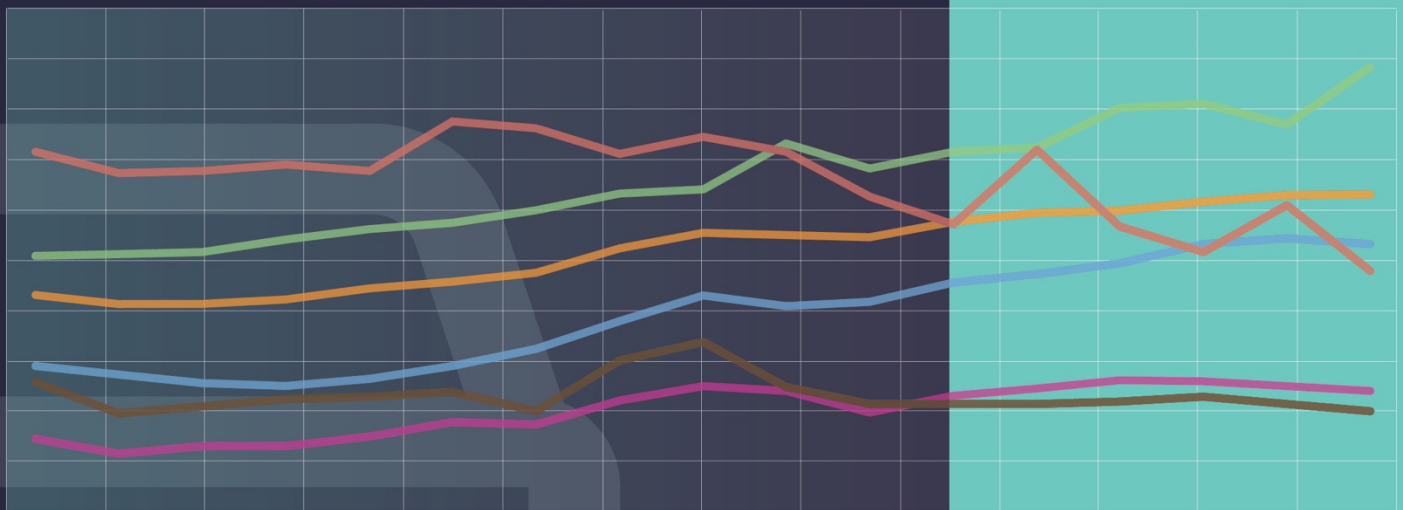


AUTOMOTIVE INDUSTRY LABOUR MARKET ANALYSIS

REGIONAL AUTOMOTIVE TECHNOLOGY CLUSTERS: KITCHENER-WATERLOO-CAMBRIDGE CLUSTER



The project is a collaboration of the Canadian Skills Training and Employment Coalition, Prism Economics and Analysis, and the Automotive Policy Research Centre.

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futureautolabourforce.ca

THIS PAPER was prepared for the Auto Labour Market Information (LMI) Project, now known as the Future of *Canadian Automotive Labourforce (FOCAL) Initiative*.

The goal of the project is to help stakeholders better understand the automotive labour market. The Project will create industry-validated, regional, occupational supply and demand analyses and forecasts and skill profiles for skilled trades and other key skilled occupations in the broader automotive sector including vehicle assemblers, parts manufacturers and technology companies that supply the industry. The project will also examine various labour market trends in the sector and facilitate discussions among stakeholders about how to address any forecasted skills shortages and other labour market challenges. The planned outcome of the project is enhanced regional labour market information that will support colleges, employers, policy makers and other stakeholders in taking practical steps to address skills shortages and other labour market challenges in the automotive sector.

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INTRODUCTION

In this series of reports, we observe the contributions of Canada's six automotive technology clusters located in Vancouver, the Greater Toronto and Hamilton Area (GTHA), Kitchener-Waterloo-Cambridge (KWC), Windsor, Ottawa and the Greater Montreal Area (GMA). In doing so, we shed light on each regional cluster's domains of technological expertise, its employment and skills distribution, and the factors that sustain its development. Moreover, we examine the pivotal role played by Canada's automotive technology clusters in the advancement of the country's broader automotive sector through their contributions to its manufacturing capability, development of new product technologies and enhancements to product quality.

This report focuses on the automotive technology cluster located in KWC. It examines the distribution of automotive technology companies and organizations in the region, highlighting the cluster's domains of technology focus. Furthermore, using the APRC's¹ comprehensive automotive database and through an establishment-level approach, it maps the regional distribution of employees that are engaged in advanced automotive technology manufacturing and research & development (R&D) activities. It sheds light on the concentration of labour and skills in specific technology fields within the cluster. Finally, through a survey of occupational profiles within selected companies, this report provides details on the occupations and skill streams that are in most demand in the local labour market.

In performing the profiling and occupation analysis, we refer to FOCAL's "Canada's Automotive Technology Clusters: Labour Market Characteristics and Regional Specializations" report. That report outlines the full spectrum of current trends shaping innovation in the automotive industry and provides details on the ten main domains of technological progress in the sector. Those ten automotive technology domains include: (1) Autonomous Vehicle (AV) Technologies, (2) Connected Vehicle Technologies, (3) Artificial Intelligence & Machine Learning (AI & ML), (4) Materials & Light Weighting, (5) Battery Electric & Hybrid Vehicle Technologies, (6) Hydrogen Fuel Cell (HFC) Technologies, (7) Internal Combustion Engine (ICE) Powertrain Technologies, (8) Production Technologies, (9) Vehicle Safety & Security and (10) Other Software & Electronics.

¹ APRC: Automotive Policy Research Centre

Additionally, FOCAL's report "Canada's Automotive Technology Clusters: Labour Market Characteristics and Regional Specializations" sets out the methodology that we used to identify and profile each cluster. It also provides details on the 18 highly skilled automotive occupations selected to examine the clusters' occupational distribution.

BACKGROUND ON THE KITCHENER-WATERLOO-CAMBRIDGE TECHNOLOGY CLUSTER

The KWC automotive technology cluster is home to two formally separate but increasingly interwoven segments: an information and communication technologies (ICT) cluster and one that is oriented around traditional automotive manufacturing. The ICT industry in the area is one of Canada's largest technology clusters and hosts several major companies, including Blackberry, OpenText, D2L, IBM, Google, Oracle, and SAP. The region is also a significant hub for high-tech employment, currently holding the 2nd highest share in North America (Waterloo EDC, 2020).

The formation of the KWC ICT cluster can be attributed to the establishment of the University of Waterloo in the region (Wolfe, 2009). Since its founding in 1957, the university has sought to forge linkages with industry and encourage development in the region. In doing so, it has emphasized science, technology, engineering and mathematics (STEM) in its curriculum and established Canada's largest co-operative education program. Additionally, the university has encouraged local entrepreneurship through an intellectual property policy that permits scientists to maintain ownership over their research. Studies suggest that beginning in the 1970s, those policies played a critical role in the development of an ICT sector in the region, yielding as many as 250 spin-off companies by the early 2000s (PWC, 2000; Bramwell, Nelles and Wolfe, 2008; Wolfe, 2009). Further to direct company spin-offs, the university has served as an important generator of talent for the region, providing Canada's top-rated computer science program and second ranked engineering program (Waterloo EDC, 2020).

In addition to its ICT cluster, the KWC region is home to a sizeable number of automotive manufacturing assembly and parts firms. In 1988, Toyota Motor Manufacturing Canada (TMMC) established its Cambridge facility. The company has since expanded its Canadian operations and attracted numerous investments by independent parts manufacturers, establishing KWC as one of Canada's most prominent automotive manufacturing regions.

More recently, other automotive OEMs have invested in the region. In 2019, Ford Motor Company established its Waterloo Connectivity and Innovation Centre to work on vehicle communications and infotainment infrastructure. The company selected the location for its proximity to the University of Waterloo's campus, hoping to benefit from the university's abundance of relevant skills and expertise. Additionally, General Motors of Canada established an office in the region's Communitech Hub with engineers and experts focusing on urban mobility, car sharing and mobile app innovation.

Within the KWC automotive technology cluster, numerous public research labs and organizations provide essential facilities for developing, designing, and testing new vehicle technologies. The University of Waterloo's Waterloo Centre for Automotive Research (WatCAR) is among Canada's largest automotive research and technology development centres. It houses more than 125 faculty members from different disciplines and engineering departments. WatCAR maintains six major automotive focus areas, including vehicle connectivity, cybersecurity, advanced powertrains, artificial intelligence, autonomous driving, and structural light-weighting. The University of Waterloo also hosts the Velocity and Concept incubator programs, as well as the David Johnston Research + Innovation Park. Within the KWC region, Conestoga College offers additional research labs and centres dedicated to advancing automotive production technologies. For example, the college's Centre for Smart Manufacturing and the Magna Centre for Supply Chain Excellence focus on improving productivity, technology, and sustainable manufacturing processes.

In 2015, the Real-time Embedded Software Group at WatCAR partnered with the Automotive Parts Manufacturers' Association (APMA) and 13 Canadian automotive industry partners to develop the APMA's Connected Vehicle Demonstrator. The APMA continues to advance new technology development in the KWC region through several initiatives such as support for the Autonomous Vehicle Innovation Network (AVIN), administration of the Ontario Automotive Modernization Program (O-AMP), and development of a Career-Ready Fund. In October 2018, the APMA also launch of Project Arrow which intends to build Canada's first full zero-emission concept vehicle and showcase the innovative capabilities of regions such as KWC.

Additional innovation support in the KWC automotive technology cluster is furnished by several incubators and innovation centres. The region is home to Catalyst 137, the Communitech Hub, the Communitech Data Hub and the Accelerator hub in Waterloo, Ontario. Those incubators possess a unique open design that encourages communication among their

tenants; they host small businesses, start-ups, automotive OEMs, automotive parts suppliers, and multinational technology corporations. Prominent examples include TMMC's Innovation and Advanced Technology, FleetCarma (Geotab) and Borgwarner at the Catalyst 137 hub, the General Motors Innovation Research Zone, IBM and AVIN at Communitech, and Trak Group - formerly IMS (Insurance & Mobility Solutions) - at the David Johnston Research & Technology Park.

KITCHENER-WATERLOO-CAMBRIDGE CLUSTER PROFILING AND OCCUPATIONAL ANALYSIS

Of the total 118 facilities in the KWC region, we identified 65 companies and organizations conducting activities relevant to this study. Those 65 organizations and entities included: 40 companies, 23 academic labs and facilities, and two partnerships and not-for-profit organizations. Moreover, within those 65 companies, facilities and labs, we identified a total of 1,850 employees.² This section provides a breakdown of the technologies, occupations and skills present in the KWC automotive technology cluster.

Distribution of Companies and Organizations

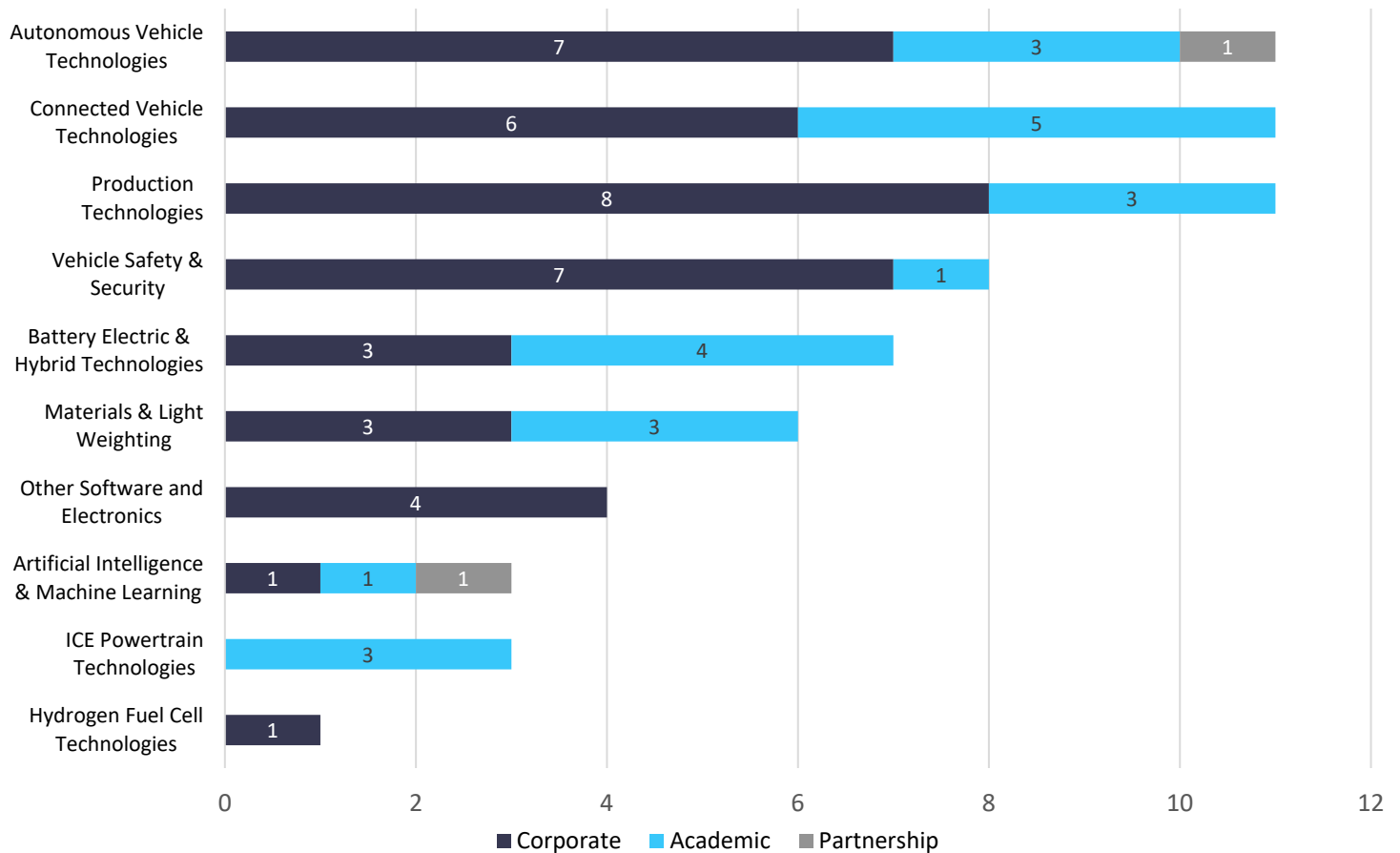
The KWC region is home to a vast array of companies and organizations that are engaged in the development of new automotive vehicle and production technologies. In fact, we identified at least one organization for each of the 10 automotive vehicle and production technologies under study. This section examines the distribution of companies, labs, and facilities in the KWC automotive technology cluster.

According to the distribution of companies and organizations, the three leading technologies in the region are (1) autonomous vehicle technologies, (2) connected vehicle technologies and (3) production technologies (Figure 1). We identified 11 organizations that are developing autonomous vehicle technologies. Those organizations included 7 companies specializing in the development of AV-solutions, such as Nuvation Engineering, which develops LIDAR sensors and autonomous vehicles software. Other AV companies included Jakarto, which

² In this report, 'employees' refers to employees of private companies, as well as professors, researchers and students working in university labs and other research partnerships.

focuses on AI-powered mapping and GIS for autonomous cars. We further recognized three academic labs at the WatCAR which are active in developing autonomous vehicle technologies; notable examples included Waterloo Autonomous Vehicle Laboratory (WAVELab) and the Real-time Embedded Software Group.

Figure 1. Distribution of automotive-related technology companies and organizations in the KWC cluster by technology



In addition to the 11 AV-related companies and organizations, we identified 11 that were active in the design and development of connected vehicle technologies. Among those 11 facilities, six companies are connected technology providers; they include Trak Global Canada - formerly Intelligent Mechatronic Solutions (IMS) - and Industrial Cyber Sensing (ICS). We recognized five labs at WatCAR that are developing connected vehicle technologies. Those labs included the Centre for Intelligent Antenna and Radio Systems (CIARS), the Broadband Communications Research Group (BBCR) and the Emerging Radio Systems Group (EmRG).

Other organizations developing connected vehicle technologies in the region comprised General Motors Innovation Research Zone at Communtech and its mobile app innovations.

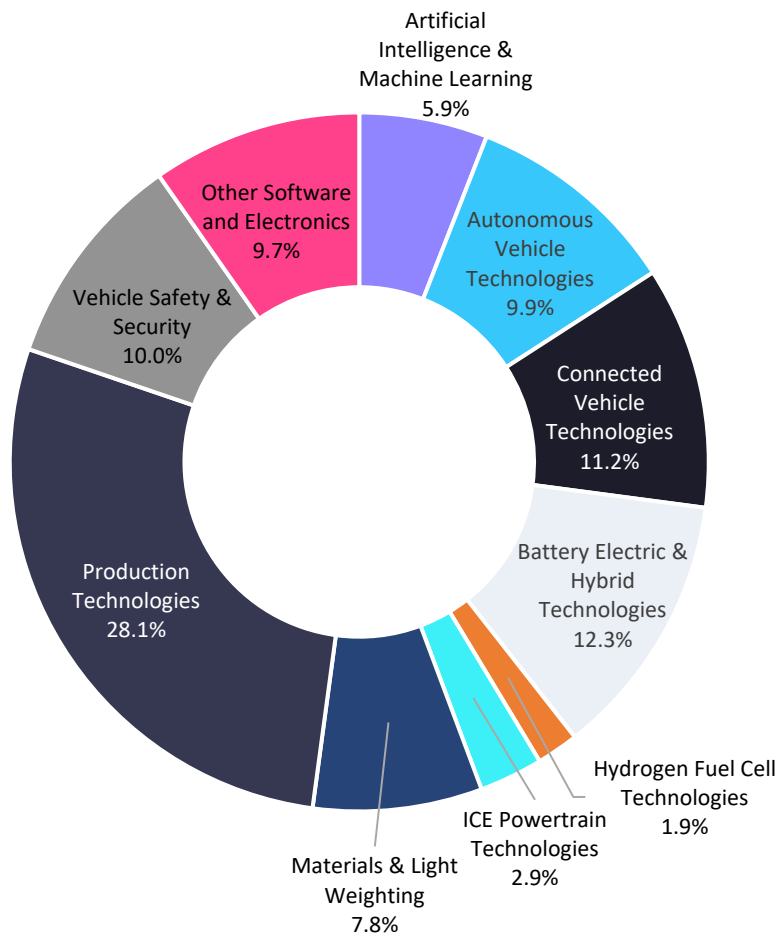
As figure 1 illustrates, production technologies are another field in which the KWC automotive technology cluster excels. In total, we identified 11 facilities - eight companies and three academic labs – that are developing new production technologies in the region. Several companies developing those tools include Descartes Software, Majik Systems, SigmaPoint Technologies and Northern Digital (EDC Waterloo – Northern Digital, 2020). Other organizations developing production technologies in the region include Conestoga College, which hosts two research facilities: the Smart Manufacturing and Advanced Recycling Technologies (SMART Centre) and the Magna Centre for Supply Chain Excellence.

Other notable technology subcategories in the KWC automotive technology cluster included vehicle safety and security, battery-electric & hybrid technologies, materials and light-weighting, and other software & electronics. Under the vehicle safety and security category, the KWC automotive technology cluster is home to ESCRYPT and Trust Point Innovation Technologies; both are actively developing software and systems to secure V2X communications. In the electric vehicle category, we recognized FleetCarma (a division of Geotab), which develops systems that process and analyze electric vehicle data to improve energy management in electric vehicle fleets. Finally, in the other software & electronics category, we identified Ford Motor Company's Waterloo Connectivity and Innovation Centre, which develops in-vehicle connectivity and infotainment infrastructure.

Distribution of Employment and Skills

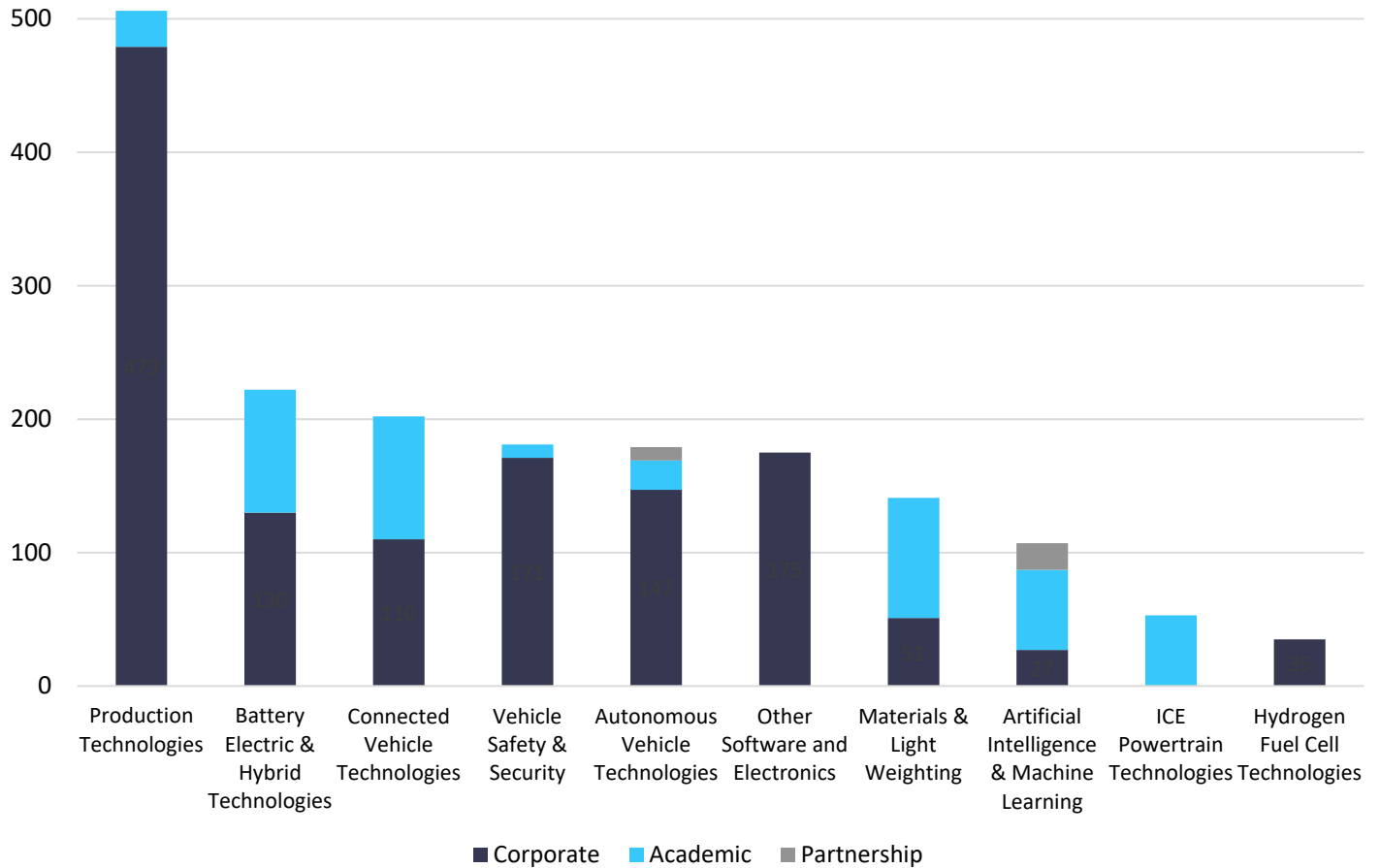
As presented in Figures 2 and 3, the largest proportion of individuals working within the KWC automotive technology cluster are engaged in developing new production technologies: 28% of the total 1,850 employees and associated individuals. The majority of employment under this category is distributed among three leading companies: Descartes Software, Northern Digital and Inksmith Limited. Collectively, those three companies account for more than 400 employees in the region, most of whom are engaged in developing industrial and manufacturing technology sensors, systems, and solutions.

Figure 2. Distribution of employees and associated individuals (by percentage) in the KWC region by technology



As Figure 3 demonstrates, a significant number of individuals are also engaged in the development of battery electric vehicle and hybrid (BEV-H) technologies. We identified 225 employees currently employed in the category (12.3% of the total 1,850). Major BEV-H employers in the region include FleetCarma (a division of Geotab) with close to 80 engineers and developers. Borgwarner, another major BEV-H manufacturer, employs 40 mechanical, electrical and software engineers focusing on R&D for hybrid and electric vehicles. In addition, WatCAR’s Green and Intelligence Automotive Facility (GAIA) and the Power and Energy Systems Group contribute as many as 90 researchers and associated staff in the region.

Figure 3. Distribution of employees and associated individuals (by numbers) in the KWC region by technology



Within the KWC automotive technology cluster, connected vehicle technologies and vehicle safety and security technologies accounted for 11.2% and 10% of employment, respectively. Major connected vehicle technology employers include Trak Global Group, whereas safety and security companies comprise organizations such as ESCRYPT, TrustPoint Innovation Technologies, NCC Group, ISARA Corporation, Labforge and Sober Steering. Other technology categories accounted for less than 10% of the 1,850 employees in the region.

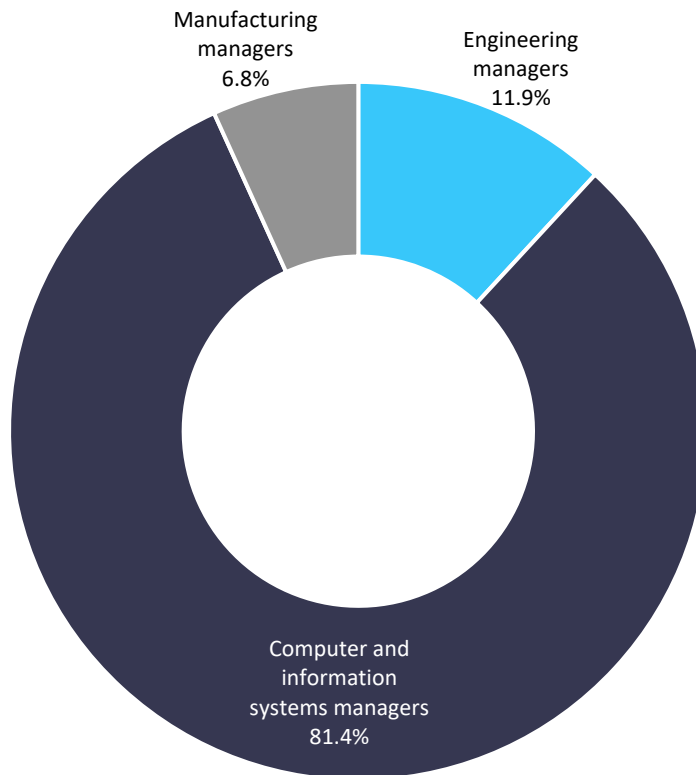
Occupational Distribution

Our occupational distribution analysis entailed a review of 558 profiles out of the total 1350 employees in the region's 40 automotive technology companies. Of those 558 profiles, 365 were found to be relevant to the 18 highly skilled occupations selected for this study. Our results revealed that the occupations, talent, and skills in the KWC automotive technology cluster are strongly skewed towards software engineering, design, development, and programming. This is understandable given the region's abundance of companies, organizations, skills and talent in the computer and information systems management and software engineering, designing and developing fields. This section reviews the distribution of occupations in three categories: management, engineering, and engineering technicians and technologists.

Management Occupations

As presented in Figure 4, 81.4% of the management occupations in our survey were "Computer and information systems managers." A likely explanation for this result is that company operations in the KWC automotive technology cluster are oriented towards software-based services and related R&D activities. The majority of the "Computer and information systems managers" have previous experience in software engineering and designing or computer programming. The other two management occupations in the region, "Engineering managers" and "Manufacturing managers," accounted for 12% and 6.8% of the sample.

Figure 4. Occupational distribution for management occupations in the automotive technology companies of KWC



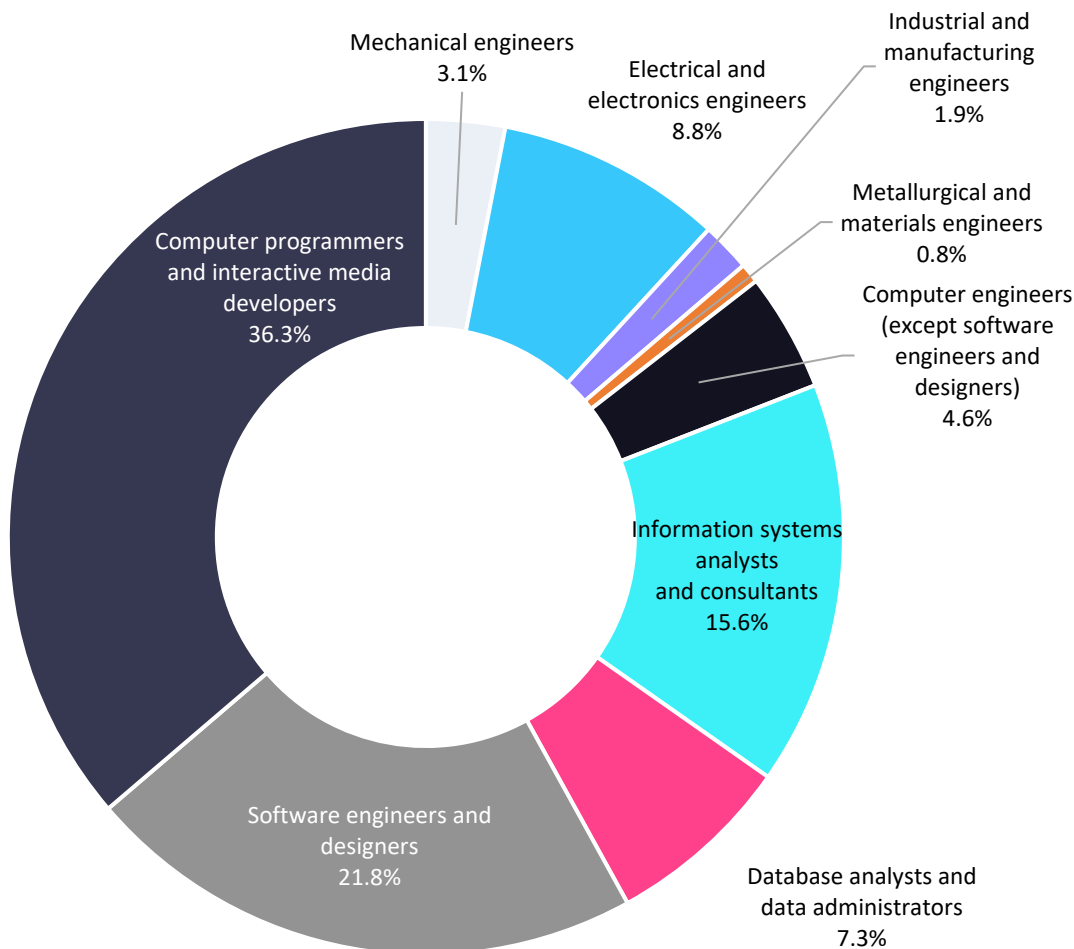
Engineering Occupations

The three most common engineering occupations in the KWC automotive technology cluster were “Computer programmers and interactive media developers,” “Software engineers and designers,” and “Information systems analysts and consultants,” which accounted for 36.3%, 21.8% and 15.6% of the sample (Figure 5). “Computer programmers and interactive media developers” are generally responsible for writing, modifying and testing software code. “Software engineers and designers” are typically responsible for developing the code’s architecture along with its logical specifications. Lastly, “Information systems analysts and consultants” are usually engaged in developing security systems (i.e., vehicle safety & security).

Additional engineering occupations that were common in the region include electrical, mechanical and industrial engineers. Such occupations are most commonly present in

companies that carry out operations involving physical or electrical systems. They comprised less than 15% of the total engineering occupations under consideration in our sample.

Figure 5. Occupational distribution for engineering occupations in the automotive technology companies of KWC

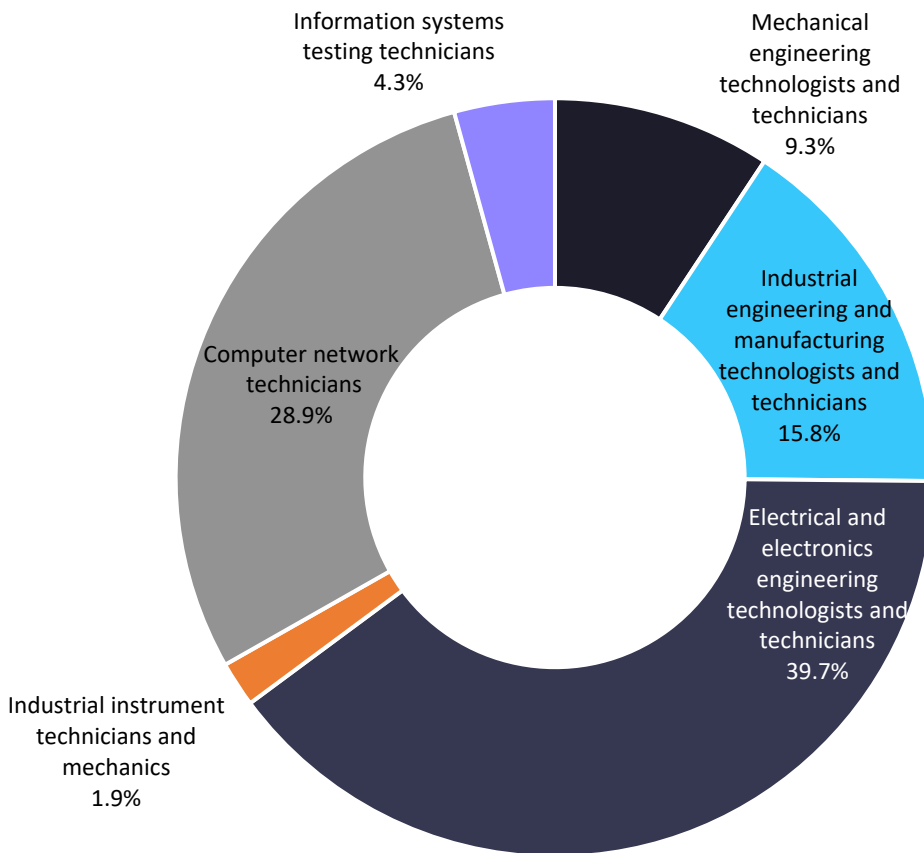


Engineering Technologists and Technicians Occupations

The third category in our occupational distribution analysis - engineering technologist and technician occupations - provides a more nuanced perspective on the nature of operations in the KWC automotive technology cluster. As figure 6 shows, while “Computer network technicians” remained prominent in our occupational distribution analysis, the highest proportion of technicians were “Electrical and electronics engineering technologists and

technicians” (39.7%) and “Industrial engineering and manufacturing technologists and technicians” (15.8%). Within the region, “Electrical and electronics engineering technologists and technicians” and the “Industrial engineering and manufacturing technologists and technicians” are often found in electronics and electrical systems development companies, as well as electric vehicle technology companies and other electronics suppliers.

Figure 6. Occupational distribution for engineering technologist and technician occupations in the automotive technology companies of KWC



HIGHLIGHTS AND CONCLUDING REMARKS ON THE KITCHENER-WATERLOO- CAMBRIDGE CLUSTER

Compared with other Canadian automotive technology clusters, the KWC region is defined by a unique automotive innovation ecosystem. Instead of being organized around a singular technology (e.g., HFCVs in the Greater Vancouver Metropolitan Area) or industry (e.g., automobile manufacturing in Windsor), the KWC cluster hosts companies and organizations that specialize in a variety of products, services and sectors. Furthermore, the KWC automotive technology cluster is distinguished by its abundance of advanced skills and talent related to software design and development. Instead of the mechanical research, design and assembly-related occupations that are disproportionately found in some other Canadian automotive technology clusters, we identified a significant number of individuals in software engineering and design and computer programming occupations. The KWC automotive technology cluster's disproportionate share of employees in those occupations can be attributed to several factors, including the presence of the University of Waterloo and the region's established ICT industry. It can also be ascribed to the numerous automotive CAV-related R&D centres in the region, including Ford Canada's Waterloo Connectivity and Innovation Centre and General Motors's Innovation Research Zone.

Another notable feature of the KWC automotive technology cluster is the existence of numerous start-ups, collaborations and partnerships in the region. Of the 65 technology companies and organizations in the KWC automotive technology cluster, most are SMEs and university-based research labs. Such organizations play a critical role in the development of new automotive technologies, especially as ICT and automotive technologies become increasingly intertwined.

In sum, the KWC automotive technology cluster is home to a unique automotive innovation ecosystem. It hosts an established ICT cluster and traditional manufacturing industry; which, are increasingly amalgamating through CASE vehicle advancements. Moreover, the region is home to an abundance of skills and engineering expertise, especially in software engineering and development. Those attributes place the KWC region in a competitive position to design and develop Canada's vehicles of the future.

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