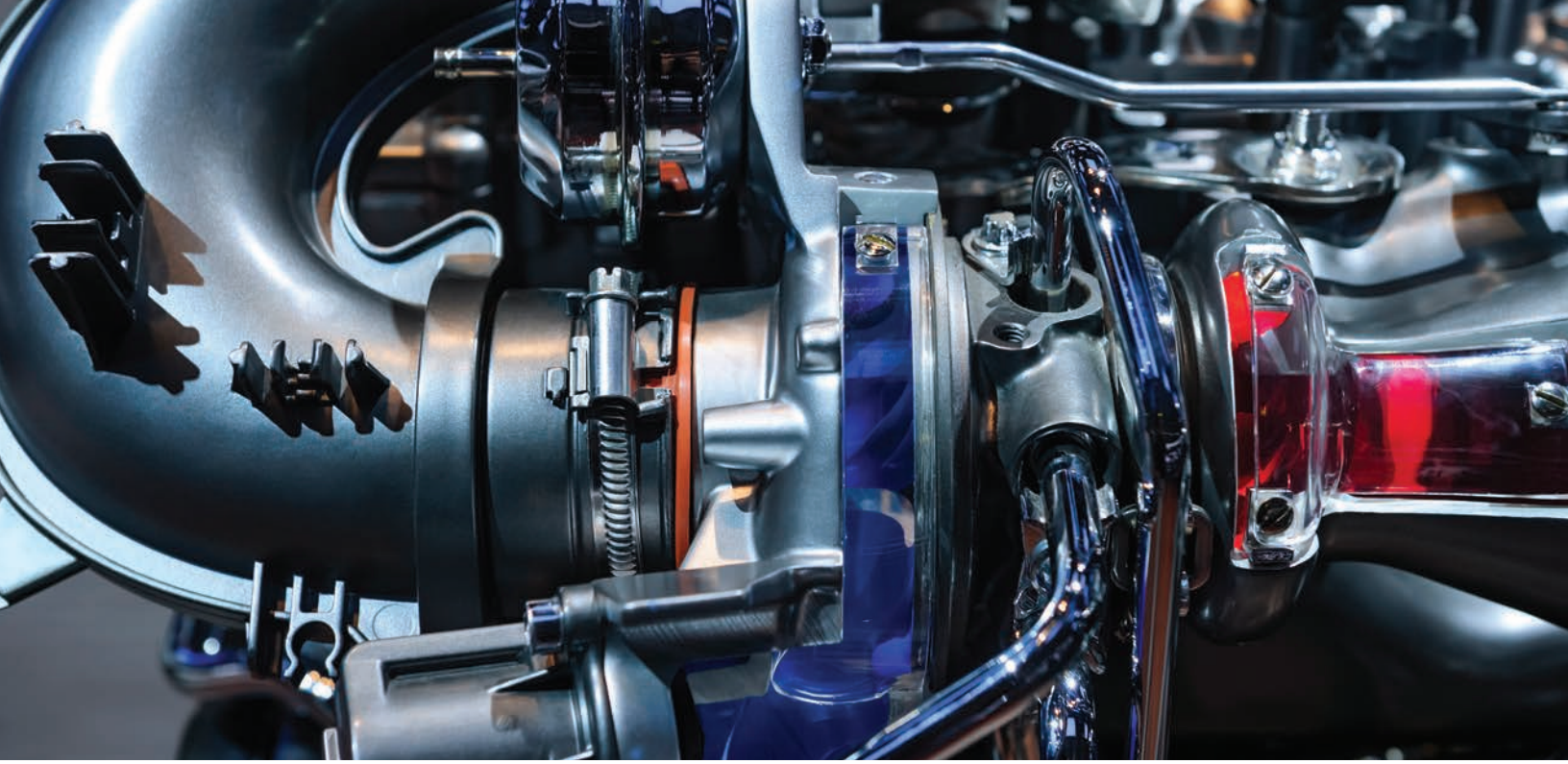
Finally, many other professional associations in the world of transportation planning are weighing in on the regulations that should govern connected and automated vehicles, both in testing and at full deployment. The National Association of City Transportation Officials (NACTO), for example, released their policy recommendations on automated vehicles in June 2016.[2] 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. In contrast to the state laws passed on CAV, NACTO's policy recommendations warn against deployment of partially-automated vehicles and the speeds at which automated vehicles are tested. These concerns arise from the different context in which NACTO's members operate, namely the level of city transportation planning, compared to the concerns of state and federal highway officials captured largely by state laws and new USDOT policy. While USDOT, FHWA, and NHTSA have regulation authority, the policy recommendations made by national professional associations, like NACTO and others, will become important as research progresses.

[2] *National Association of City Transportation Officials. (2016, June 22). NACTO Policy Statement on Automated Vehicles. Retrieved from <http://nacto.org/wp-content/uploads/2016/06/NACTO-Policy-Automated-Vehicles-201606.pdf>.*





CONCLUSIONS AND FUTURE DIRECTIONS



CAV is still the new frontier of travel. Companies and research institutes are still scratching the surface of what is possible and necessary to make CAV and all connected transportation systems a reality. Not only do workers need the skills necessary to design and manufacture CAVs but regulations need to be set in place so that CAVs can function on current and future roadways with drivers, pedestrians, and first-responders able to manage the roll-out of their use.

For the workforce side of CAV to move forward, WIN makes the following recommendations to companies, policymakers, and other stakeholders:

1. Employers must work together to create a common set of requirements for workers in the CAV space. Without this, educational and training institutions will not be able to provide the right programming and skills to future workers or to current workers looking to upskill.

2. Current workers in CAV-related occupations who lack CAV-related skills must start to cross-train and develop related skills in order to remain competitive. Without upskilling and cross-training, the current workforce may render itself obsolete when CAV become the norm.

3. Connections between employers and the talent system, made up of community colleges, workforce boards, universities and 4-year colleges, must be strengthened to enhance the training provided to and received by the current and future workforce. Without proper engagement by employers, the talent system will not know what employers need in order to train new workers or upskill current workers. The number of individuals able to obtain a bachelor's degree is limited. Community colleges are the best place for upskilling current workers and preparing new workers for CAV jobs. Transfer programs will help those that can move onto a bachelor's program or beyond, but community colleges must be engaged for much of the early training. If they are not engaged, there may not be enough space for all future workers to obtain the proper training.

4. Regulations must be set in place that allow for more companies to test CAV on roadways in real-life situations. Simulations are helpful but with few states allowing the testing of CAV, companies are limited in their ability to develop vehicles that can appropriately handle current transportation technology as well as future, more connected, transportation technology.

5. Funding must be provided to develop public-private partnerships to create inclusive intelligent transportation systems. Roadways and vehicles can be connected but without the proper inclusion of the public, first responders, the disabled community, and other stakeholders, their potential safety benefits may not be realized.

Appendix A: Occupation Codes and Group Definitions

Occupation Name	O*NET Code
Connected & Automated Vehicle Design & Testing	
1. Electrical Engineers	17-2071.00
2. Electronics Engineers, Except Computer	17-2072.00
3. Materials Engineers	17-2131.00
4. Mechanical Engineers	17-2141.00
5. Mechanical Drafters	17-3013.00
6. Electrical and Electronic Engineering Technicians	17-3023.00
7. Electronics Engineering Technicians	17-3023.01
8. Electrical Engineering Technicians	17-3023.03
9. Mechanical Engineering Technicians	17-3027.00
10. Engineering Technicians, Except Drafters, All Other	17-3029.00
11. Commercial and Industrial Designers	27-1021.00
Connected & Automated Vehicle Manufacturing	
12. Industrial Safety and Health Engineers	17-2111.00
13. Industrial Engineers	17-2112.00
14. Validation Engineers	17-2199.02
15. Mechatronics Engineers	17-2199.05
16. Robotics Engineers	17-2199.08
17. Electricians	47-2111.00
18. Team Assemblers	51-2092.00
Connected & Automated Vehicle IT Design	
19. Computer Programmers	15-1131.00
20. Software Developers, Applications	15-1132.00
21. Software Developers, Systems Software	15-1133.00
22. Computer User Support Specialists	15-1151.00
23. Computer Network Support Specialists	15-1152.00
24. Computer Hardware Engineers	17-2061.00
Quality Control	
25. Quality Control Systems Managers	11-3051.01
26. Compliance Officers	13-1041.00
27. Quality Control Analysts	19-4099.01
28. Inspectors, Testers, Sorters, Samplers, and Weighers	51-9061.00
Data Management & Cybersecurity	
29. Computer and Information Systems Managers	11-3021.00
30. Security Management Specialists	13-1199.02
31. Computer Systems Analysts	15-1121.00
32. Information Security Analysts	15-1122.00
33. Database Administrators	15-1141.00
34. Network and Computer Systems Administrators	15-1142.00
35. Computer Occupations, All Other	15-1199.00
36. Computer Systems Engineers/Architects	15-1199.02
37. Geospatial Information Scientists and Technologists	15-1199.04
38. Database Architects	15-1199.06
39. Data Warehousing Specialists	15-1199.07
40. Software Quality Assurance Engineers and Testers	15-1199.01

Occupation Name	O*NET Code
Intelligent Transportation systems/Infrastructure Design	
41. Computer Operators	43-9011.00
42. Transportation Managers	11-3071.01
43. Logisticians	13-1081.00
44. Computer Network Architects	15-1143.00
45. Civil Engineers	17-2051.00
46. Transportation Engineers	17-2051.01
47. Civil Engineering Technicians	17-3022.00
48. Telecommunications Line Installers and Repairers	49-9052.00
49. Traffic Technicians	53-6041.00

Appendix B: Works Consulted

Literature Review

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Appendix C: CAV Keyword and Industry Data Collection Filters

Keyword Filters

1. Forward Collision Warning
2. Emergency Electronic Brake Light
3. Intersection Movement Assist
4. Blind Spot Warning
5. Verification-on-Demand
6. Verify-All
7. Automation Level
8. Advanced Driver Assistance Systems
9. On Board Equipment
10. Road Side Equipment
11. Aftermarket Safety Device
12. Retrofit Safety Device
13. Integrated Safety System
14. Do Not Pass Warning
15. Left Turn Across Path
16. Right Turn in Front Warning
17. Curve Speed Warning
18. Sensor fusion
19. On Board Units
20. Vehicle to Vehicle
21. Vehicle to Infrastructure
22. Vehicle Awareness Device
23. Pedestrian Detection System
24. Dedicated Short Range Communications
25. Data Use Analysis & Processing System
26. Vehicle to Everything
27. Intelligent Transportation System
28. Signal Phasing and Timing
29. Connected Vehicle Professional
30. Vehicle software development
31. Automated Vehicles
32. Connected Vehicles
33. Cybersecurity
34. Wireless communications
35. Wireless integration
36. Integrated smart systems
37. Connected car design
38. Anti-hacking software development
39. Defensive design
40. Self-calibration

Keyword Filters

41. Radar signal processing
42. Intelligent car
43. Semi-autonomous systems
44. Connected Vehicle Trade Association
45. Threat assessment
46. Ethical interface
47. Fault detection
48. Image processing
49. Platooning
50. Driverless car
51. Crash prevention
52. Platoon control
53. Platoon communications
54. Secure connected software
55. OMNI Air
56. V2I Applications
57. V2V Applications
58. Crash avoidance
59. V2X Cyber Analysis Platform
60. Traveller Information Messages

Industry Filters

Industry Name	NAICS Code
61. Computer and Peripheral Equipment Manufacturing	3341
62. Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	3345
63. Other Electrical Equipment and Component Manufacturing	3359
64. Motor Vehicle Manufacturing	3361
65. Motor Vehicle Parts Manufacturing	3363
66. Software Publishers	5112
67. Data Processing, Hosting, and Related Services	5182
68. Architectural, Engineering, and Related Services	5413
69. Computer Systems Design and Related Services	5415
70. 1Management, Scientific, and Technical Consulting Services	5416
71. Scientific Research and Development Services	5417
72. Other Professional, Scientific, and Technical Services	5419
73. Colleges, Universities, and Professional Schools	6113
74. National Security and International Affairs	9281

Appendix D: Glossary

Definitions

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.

Burning Glass Technologies: The primary source for job postings data used in this analysis. Burning Glass Technologies collects online job ads from nearly 40,000 sources and de-duplicates same job postings in order to provide a collection on job demand across the Internet.

Certifications: This research filter in the Burning Glass Technologies tool allows researchers to collect data on professional certifications required or preferred in online job postings.

Data Management & 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).

Educational attainment: This dataset from Burning Glass Technologies 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.

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 Burning Glass Technologies.

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). See also appendix A.

Programs of study: Drawn from online job postings data from Burning Glass Technologies, companies hiring may specify a degree and/or degree program which is required or preferred for the open role.

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: Advertised in online job postings collected by Burning Glass Technologies, employers may specify a salary range or hourly wage. These data are represented as annual salary-equivalents.

Skills, employability: Coded from online job postings, Burning Glass Technologies presents these as baseline skills necessary for successful employment in the open position.

Skills, technical: Coded from online job postings, Burning Glass Technologies presents these as the technical skills necessary for successful employment in the open position.

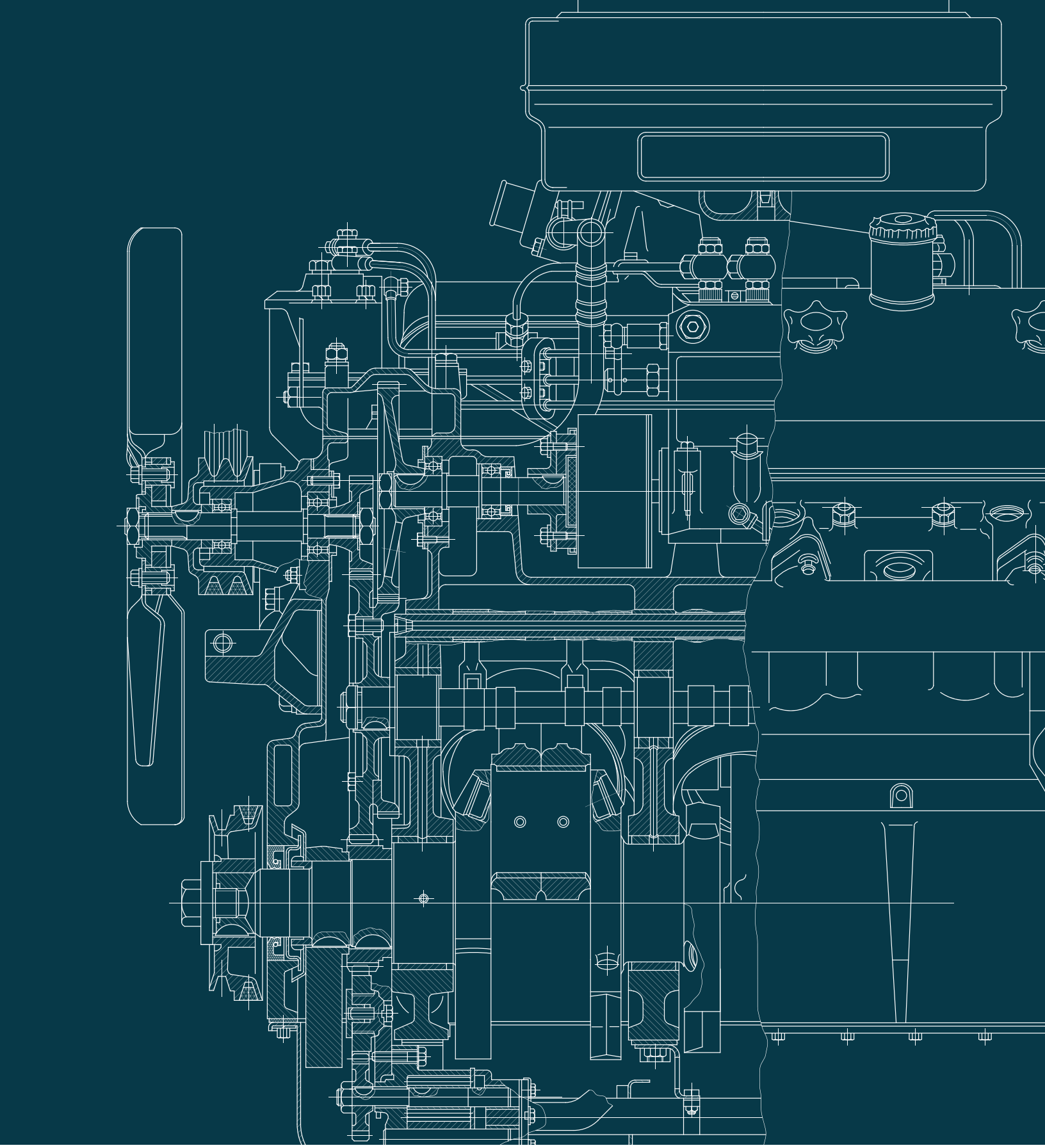
Standard Occupational Classification (SOC): Used by the federal government to define worker type, this classification system features a set of 6-digit codes (aligned with O*NET codes) to delineate distinct occupations. See also: O*NET.

Top posting employers: Based on online job postings data from Burning Glass Technologies, 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 & 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.



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