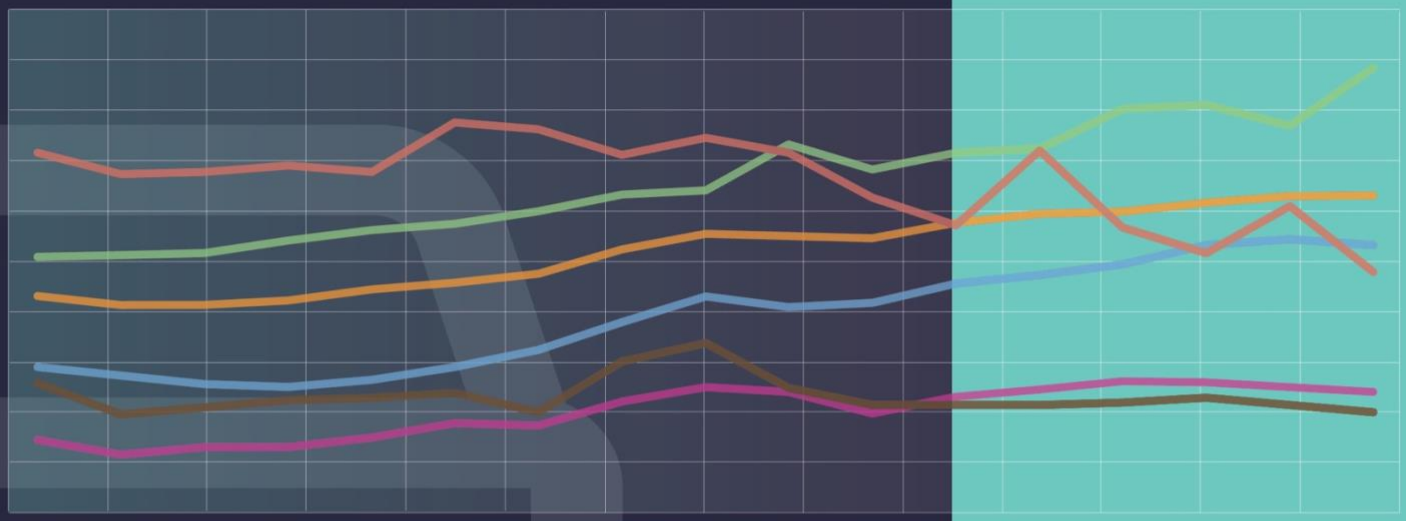
FOCAL Initiative
Future of Canadian Automotive Labourforce
Sur l'avenir de la main-d'œuvre de l'industrie automobile canadienne

TREND REPORT

AUTOMOTIVE INDUSTRY LABOUR MARKET ANALYSIS

REGIONAL AUTOMOTIVE TECHNOLOGY CLUSTERS: GREATER TORONTO & HAMILTON AREA (GTHA) CLUSTER



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

September 2020

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.

This project is funded by the Government of Canada's Sectoral Initiatives Program. The opinions and interpretations in this publication are those of the author(s) and do not necessarily reflect those of the Government of Canada.

(FOCAL) Initiative, *futureautolabourforce.ca*

Canadian Skills Training and Employment Coalition, *cstec.ca*

Prism Economics and Analysis, *prismeconomics.com*

Automotive Policy Research Centre, *automotivepolicy.ca*

September, 2020

TABLE OF CONTENTS

Introduction *4*

Background on the GTHA Technology Cluster *5*

GTHA's Cluster Profiling and Occupational Analysis *7*

Distribution of Companies and Organizations 7

Distribution of Employment and Skills 10

Occupational Distribution 13

Management Occupations 13

Engineering Occupations 14

Engineering Technologists and Technicians Occupations 15

Highlights and Concluding Remarks on the GTHA Cluster *16*

Reference *18*

LIST OF FIGURES

Figure 1. Distribution of automotive-related technology companies and organizations in the GTHA by technology 8

Figure 2. Distribution of employees and individuals (by percentage) associated with automotive activities by technology in the GTHA cluster 11

Figure 3. Distribution of employees and individuals associated with automotive activities by technology in the GTHA cluster 12

Figure 4. Occupational distribution for management occupations in the automotive technology companies of the GTHA 13

Figure 5. Occupational distribution for engineering occupations in the automotive technology companies of the GTHA 14

Figure 6. Occupational distribution for engineering technologist and technician occupations in the automotive technology companies of the GTHA 15

LIST OF FIGURES

Table 1. Examples of Companies and Organizations in Autonomous, Electric, Connected and Production Technologies 9

Table 2. Examples of Companies and Organizations in AI & ML, Materials & Light Weighting, Other Software & Electronics and Vehicle Safety & Security 10

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 the GTHA. It examines the distribution of automotive technology companies and organizations in the region, highlighting the cluster's domains of technology focus. Furthermore, using FOCAL's comprehensive automotive database and through an establishment-level approach, it maps the regional distribution of employees and individuals 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.

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 automotive highly skilled occupations which are selected to examine the occupational distribution in the clusters.

BACKGROUND ON THE GTHA TECHNOLOGY CLUSTER

The GTHA automotive technology cluster is home to two formally separate but increasingly interconnected segments: an information and communication technology (ICT) cluster and one that is oriented around traditional automotive manufacturing. The region's ICT cluster is one of the fastest-growing in North America (FedDev Ontario, 2019). It comprises as many as 16,000 companies and includes large multinationals such as GE, Oracle, AMD, Philips, Qualcomm, Huawei and Hewlett Packard Enterprise (Avison Young, 2019). Additionally, the GTHA is home to over a third of Canada's tech talent; and 11 universities and colleges that produce over 40,000 STEM graduates annually (Toronto Global, 2020).

The GTHA's established ICT cluster has recently factored into the region's emergence as an important Canadian Connected, Autonomous, Shared, and Electrified (CASE) vehicle technology hub. The GTHA hosts one of Canada's largest AI company clusters specializing in machine learning and the highest concentration of AI and deep learning start-ups in Canada (Toronto Global, 2020). AI and deep learning are critical for the development of connected and autonomous vehicle (CAV) technologies as well as the production process improvements associated with Industry 4.0 (see FOCAL Initiative, 2019).

CAV technologies are advanced in the region by the Autonomous Vehicle Innovation Network (AVIN). AVIN is an $85M program designed to supports small- and medium-sized enterprises (SMEs) developing solutions related to driverless cars, vehicle cybersecurity and real-time fleet routing. The network maintains three technology development centres in the GTHA: AVIN at MaRS, the Automotive Centre of Excellence (ACE) at Ontario Tech University, and The Centre for Integrated Transportation and Mobility (CITM) in Hamilton, Ontario (AVIN, 2020). Each AVIN supported centre maintains a distinct focus relating to the development of CAV technologies. For instance, the AVIN at MaRS focusses on AI and machine learning. In contrast, AVIN's ACE concentrates on testing, and CITM provides business and technical advisory services and resources to Ontario-based start-ups and SMEs.

Additionally, the GTHA is home to the Vector Institute, a non-profit research institution dedicated to advancing Canadian AI research. Notable corporate partners of the institute

include Google, Shopify, Loblaws, Accenture, NVIDIA, Uber, and Canadian-owned automotive companies such as Magna International and Linamar (Vector Institute, 2020).

The GTHA is also home to a sizeable collection of traditional automotive firms that perform R&D. For instance, GM maintains two technical centres in the region. The company's Markham Technical Centre specializes in developing autonomous technologies, including autonomous vehicle software and controls, active safety, and vehicle dynamics technology. GM's other major R&D facility in the region - the Oshawa Technical Centre - performs R&D related to chassis and body subsystems and ICE powertrain and transmissions. Near that facility, in 2019, the company began construction on its autonomous vehicle test track named the Canadian Technical Centre McLaughlin Advanced Technology Track (GM, 2019). In addition to GM, the region hosts several independent automotive supplier R&D facilities. One notable example is Aurora-based Magna International, which maintains three technical centres in the region: Magna-NRC Composites Centre of Excellence, Magna's Promatek Research Centre, and the Magna Mirrors Technical Centre.

CASE vehicle technologies are further advanced in the region (and country) by the Automotive Parts Manufacturers Association (APMA), Canada's national association representing OEM producers of parts, equipment, tools, supplies, advanced technology, and other auto-related services. The APMA does so through several initiatives, including support for AVIN, administration of the Ontario Automotive Modernization Program (O-AMP), and the development of a Career-Ready Fund. In October 2020, the association also launched its Project Arrow initiative, Canada's first full-build zero-emission concept vehicle. The program will run through 2022, culminating with the release of a concept car and a North American-wide tour.

In addition, the region hosts Canada's Advanced Manufacturing Supercluster, Next Generation Manufacturing Canada (NGen). NGen's mandate is to strengthen the competitiveness of Canada's manufacturing sector. It does so by funding collaborative, industry-led projects for the development of advanced manufacturing technologies and solutions such as those involved in Industry 4.0 (see FOCAL Initiative, 2019). The supercluster also plays a vital role in connecting ICT and manufacturing companies, researchers and investors. As of October 2020, the centre has funded 23 projects, totalling $76.8M (NGEN, 2020).

GTHA CLUSTER PROFILING AND OCCUPATIONAL ANALYSIS

A total of 446 automotive manufacturing and technology development facilities were identified within the GTHA. Of those 446 companies and organizations, we identified a total of 83 automotive technology organizations including 66 companies, eight academic labs, one government facility and eight partnerships and not-for-profit organizations. We also identified a total of 13,048 employees and associated-individuals within the GTHA automotive technology cluster.[1] This section provides a breakdown of the cluster's technologies, occupations and skills.

Distribution of Companies and Organizations

Based on the distribution of companies and organizations by technology in the GTHA cluster, it can be noted that the region hosts a mix of all 10 automotive vehicle and production technologies (Figure 1). With that being said, the region does specialize in several technical areas. This section identifies the region's main technological capabilities and strengths.

1 - *Technology categories with more than ten companies and organizations:* This level includes technologies such as autonomous vehicle technologies, battery-electric and hybrid vehicle technologies, connected vehicle technologies and production technologies. Notable companies and organizations in each category are presented in Table 1.

[1] 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.

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

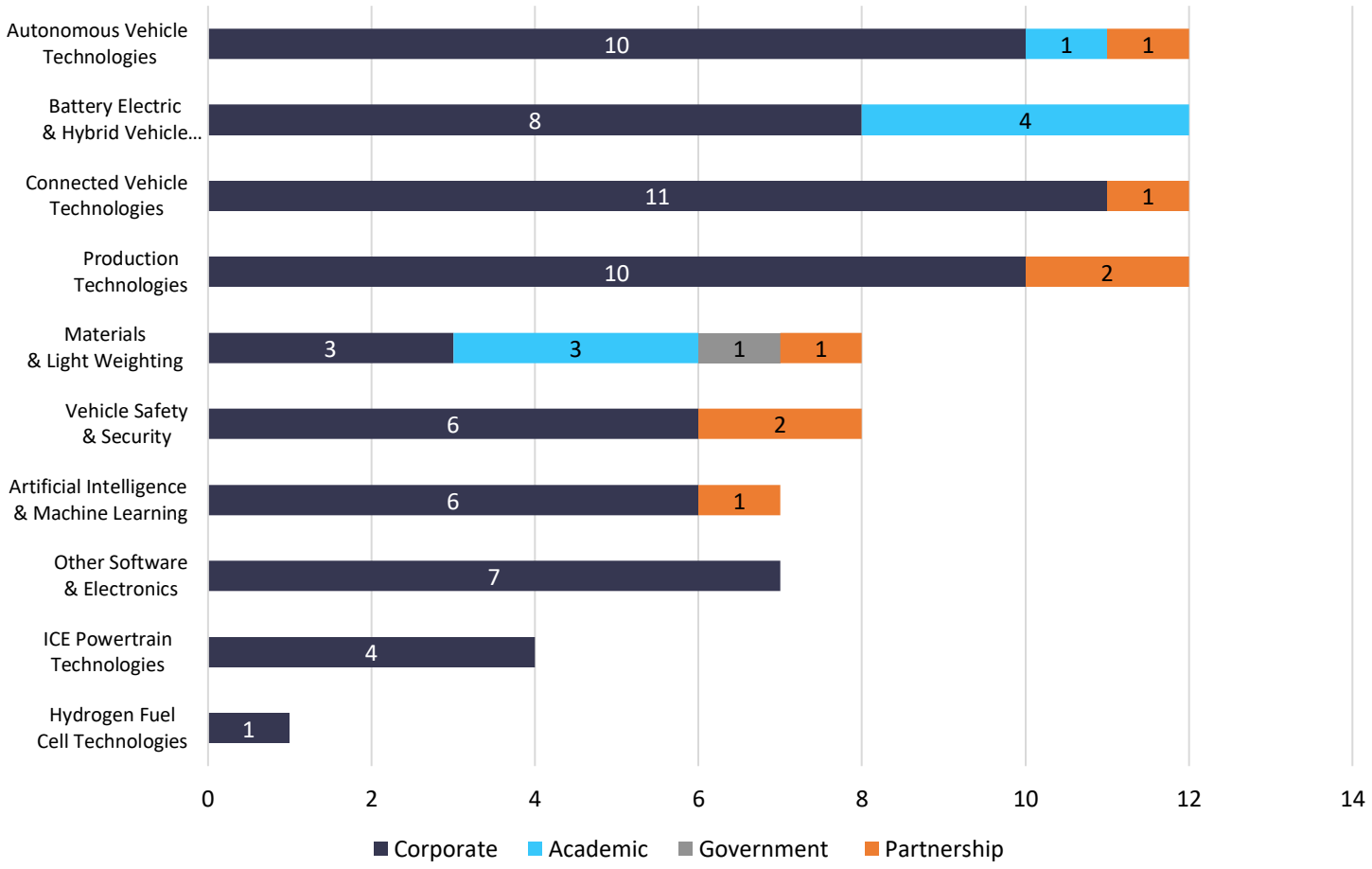


Table 1. Examples of Companies and Organizations in Autonomous, Electric, Connected and Production Technologies			
Technology Category	Company / Organization	Type	Automotive Technology Activities
Autonomous Vehicle Technologies	GM Markham Technical Centre	Corporate	Developing GM autonomous technologies including autonomous vehicle software and controls and vehicle dynamics technology
	Maxar Technologies (formerly MDA Technologies)	Corporate	Providing and developing HD maps and geospatial data for autonomous and semi-autonomous vehicles
	Uber Advanced Technologies Group - Toronto	Corporate	Research, development & testing of self-driving systems (software & sensors)
	Centre for Integrated Transportation and Mobility (CITM) by Autonomous Vehicle Innovation Network (AVIN)	Partnership	Working on the advancement of multi-modal and integrated mobility
Battery Electric & Hybrid Vehicle Technologies	Electrovaya Inc.	Corporate	Developing and manufacturing of Lithium-ion cells and energy storage modules
	D&V Electronics	Corporate	Developing and manufacturing of electric motor testing machines and equipment
	Electric Vehicle Research Centre (UTEV) at the University of Toronto	Academic	Technical research in power electronic converters for EV drivetrains and energy storage for EVs
	Advanced Powertrain and Electric Vehicles (CERC) at the McMaster Automotive Research Centre	Academic	Technical research in sustainable energy-efficient solutions for electric, hybrid electric and plug-in hybrid electric vehicles
Connected Vehicle Technologies	Celestica	Corporate	Developing and manufacturing of communications modules and printed circuit boards
	Geotab	Corporate	Developing and providing fleet management platforms, vehicle connectivity systems and vehicle data web-based analytics software
	b1 Embedded Solutions Canada	Corporate	Developing and providing solutions for automotive communication platforms.
	Connected Vehicles and Smart Transportation (CVST) at the University of Toronto	Partnership	A university-industry-government partnership for advancing cloud-based wireless communications using mobile computing technique
Production Technologies	Bosch Rexroth - Burlington	Corporate	Providing and developing Industry 4.0 production systems and technologies
	Oracle	Corporate	Providing cloud-based manufacturing platforms and Internet of Things (IoT) solutions for automotive OEMs and suppliers
	Burloak Technologies - SAMUEL	Corporate	Precision manufacturing and prototyping through additive manufacturing and CNC machining
	Partners for the Advancement of Collaborative Engineering Education (PACE)	Partnership	Advancing vehicle design and simulation solutions

2 - *Technology categories with more than five but less than 10 companies and organizations*: This level includes technological categories such as Artificial intelligence & machine learning, Materials & light-weighting, other software and electronics and vehicle safety & security. Table 2 provides two examples of companies or organizations performing activities relating to each of the technology categories.

Table 2. Examples of Companies and Organizations in AI & ML, Materials & Light Weighting, Other Software & Electronics and Vehicle Safety & Security

Technology Category	Company / Organization	Type	Automotive Technology Activities
Artificial Intelligence & Machine Learning	iNAGO Corporation	Corporate	Developing and providing in-vehicle AI-based intelligent conversational assistant
	Pitstop	Corporate	Developing AI-based predictive maintenance and diagnostics systems for vehicles
Materials & Light Weighting	Advanced Research Lab for Multifunctional Lightweight Structures Tests at the University of Toronto	Academic	Testing, simulation, and optimization of new material and structural designs in automotive vehicles
	NRC's CANMET - Materials Technology Laboratory	Government	Optimizing, fabricating, processing and evaluating vehicle metals and materials
Other Software & Electronics	Magna Mirrors Technical Centre	Corporate	Research & development of electronics and software for vehicle mirror controls and sensors
	Etratech – Gentherm Electronics	Corporate	Development and manufacturing of electronic control components for various automotive applications
Vehicle Safety & Security	Veoneer Canada	Corporate	Development and manufacturing of airbag sensors, security products and electronic displays
	Cloud GRC	Corporate	Developing and providing cybersecurity solutions for the automotive industry

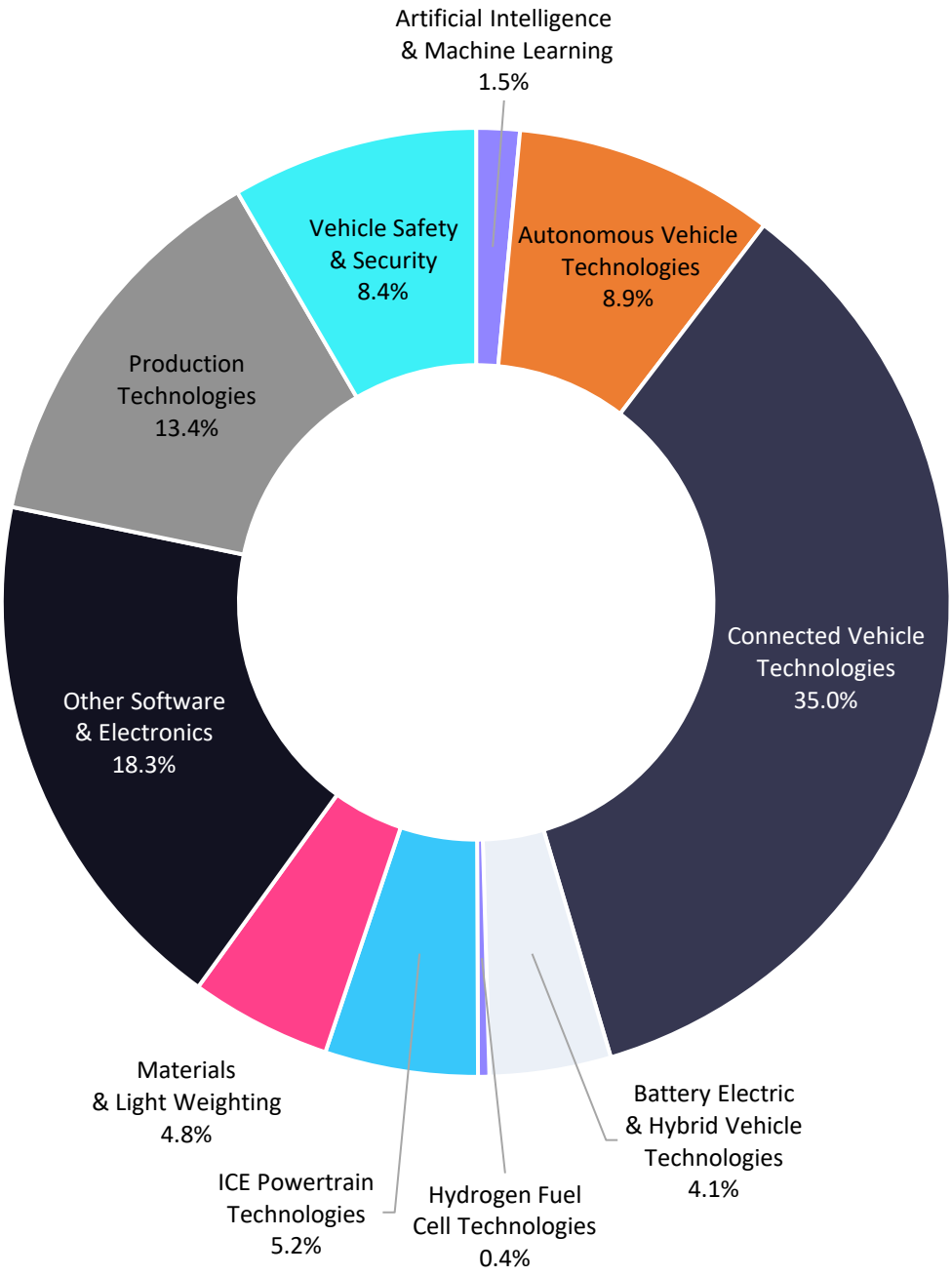
3 - *Technology categories with less than 5 companies and organizations*: Notable companies under this category include the Innovative Hydrogen Solutions for enhancing combustion cycles under the ICE powertrain technologies category and Hydrogenics for hydrogen generation and fuel cell solutions.

Distribution of Employment and Skills

Within the 83 companies, labs and organizations in the cluster, we identified a total of 13,048 automotive technology employees. As Figure 2 shows, those individuals are engaged in developing a wide range of automotive technologies. Of the technologies that were selected

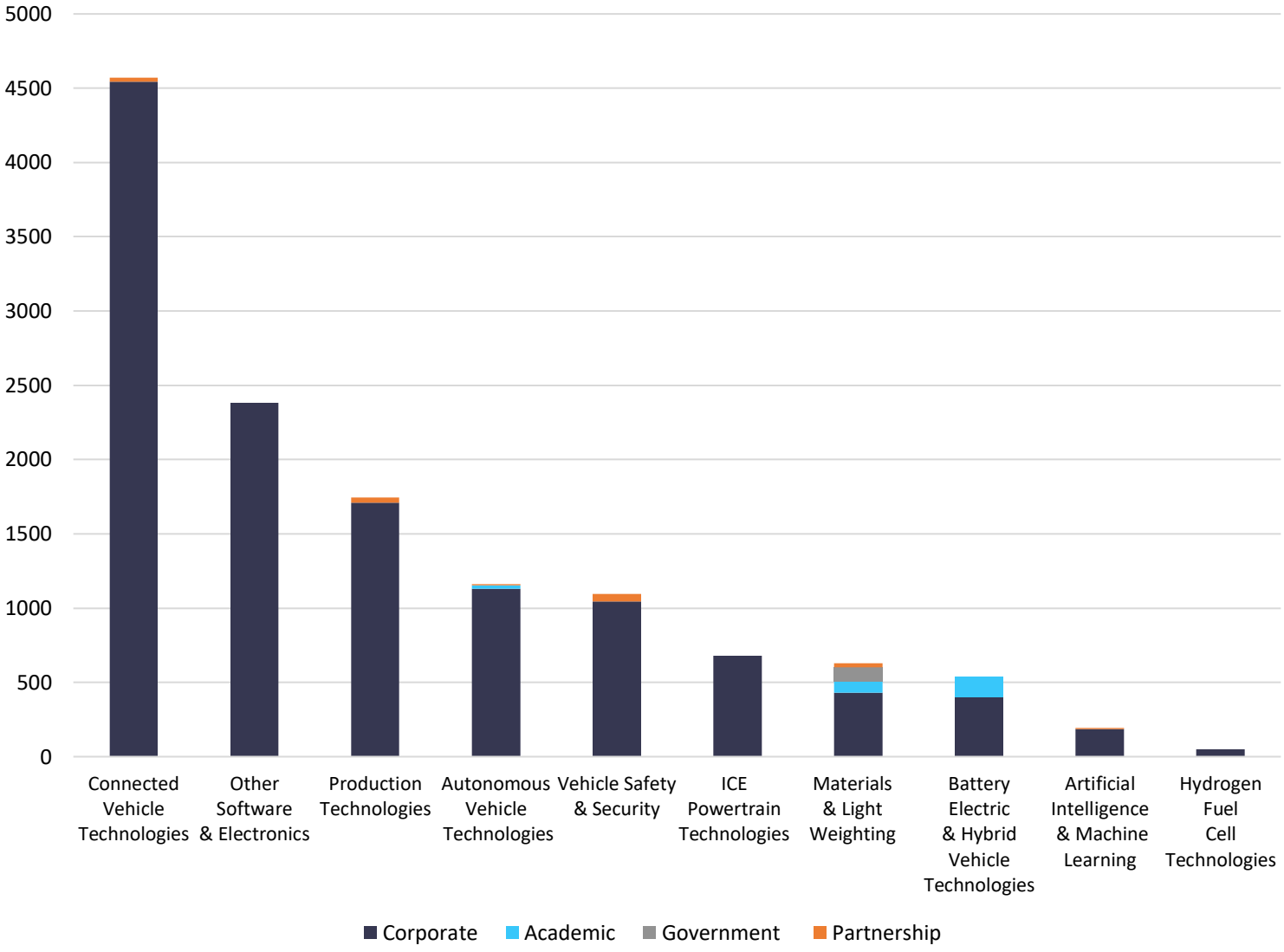
for the study, connected vehicle solutions ranked first in terms of the number of employees (35% of the 13,048). Notable companies developing connected vehicle technologies in the region include Geotab and Celestica; those organizations account for the majority of connected vehicle employment, employing 1,200 and 700 connectivity experts, respectively. Other companies developing connectivity solutions include TTM Technologies, Flex Ltd. Design Centre and Fleet Complete, which collectively employ more than 550 electronics and software engineers.

Figure 2. Distribution of employees and individuals (by percentage) associated with automotive activities by technology in the GTHA cluster



Within the region, the second-ranked technological category by employment was software & electronics (18.3% of 13,048). Under this category, one major employer is ATI Technologies (a subsidiary of Advanced Micro Devices – AMD), which employs more than 2,000 engineers and technicians working in the development and assembly of circuit board graphic accelerators. Other important companies include Etratech and Artaflex, which employ close to 140 engineers and technologists.

Figure 3. Distribution of employees and individuals associated with automotive activities by technology in the GTHA cluster



The third-ranked technological category by employment share in the region was production technologies, representing 13.4% of the region's total 13,048 employees. The majority of employment in the production technology category is attributed to companies such as Oracle, SAP, Hexagon and Bosch Rexroth.

As for the rest of the technology categories, our analysis identified that they each accounted for less than a 10% employment share of the region's 13,048 employees.

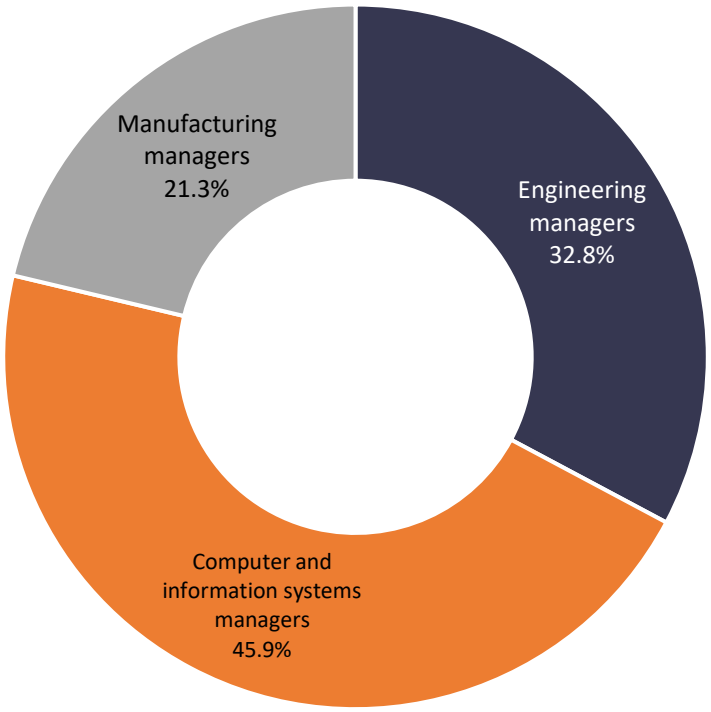
Occupational Distribution

Out of the 12,551 employees associated with the 66 automotive technology companies in the GTHA cluster, we surveyed a total of 2,690 profiles in our occupational distribution analysis. Of those 2,690 profiles, we recognized a total of 1,030 profiles relevant to the 18 highly skilled occupations selected for this study. The analysis of those profiles revealed an abundance of talent and skills in the software engineering, designing and development streams. Additionally, we identified numerous individuals engaged in the data management and analysis fields. The following section provides further details on the occupational distributions for the three main highly skilled categories examined in our study.

Management Occupations

Our analysis revealed three main management occupations within the GTHA automotive technology cluster. Of those, "Computer and information systems managers" were the most common, accounting for 45.9% of the surveyed management profiles. The other two management occupations, "Engineering managers" and "Manufacturing managers," accounted for 32.8% and 21.3% of the profiles.

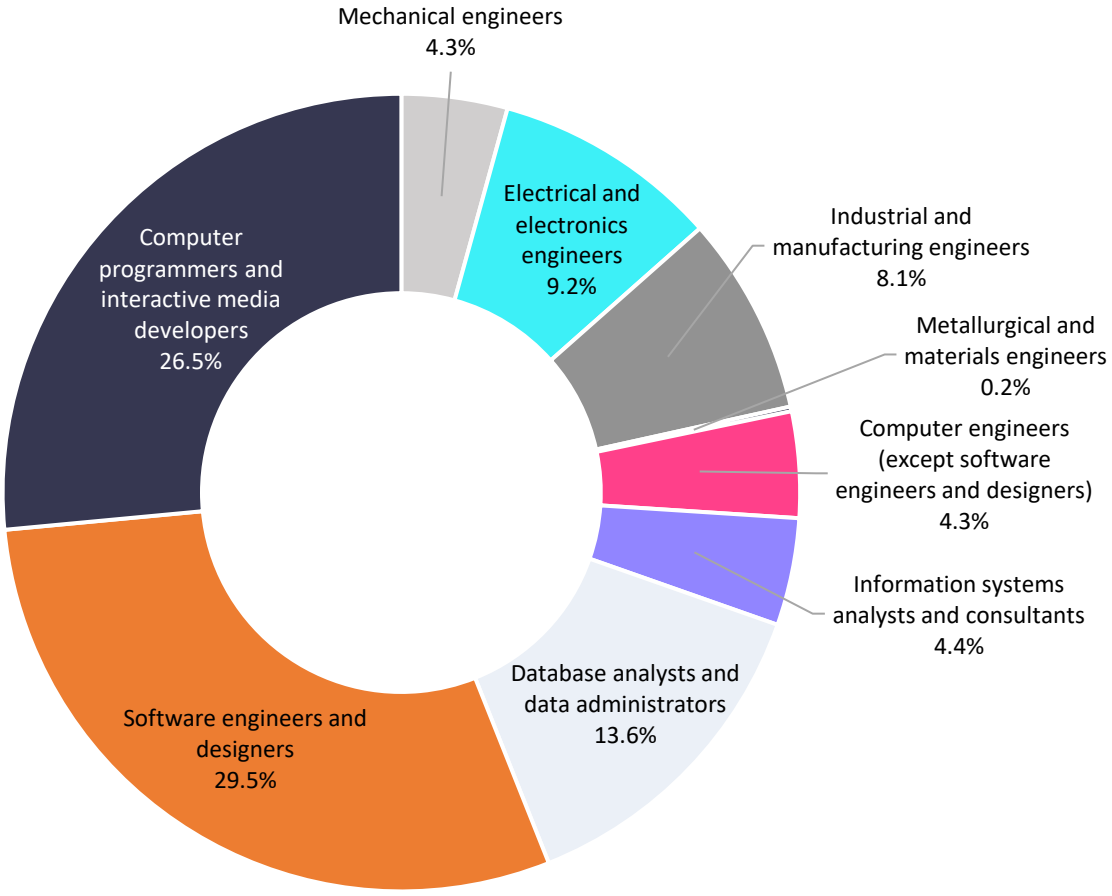
Figure 4. Occupational distribution for management occupations in the automotive technology companies of the GTHA



Engineering Occupations

Our analysis revealed that the GTHA automotive technology cluster is home to a wide range of engineering occupations. One of the main findings was that software and data related occupations account for the majority of the engineering-related profiles. Software and data engineers are essential contributors to the R&D relating to vehicle connectivity and autonomy, as well as the cyber technologies and platforms of advanced production systems. We found that "Software engineers and designers" and "Computer programmers and interactive media developers" accounted for 29.5% and 26.5% of the total engineering occupations within the region. In addition, we found that "Database analysts and data administrators" represent 13.6% of the engineering occupational group. It should be noted that, compared to the other five automotive technology clusters in Canada, the GTHA cluster is home to the highest share of data analysts and scientists. Our analysis found that "Database analysts and data administrators" were most commonly present in companies developing vehicle connectivity platforms and services.

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

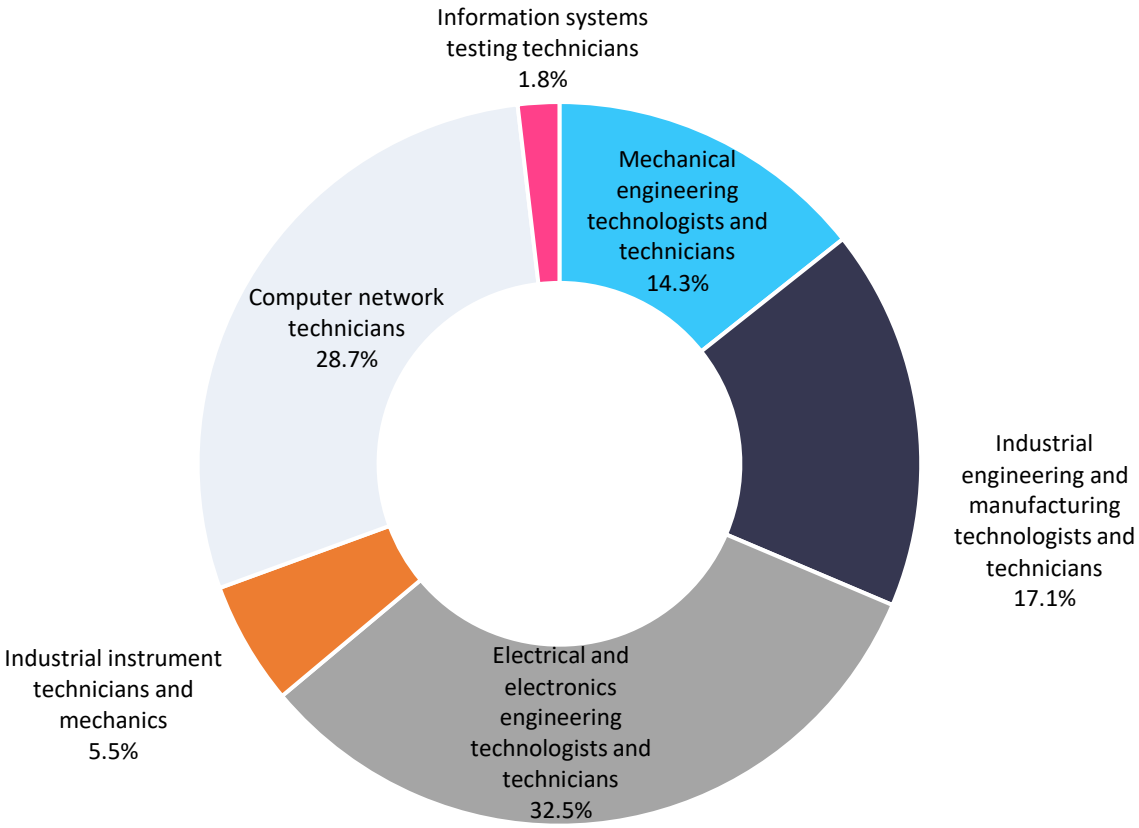


Further to software and data fields, we found that mechanical, electrical, electronics, industrial and manufacturing engineers collectively accounted for 21.6% of the region's engineering occupations. Traditional automotive manufacturers employ the majority of those individuals (e.g., GM, Magna, Vari-Form, and Dana) rather than new automotive technology organizations.

Engineering Technologists and Technicians Occupations

"Electrical and electronics engineering technologists and technicians" and "Computer network technicians" were the two most common technologist and technician occupations, accounting for 32.5% and 28.7% respectively (figure 6). "Electrical and electronics engineering technologists and technicians" are generally found in automotive electronics manufacturing and development companies. In contrast, network technicians can be found in companies with operations relating to vehicle connectivity. Our analysis further revealed that "Industrial engineering and manufacturing technologists and technicians" are common occupations in the region, accounting for 17.1% and are mostly employed in companies active in developing production technologies.

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



HIGHLIGHTS AND CONCLUDING REMARKS ON THE GTHA CLUSTER

The GTHA is widely considered to be one of Canada's primary automotive manufacturing centres. It is home to numerous OEM facilities and independent parts manufacturers and contributes a significant share of Canadian automotive manufacturing employment (FOCAL, 2019). However, based on the analysis conducted in this study, we argue that the region should also be considered to be Canada's preeminent automotive technology development hub. In fact, compared to the other five clusters covered by this study, the GTHA hosts the highest number of automotive technology companies and organizations (83). Those organizations contribute to the advancement of all 10 automotive vehicle and production technologies under study. Additionally, the cluster contributes the highest number of automotive technology employees, researchers and experts to the Canadian economy (13,048).

This study revealed that companies and organizations within the GTHA automotive cluster specialize in (1) autonomous and connected vehicle technologies, (2) electric vehicle technologies and (3) advanced manufacturing/production systems. Significant contributors to that specialization are the OEM research & development centres, major automotive suppliers active in advanced technology manufacturing and development, and the numerous academic institutions and partnerships in the region. They include General Motors, Magna International, McMaster's Automotive Research Centre and the Autonomous Vehicle Innovation Network (AVIN). In addition, several ICT companies, which are considered non-traditional to the automotive industry, were significant contributors to automotive employment in the region. For example, Oracle and SAP offer products, services, and platforms that achieve vehicle connectivity or offer cloud platforms for advanced manufacturing systems and are major employers in the region.

Our examination of the GTHA automotive technology cluster's distribution of employees revealed that employment is concentrated in the connected vehicle technologies, software & electronics, and production technologies fields. Those results were reflected in our occupational analysis, which demonstrated that software-related occupations (i.e., software engineers and designer, programmers and data analysts) are most common in the region. Such occupations are critical for the developments of automotive software-related technologies (e.g. vehicle data analytics, connectivity and autonomous driving algorithms). We

also found that Electrical and electronic engineering streams were common in the region. Many of the individuals in those occupation streams are engaged in designing and manufacturing hardware technologies related to vehicle connectivity, autonomy and other in-vehicle applications.

In sum, the GTHA is both a critical Canadian automotive manufacturing and auto-tech R&D region. Recent advancements in automotive vehicle and production technologies are encouraging ICT companies to engage with traditional automotive manufacturers in the region. Similarly, within the region, many traditional automotive manufacturers are investing in ICT tools, technologies and companies to enhance their capabilities. Thus, the GTHA provides a critical ecosystem for new vehicle technology development in Canada.

REFERENCES

AVIN. 2020. Regional Technology Development Sites. Retrieved from: *https://www.avinhub.ca/regional-technology-development-sites/*

Avison Young. 2019. The Technology Sector in the Greater Toronto Area: A Multi-Market Success Story. Retrieved from: *https://www.avisonyoung.com/documents/20342/69545959/aytopicalreportgreatertorontoareaictsectormay15-19final.pdf?_ga=2.153109368.1927978135.1602021624-418592785.1602021624*

FedDev Ontario. 2019. Southern Ontario Regional Overview. Retrieved from: *https://www.feddevontario.gc.ca/eic/site/723.nsf/eng/02557.html?OpenDocument#s1.1*

FOCAL Initiative. 2019. Impact of Industry 4.0 Technologies on Key Occupations in Automotive Manufacturing. Retrieved from: *https://www.futureautolabourforce.ca/wp-content/uploads/2020/06/Final-Impact-of-Industry-4.0-on-Automotive-Manufacturing-Occupations.pdf*

GM. 2019. GM Canada Honours its Roots and Prepares for the Future with the Newly-Named' CTC McLaughlin Advanced Technology Track'. Retrieved from: *https://media.gm.ca/media/ca/en/gm/news.detail.html/content/Pages/news/ca/en/2019/Oct/1022_GM-honours-its-roots-and-prepares-for-the-future.html*

Magna International. 2017. News Release - Magna Commits Investment of $5 Million in Artificial Intelligence Research Institute. Retrieved from: *https://www.magna.com/company/newsroom/releases/release/2017/03/30/news-release---magna-commits-investment-of-5-million-in-artificial-intelligence-research-institute*

NGEN. 2020. Corporate Plan 2020/2021. Retrieved from: *https://www.ngen.ca/hubfs/Documents/NGenFiveYearStrategy_EN_V1.0.pdf*

Toronto Global. 2020. AI. Retrieved from: *https://torontoglobal.ca/ai*

Vector Institute. 2020. The Vector Institute. Retrieved from: *https://vectorinstitute.ai/about/*