



# SYMPOSIUM ON ARTIFICIAL INTELLIGENCE

Connected and Automated Vehicles

SUMMARY REPORT

NOVEMBER 2018





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## ARTIFICIAL INTELLIGENCE: CONNECTED AND AUTOMATED VEHICLES

# EXECUTIVE SUMMARY

Advances in artificial intelligence (AI) and related technologies are expected to have profound implications in nearly all sectors of the economy, government and society, including the way that people, goods and services move. The integration of AI into various commercial sectors is opening new markets and is expected to bring unprecedented opportunities for innovation, value creation and economic growth. AI is projected to contribute up to \$15.7 trillion to the global economy by 2030<sup>1</sup>.

There is a clear link between AI and connected and automated vehicles (CV/AVs). The transportation and automotive sector is currently undergoing a period of disruption shaped by the move towards ever-increasing levels of connectivity and automation, which is being supported by the integration of AI, machine learning/deep-learning and related technologies. AI is enabling vehicles to observe their environment, analyse the data collected and render the best decision possible in a way that could mirror the human decision-making process.

Drawing on insights learned from a symposium aimed at better understanding AI's potential in Canada's automotive sector, this report provides an overview of the main challenges and opportunities in the adoption of AI applications to CV/AVs in Canada and offers 12 key recommended policy responses for the broad range of stakeholders working in this space, recognizing the need to work collaboratively.

Canada's automotive industry is uniquely positioned to play a leading role in the AI and CV/AV market due to the country's growing AI capacity and its mature automotive manufacturing footprint. A number of researchers and companies are already exploring and leveraging AI for automated car technologies and Canada is quickly becoming a global leader as a host of companies—from local start-ups to well established MNEs—are pouring millions of dollars into Canada for AI research and development.

However, Canada faces challenges on talent development and retention as well as with leveraging its leadership and capabilities to develop applications for the marketplace, to scale-up and to drive growth in the Canadian economy. Given a particularly risk-averse investment culture, Canada could increase its efforts at showcasing its capabilities in areas such as the automotive sector to attract investment and remain competitive. Opportunities for Canada to take a leadership role in this sector and capitalize on the car of the future, which includes CV/AVs, include developing a national data framework, refining the thinking around the ethical use of AI, as well as leading the way in addressing challenges around digital infrastructure, privacy and security for vehicle applications.

Policy action that is flexible enough to allow innovation will be needed to address the technical, ethical and socioeconomic challenges of AI, while simultaneously ensuring that the expected benefits to Canada's

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<sup>1</sup> [PwC's Global Artificial Intelligence Study: Sizing the prize \(2017\)](#).

automotive sector are realised. A key recommendation is therefore to work with industry and academia in the development of a coordinated national strategy on connected and automated vehicles, which would include a balanced approach to addressing issues related to the adoption of AI and CV/AVs.

## LIST OF RECOMMENDATIONS

The following are 12 key recommendations drawn from the discussions that took place during the symposium, with the aim of advancing Canada's leadership in the AI and CV/AV domain:

### Canada's AI Economic Ecosystem

1. Work with stakeholders from industry, academia and all orders of government to **develop a national CV/AV strategy** that includes addressing challenges related to AI applications and that coordinates all efforts to position Canada as a global leader in this space;
2. **Update and create flexible, self-improving regulations** to close the gap between the pace of technological advances in both AI and CV/AVs and the pace of regulatory response, all while maintaining a regulatory regime that encourages innovation — including updating Canada's transportation, infrastructure, telecommunication, IP, privacy and cybersecurity laws and regulations;
3. **Cooperate with the United States to ensure interoperability of AI and CV/AV innovations**, as well as safety, data, cybersecurity and infrastructure standards in both countries.
4. **Create a single-window concierge service for the coordination of incentive programs** at the federal, provincial and municipal levels, to reduce the added administrative burden to Canadian businesses;

### Brain Gain vs. Brain Drain

1. **Convene a network of Canadian global management talent** with a proven track record in scaling-up and managing MNEs to **mentor, provide advice and opportunities** for Canadian tech companies, including those in the CV/AV space;
2. As part of a broader skills strategy, **commit to identifying, developing, attracting and retaining the talent and skills** needed to advance AI and CV/AVs in Canada;

### AI for Social Good

1. **Build a national data framework** to ensure due diligence in the collection, use, access, protection, cooperation and interoperability of big data—including the **development of shared public datasets** and environments for AI training and testing with respect to CV/AVs;

2. **Develop a Canadian code of ethics for AI** that establishes standards and best practices in the development and use of intelligent machines and vehicles;

### **Leadership Areas for Automotive AI**

1. **Invest in digital infrastructure** and rethink the relationship between digital and traditional infrastructure to create an environment where AI innovation can thrive — including integrating digital infrastructure assessments in all future infrastructure spending and planning decisions related to CV/AV and more broadly;
2. Continue to work with businesses to **showcase and promote Canadian talent, AI capabilities and our automotive cluster** to attract inward investment and establish Canada as a global leader in the development and implementation of AI and CV/AVs, and work with Canada’s trade commissioners in key markets to identify export opportunities and investment leads.
3. **Grow the Government’s role as an early investor and first customer** for Canadian start-up innovations and technology by investing in and expanding programs that **bridge the pre-commercialization gap**, such as the Build in Canada Innovation Program (BCIP) which aims to procure and test late-stage innovative goods and services within the federal government before taking them to market.
4. **Continue to invest in research and development** for automated and connected vehicles, including ensuring a wide range of testing facilities and environments to validate the development and implementation of emerging technologies.

# SYMPOSIUM OVERVIEW

On June 12 and 13, 2018, the Public Policy Forum, in partnership with the Department of Innovation, Science and Economic Development (ISED), hosted back-to-back symposia exploring the theme of AI's potential in key sectors of the Canadian economy. The June 12<sup>th</sup> symposium focused on artificial intelligence (AI) and connected and automated vehicles (CV/AVs), while the June 13<sup>th</sup> symposium focused on AI and precision medicine (PM).

The symposium on AI and CV/AVs offered a platform for leading thinkers and practitioners from industry, academia and various orders of government to discuss current challenges and opportunities in this domain and determine the future course of action needed to leverage Canada's strengths in AI and the automotive sector.

Participants were divided into four diverse groups, and each group participated in four roundtable discussions. Each discussion theme was supported by a facilitator and a note taker. The four themes were:

1. **Canada's AI Economic Ecosystem:** *How to strengthen and integrate the AI ecosystem to advance automotive innovation,*
2. **Brain Gain vs. Brain Drain:** *How to identify, attract and retain the talent and skills needed to advance AI and CV/AVs in Canada,*
3. **AI for Social Good:** *How to address privacy, data sharing, security and ethical considerations to break down barriers to consumer adoption of AI applications to CV/AVs, and,*
4. **Leadership Areas for Automotive AI:** *What are the most promising areas where Canada can best develop global leadership in AI and CV/AVs?*

This report provides an overview of the main challenges and opportunities in the adoption of AI applications to CV/AVs in Canada, as well as a list of key recommendations drawn from the discussions that took place during the symposium and the four facilitated roundtables. The symposium agenda, including questions that helped to shape the discussions, are included in Appendix A and a participant list is included in Appendix B. A second, separate, report summarizes the discussion on AI and precision medicine.



# CANADA'S AI ECONOMIC ECOSYSTEM

## The Canadian AI ecosystem

Canada has developed a leading network of AI talent, research and SMEs with over 650 AI companies<sup>2</sup> and five main centres of commercial AI expertise in Toronto, Vancouver, Montreal, Kitchener-Waterloo, and Edmonton. Canada's growing AI ecosystem and network of clusters have facilitated increased investment spread across start-ups, incubators and research institutes. According to PwC, Canada's AI sector received US\$252 million in private investment in 2017<sup>3</sup>, surpassing the previous record of US\$158 million in 2015.

Numerous government innovation-funding programs at both the federal and provincial levels have contributed to Canada's strategic advantage. Most notably, the federal government launched the Pan-Canadian Artificial Intelligence Strategy in 2017 to help retain and attract top academic talent in the field of AI, and position Canada as a world-leading destination for companies seeking to innovate through AI technologies. Several Canadian AI initiatives have arisen as a result of Canada's strategic advantage, including the Vector Institute, the Montreal Institute for Learning Algorithms—MILA, Enterprise Machine Intelligence and Learning Initiative—EMILI and Alberta Machine Intelligence Institute—AMII. The Creative Destruction Lab at the Rotman School of Management has also established itself as a key hub linking AI start-ups with venture capital. And the SCALE.AI business consortium, dedicated to building the next-generation supply chain and boosting industry performance by leveraging AI technologies, was selected in February 2018 as one of five winning proposals under the federal Innovation Superclusters Initiative.

Canada's investment in this ecosystem has strengthened AI capabilities and has also attracted significant investments from major technology companies. Multinationals are not only building research labs, they are also funding development of talent, carving out research niches and recruiting experts in the field to attract new graduates, including Uber ATG, which launched an AI research lab in Toronto to study automated vehicles. However, much work remains to be done in connecting Canada's AI research and start-ups with our mature automotive cluster to drive growth in automotive AI innovations and scale up AI start-ups and SMEs.

## A national CV/AV strategy

Canada is presented with a great opportunity to claim a leading spot in the global race for CV/AV technology development and adoption by leveraging this growing AI ecosystem and its automotive footprint. While there are numerous initiatives from government, academia and industry aimed at advancing Canada's role in this space, there is also a growing need to coordinate efforts to ensure progress continues to be made collaboratively. In order to strengthen and integrate the AI ecosystem to advance automotive innovation, challenges and considerations in relation to AI need to be addressed as part of a broader CV/AV

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<sup>2</sup> [Element AI: Canada's AI Ecosystem Report \(2018\)](#); includes pure-play AI companies and companies working to adopt AI-related technologies.

<sup>3</sup> [PwC's Global Artificial Intelligence Study: Sizing the prize \(2017\)](#).

strategy. Therefore, participants recommended that the federal government take a leadership role and **work with stakeholders from industry, academia and all orders of government to develop a national CV/AV strategy that includes addressing challenges related to AI applications and that coordinates all efforts to position Canada as a global leader in this space.**

A similar recommendation was also identified in the 2017 Standing Senate Committee on Transport and Communications report, *Driving Change: Technology and the future of the automated vehicle*. In this report, the Committee recommended that the federal government establish a policy capacity and governance structure jointly led by ISED and Transport Canada to coordinate federal efforts and implement a national CV/AV strategy. Since the time of the symposium, the Government of Canada released an official response to the report that supports this recommendation and notes that the two departments are already undertaking joint policy development to align appropriate government actions in this space. Efforts at the federal level are currently ongoing and an interdepartmental task team has been put in place to develop a whole-of-government strategy on CV/AVs.

A Canadian CV/AV strategy should offer a long-term vision that knits together all initiatives and approaches, is tailored to the Canadian context and is informed by a broad range of interests and various technical, socioeconomic and ethical challenges. It should also provide guidance to help industry and stakeholders focus their efforts and establish a roadmap that leads to desired beneficial outcomes for Canada. This strategy should set out a broad vision beyond connected and automated vehicles — that takes into consideration electrification, automotive AI applications, intelligent transportation systems, smart cities and other new and emerging automotive technologies. It should also address associated challenges related to safety, infrastructure, data access, privacy, consumer adoption and cybersecurity, among others. While both regulatory and non-regulatory tools could be considered as part of this strategy, any regulatory changes should not impose unnecessary barriers for industry to innovate.

### **A flexible, modernized and interoperable regulatory regime**

Modernizing the regulatory regime may be needed to adapt to technological advances in both AI and CV/AVs. This should be done in a way that preserves public acceptance and simultaneously facilitates scientific discovery and innovation. These policy opinions are frequently contradictory. However, addressing privacy, security and safety concerns could stimulate growth and innovation by growing public trust and adoption. A balanced regulatory framework needs to be achieved on the grounds that efforts to introduce a governance regime could add unnecessary regulatory and administrative burdens and turn away industry players. Therefore, participants recommended that all orders of government work collaboratively to **update and create flexible, self-improving regulations to close the gap between the pace of technological advances in both AI and CV/AVs and the pace of regulatory response, all while maintaining a regulatory regime that encourages innovation — including updating Canada’s transportation, infrastructure, telecommunication, IP, privacy and cybersecurity laws.** One way to achieve this is to work closely with industry so that policy-makers have a good understanding of the technology and are well-informed of the

consequences of overregulating. Due to the fact that AI applications for CV/AV are at an early stage of development, there are high risks in stalling or even stifling innovation through new and stringent regulation, which could in turn risk Canada's leadership in the development of these technologies.

Regulation and standards can also play a positive role for economic growth and innovation by bringing credibility to technology advancements and facilitating an expanded interoperable marketplace.

Interoperability is necessary for emerging automotive technologies to work seamlessly across borders in the movement of goods and people and will enable different AI systems and software applications to communicate, exchange data, and use the information that has been exchanged. There is a growing need for cross-border co-operation when developing standards and principles for automotive AI innovations in order to ensure interoperability across markets and borders. As Canada's main trading partner is the United States, accounting for \$508 billion in total trade<sup>4</sup>, harmonization of industry standards and laws with the U.S. is of particular importance for Canada's strategic advantage. Participants therefore recommended that Canada **cooperate with the United States to ensure interoperability of AI and CV/AV innovations as well as safety, data, cybersecurity and infrastructure standards in both countries**. Overall, symposium participants stressed that government should continue to actively engage with industry, the Canadian public and all stakeholders when making regulatory changes. A regulatory regime for AI automotive innovations must balance the need for safe, secure, responsible and ethical use of technological advances, cross-border interoperability, sufficient flexibility to allow the innovative progress needed to realize AI's expected social and economic benefits, and avoidance of unnecessary additional administrative and regulatory burdens to industry.

### **Coordinated incentive programs**

Numerous actions from the federal and provincial governments in support of fostering research and development in Canada have contributed to Canada's strategic advantage and leading AI ecosystem. However, there is a need for increased coordination of these programs to reduce unnecessary administrative burdens to industry, and in particular to SMEs. For example, private enterprises tend to be in favour of the federal Scientific Research and Experimental Development (SRED) tax incentive program, but may lack the capacity to manage the administration required to access funding. There is also added bureaucratic stress caused by a perceived lack of coordination with other federal programming, leading to duplication and overlap. These "silos" of programs and incentives extend beyond the federal government, with different incentives and key performance indicators for each order of government. Consequently, participants recommended that the federal government take a leadership role and **create a single-window concierge service for the coordination of incentive programs at the federal, provincial and municipal levels, to reduce added administrative burden to Canadian businesses**.

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<sup>4</sup> [Statistics Canada \(2018\)](#)

# BRAIN GAIN VS. BRAIN DRAIN

## The future of work

Transformative technologies like CV/AVs are expected to have profound impacts on the labour market. A growing need for digital skills to support technological advancements is likely to disrupt many occupations and redefine the future of work. The automotive sector is already starting to see an increased demand for information and communication technology (ICT) and AI skills as they work towards building the car of the future. However, multiple sectors are competing for these highly sought after skills and the future supply is not expected to meet the growing demand. Given this exponential global shortage of engineers and ICT-related skills, talent is becoming a contributing factor for investment attraction and Canada's expertise in AI and deep learning has significantly contributed to its competitive advantage. There were approximately 213,300 engineers and ICT-skilled workers in CV/AV related industries in 2016. This number is projected to increase by 34,700 new jobs in 2021.<sup>5</sup> It is therefore critical that Canada strives to meet the forecasted skills demand in order to remain competitive.

In addition to filling the demand for engineers and ICT skills, participants also identified a critical need to improve management skills in Canada's technology sector. While Canadian AI and computer engineering talent has resulted in a surge of new technology ventures, these companies often lack the skills needed for growth. Perhaps one of the biggest challenges in advancing Canada as a high-tech economy is failing to capture the full benefits of our venture capital investments, with promising SMEs failing to become Canadian-based global companies, simply because there is a gap in management expertise to scale-up a start-up company. Participants suggested that the government may be able to help address this issue by partnering with industry to [convene a network of Canadian global management talent with a proven track record in scaling-up and managing MNEs to mentor, provide advice and opportunities for Canadian tech companies, including those in the CV/AV space](#). Through this network, Canadians with experience managing global logistics and marketing operations could be offered incentives and attractive opportunities to return to support Canadian technology companies.

## Retention and attraction

The retention and attraction of digital talent, particularly in the fields of AI and deep learning will also be key for equipping the future automotive workforce with the skills needed to succeed in the CV/AV market. Retaining and attracting top academic talent requires the right conditions to be in place to provide them with opportunities that help them realise their full potential in an inspiring environment. Competitive compensation packages and a high quality of life are contributing factors for maintaining talent in Canada. With low crime rates, a world leading education system, free health care, and responsive immigration processes, among other factors, Canada is often ranked as one of the top countries to live in. However, higher compensation rates are still a leading motivation for new graduates moving across the border.

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<sup>5</sup> [JCTC: Autonomous Vehicles and the Future of Work in Canada \(2018\)](#).

Canadian cities tend to be on the lower end of the spectrum for technology wages in North America.<sup>6</sup> Nonetheless, while competitive wages and a good quality of life are significant contributing factors in the retention and attraction of top talent to Canada, being able to offer a compelling purpose and an inspiring environment is often of equal importance. For example, Tokyo is using its preparation for the 2020 Summer Olympic and Paralympic Games to set targets and generate the enabling environment for CV/AVs to provide transportation during the Games. Participants agreed that supporting initiatives like this one and focusing resources on specific targets could provide the motivating environment needed to retain and attract skilled individuals.

The role of universities, particularly cutting-edge university research facilities, was also identified as a contributing factor in attracting and retaining talent. Although it is challenging for Canadian universities to compete with the huge endowments of U.S. top-tier schools, Canada can still make a compelling offer for many, and leverage industry partnerships to support and contribute to R&D for technology companies. For example, companies like GM, Ford, Blackberry QNX and Uber have made significant investments and partnered with Canada's research universities to develop R&D facilities in Ontario. These investments have positioned Canada as a leading destination for companies seeking to invest in innovation and have contributed to retaining and growing Canada's world-renowned AI experts and other technology expertise.

### **Pipeline growth: Education**

To ensure that Canadians are able to take full advantage of the prospective opportunities presented by emerging markets like CV/AVs, we will need to develop the skills required to equip and grow our businesses. Adapting our education system to the changing nature of work will be key in growing our digital talent pool and in preparing Canadians for the jobs of the future—this includes the ability to identify future skills requirements and provide the right training and education to our future workforce. With Canada's high tuition fees cited as a concern, the opportunity cost of post-secondary education remains a barrier for high-skilled education. Consequently, post-secondary education that is more accessible and affordable, including the integration of distance, online and flexible education, could help offset this opportunity cost and encourage more graduates to attain higher levels of education.

Besides expanding access to education, Canada will also need to ensure that school curriculums at all levels are providing the knowledge and skills needed for the future labour market. There is significant evidence that science, technology, engineering, mathematics (STEM) and digital skills will be increasingly in demand. Therefore, elementary and secondary schools should foster earlier exposure to STEM skills and should consider teaching students how to code at an early age. Participants also suggested establishing new institutions to train students in digital skills and embedding digital skills in technical education.

Companies are in need of AI and STEM talent and, with the current education system at risk of not being able to keep up with the demands of today's economy, they are stepping away from traditional models and adopting new formats to build their own talent pipelines. For example, Shopify has developed a pilot

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<sup>6</sup> [U.S. Bureau of Labor Statistics \(2016\)](#); [Statistics Canada \(2017\)](#); [CBRE Econometric Advisors, Axiometrics \(2017\)](#).

program in partnership with Carleton University in which students are able to work and study directly at Shopify instead of taking traditional classes on the university campus. Through this initiative, Shopify pays for their education while the students earn their degrees through on the job learning.

Going forward, industry, academia and government will need to work together to be able to anticipate the skills that will be needed and to be able to prepare Canadians for the future labour force.

### **Pipeline growth: An inclusive workforce**

Given the increased need for people with relevant skills from all backgrounds to support and grow Canadian enterprises and Canada's leadership in the AI space, prioritizing diversity and inclusion in STEM fields and in the AI and automotive sectors plays a key part in addressing potential barriers stemming from algorithmic bias. Symposium participants reinforced the continued need and importance of diversity in the workforce as part of efforts to fill the skills shortage. Diversity in educational backgrounds, gender and culture make for more robust and resilient organizations.

Challenges remain with the inclusion and representation of women and Indigenous Peoples in the AI community, as well as within the CV/AV and broader automotive field. Technology education programs and similar initiatives aimed at shrinking diversity gaps in industry have played a positive role. However, participants stressed that addressing the diversity gap in these industries will require a shift in workplace culture. This includes encouraging workplace environments where there is zero tolerance for discrimination and where women and other minority groups are presented with equal opportunities for career development. Moreover, while there are some pipeline initiatives in place for women, there are no comparable initiatives in place to support Indigenous Peoples, recent immigrants, or persons with disabilities; accordingly, there remains a need to develop such pipelines and create early opportunities for exposure and engagement.

### **Pipeline growth: Re-skilling and Up-skilling**

The advent of AI-powered automation and the potential widespread deployment of CV/AVs have sparked much debate over the possible loss of well-established occupations within the automotive industry. However, symposium participants agreed that while these transformative technologies are poised to change skills requirements for certain occupations, they do not foresee a significant loss of jobs in the field. They highlighted the current shortage of truck drivers and the possibility that some professions will naturally phase out. Nevertheless, Canada's automotive workforce accounts for over half a million jobs (direct and indirect), and the government should support a roadmap to re-skill and up-skill automotive workers on a continuing basis to ensure a labour force that adapts to the technological transformation of the sector. In particular, automotive-related occupations such as mechanics might require up-skilling or re-skilling to provide necessary maintenance and retrofit services to CV/AVs (and to other "cars of the future" such as zero-emission vehicles). Preparing the current and future workforces for the AI and CV/AV sectors and ensuring that sufficient workers have the necessary digital and ICT skills may also require the current

workforce to be re-skilled or up-skilled. A commitment by the Government to ensure that our education and training systems remain flexible, so that they can adapt as the demands on the workforce change, is key in preparation for potential labour disruption. As well, programs that support lifelong learning and provide workers with improved guidance to navigate job transitions would positively contribute to a Canadian skills-readiness strategy. Regardless of the model, it is evident that ongoing, continuous learning is a priority for organizations and employees if they wish to remain competitive, and certainly for many large organizations, which are increasing investment in in-house training and education programs.

There is little doubt that technological progress in the automotive sector, powered by AI and related technologies are transforming the future of work. Canada's challenge is threefold; grow and diversify the talent pool to ensure that the future workforce is able to meet the projected demand for digital and AI skills, as well as global management expertise; work with provincial governments, academia and industry in modernizing our education system to ensure it reflects changing occupational requirements; and prepare for a transitional period that could see job losses in our automotive sector and related industries. Therefore, participants recommended that **as part of a broader skills strategy, the Government of Canada commit to identifying, developing, attracting and retaining the talent and skills needed to advance AI and CV/AVs in Canada.**

## AI FOR SOCIAL GOOD

### **Addressing societal challenges with AI**

In addition to the potential socio-economic benefits that AI could bring, it has also been successfully applied to address societal problems and has the potential to generate social benefits in the future. AI-powered CV/AVs could foster social inclusion, address the “first and last mile” problem, increase accessibility and mobility for seniors and persons with disabilities as well as for communities with limited access to public transit, improve road safety, and significantly reduce traffic fatalities. There are many other social issues AI is contributing to, including in areas such as urban computing, environmental sustainability, public welfare, education, health and evidence-based policy making. For example, AI is powering predictive analytics to help physicians identify which patients genuinely require a massive transfusion, thereby reducing complications associated with over-transfusion or the needless expenditure of blood products. AI applications for social good present a unique opportunity to address consumer awareness and increase public trust in these disruptive technologies. Concurrently, there is also room to support these technologies by improving data governance, access and validity.

### **A national data framework**

Artificial intelligence is being supported by large amounts of data. AI innovations for the marketplace as well as those intended for social good could benefit from improved access and integration of data sources, better data collection and digitization, better models and predictions of individual behaviours, and a system

for validating existing and historical datasets. The federal government can play a role in improving the governance of data by helping provide checks and balances and ensuring diligence of use. The creation of a data framework that includes a public repository for data is a way to provide this. There is an opportunity for Canada to play a leading role globally in data governance, and developing a data framework would significantly help Canadian technology companies in scaling up. It would help industry optimize their operations and cut costs by being able to collect, share and analyze data while knowing the parameters of its use. A framework could also empower AI for social good and help address public concerns over privacy and security. Therefore, participants recommended that the federal government **build a national data framework to ensure due diligence in the collection, use, access, protection, cooperation and interoperability of big data—including the development of shared public datasets and environments for AI training and testing.**

Big data has many valuable applications for CV/AVs and the AI functions that support them. Vast amounts of data are already being collected from vehicles, such as the location data from satellite navigation systems, and companies are quickly monetizing these datasets. For example, companies around the world are already focused on creating value in CV/AV data by selling driver data to municipalities, mobility services and automotive manufacturers, all while helping to ensure that the resulting benefits go to drivers. In the case of CV/AV-related data pools, the data could also help to develop high-definition (HD) maps and research traffic patterns. However, when it comes to automotive datasets, there is substantial public concern over ownership, privacy and security. A good data framework will therefore be beneficial in securing appropriate protection of personal information while ensuring safe use and linking of open and non-sensitive data.

### **A Canadian code of ethics for AI**

The availability of large amounts of data and significant advances in computing expertise have led to continuous progress in AI research and development. Intelligent machines are now able to analyze information and act in a way that seeks to replicate the human decision-making process in some areas. However, it is up to decision-makers to decide the trajectory of positive and negative reinforcements that will shape the evolution of AI innovations. AI can be a major force for social good, but it depends in part on how we shape this new technology. AI-enabled vehicles and machines not only have the potential to make mistakes that could severely impact human lives but they also take on responsibilities traditionally assumed by humans, which in turn raises fundamental ethical questions, including that of liability. Currently there is a significant spotlight on the future ethical, safety and legal concerns of future applications of AI. A Canadian code of ethics could seek to answer these difficult ethical questions and allow researchers to be better equipped to guide AI in a beneficial direction. As a result, participants from the symposium recommended that governments **develop a Canadian code of ethics for AI that establishes standards and best practices in the development and use of intelligent machines and vehicles.**



# LEADERSHIP AREAS FOR AUTOMOTIVE AI

## Cybersecurity

In addition to data governance and the ethical use of AI, another prominent area where Canada could take a leadership role in advancing AI technologies for CV/AVs is cybersecurity. AI has important applications in cybersecurity, and this intersection is expected to play a growing role in vehicle integration of connectivity and automation. AI may empower cybersecurity by helping maintain the rapid response required to detect and react to the landscape of evolving threats. In turn, AI systems incorporated into CV/AVs will also require agile cybersecurity mechanisms to ensure public safety. As a result, there is a growing demand for cybersecurity skills and this field is expected to experience economic growth. Canada has already established expertise in the development of secure software for use in vehicles and could take advantage of its AI expertise to become a leader in this space by filling the growing global gap in cybersecurity capabilities.

Moreover, the expertise created by AI development for CV/AVs could also be leveraged within other rapidly growing fields. The development of highly secure AI technologies could yield benefits in other markets beyond CV/AVs potentially leading to further development of the cybersecurity industry in Canada.

## Infrastructure for a digital economy

The technological innovation surrounding AI will also likely reshape features of the built environment. In the case of CV/AVs, dramatic shifts in the design of both physical and digital infrastructure are expected. Successful AI depends on the collection, manipulation and transfer of massive amounts of data, and cutting edge wireless technologies are needed to transfer the data instantaneously. Therefore, digital infrastructure which enables large scale data flows, cutting edge wireless technologies like 5G, interconnectivity with a variety of sensors and new systems such as small cells for expanding communications, will all have to be factored in as much as traditional transportation infrastructure elements such as roads. Redefining infrastructure for the digital economy not only offers Canada an opportunity to take a leadership role but could also provide the ideal conditions for AI and CV/AV technologies to thrive.

Canada has the potential to become a global leader in digital infrastructure by implementing the right policy requirements for future infrastructure spending. While governments in Canada have committed large sums to traditional forms of infrastructure spending, consideration must be given to the infrastructure required for a data-based economy. Canada may also want to introduce a requirement to make sure that current infrastructure spending is being assessed against the future needs of a digital economy. Therefore, participants recommended that the federal government **invest in digital infrastructure and rethink the relationship between digital and traditional infrastructure to create an environment where AI innovation can thrive—including integrating digital infrastructure assessments in all future infrastructure spending and planning decisions.**

## Showcase and promote

Canada's strategic advantage to attract investments in the CV/AV space includes major clusters of AI expertise, a reputable automotive manufacturing footprint, and the factors that make it attractive to skilled immigrants, such as high quality of life, a world-renowned education system, free health care and responsive immigration practices, among other contributing factors. Canada can also leverage the diversity of Canadian geography, weather and climate conditions as a competitive advantage in providing real environment testing for the car of the future. However, symposium participants stressed that government needs to be more intentional in showcasing and promoting our value proposition and in selling Canada. Canada will need to overcome a traditionally modest culture and increase advertising efforts to showcase what it has to offer. Promoting Canadian digital products and services could not only help attract investments from large multinationals, it could also drive domestic demand and improve consumer acceptance. Consequently, participants recommended that the Government of Canada **continue to work with businesses to showcase and promote Canadian talent, AI capabilities and our automotive cluster to attract inward investment and establish Canada as a global leader in the development and implementation of AI and CV/AVs.**

## Government Leadership

Canada will also need to overcome its high risk aversion in order to scale its technology start-ups and advance as a global player in the CV/AV and emerging automotive technologies sector. Canada has not been a frontrunner in venture capital and government investment, which creates a challenge when competing with countries like the U.S., and often forces start-ups to look abroad to grow their activities. Participants referenced the example of the U.S. Department of Defense and its subsidiary, the Defense Advanced Research Projects Agency (DARPA), which has to spend a certain percentage of its annual budget on start-ups. A lot of IP in the CV/AV field has been funded in the U.S. through this agency. A parallel initiative in Canada is the recent Build in Canada Innovation Program, which is a competitive first-purchase program that provides the ability to test and sell pre-revenue technologies to the Government of Canada. Not only could this help to overcome the difficulties of bringing technology to market, but feedback gathered through the process may also support additional future sales. This demonstrates the important role government can play in being an early investor and first customer to help de-risk and accelerate the scaling-up of tech companies and bridge the pre-commercialization gap. Therefore, another recommendation from symposium participants was to **grow the Government of Canada's role as an early investor and first customer for Canadian start-up innovations and technology by investing in and expanding programs that bridge the pre-commercialization gap, such as the Build in Canada Innovation Program (BCIP).**

Canadian governments at all levels also have the opportunity to take a leadership role by addressing the challenges and opportunities in the deployment of CV/AVs mentioned throughout this report. On average, Canadians' trust in government is higher than it is in many other countries. The importance of this trust should not be underestimated as it can create the public confidence required for the adoption of the culture

shifts inevitable in a world of CV/AV technologies. Canada is also a G7 country and many international parties trust Canadian leadership and look to Canada as a guiding example.

The Government could also show leadership in promoting the safe deployment of these technologies **by continuing to invest in research and development for automated and connected vehicles, including ensuring a wide range of testing facilities and environments to validate the development and implementation of emerging technologies.**

### **Public Engagement**

Lack of public acceptance is a risk to the successful deployment of CV/AVs. Poor public trust is in part due to lack of awareness of how these technologies function and of their immediate benefits. Canadians are not only consumers of CV/AV technologies, but their perspective has the power to slow down the adoption of these emerging technologies and as result also diminish the potential economic benefits. Therefore, there was widespread agreement that significant investments in providing opportunities for the public to explore and witness CV/AV technology first-hand will be key in advancing public understanding and adoption.

This needs to be partnered with well framed messaging to reinforce the benefits to the public arising from CV/AV technologies, such as improved road safety, faster transit and cheaper transportation options. The level and quality of care required in the messaging should not be underestimated.

# CONCLUSION

AI will continue to contribute to economic growth and will be a valuable tool for the widespread deployment of CV/AVs. Canada is uniquely positioned to be a global leader in this emerging market due to our world-renowned cluster of AI expertise and well-established automotive manufacturing footprint. Canada's main challenges will include the need to focus its resources in showcasing its capabilities, scaling up technology startups and investing in digital infrastructure. However, there are many opportunities for Canada to take a leadership role in this space.

The federal government should set a clear vision to develop the benefits of AI-enabled CV/AVs, manage the resulting risks, and ensure that all Canadians have the opportunity to participate in the benefits. Reaping the economic and social benefits of this revolutionary technology will require an approach to ethics and governance that enables innovation, builds trust among citizens, establishes a stable environment for businesses and investors, and fosters appropriate access to the data and expertise necessary. The development of a whole-of-government CV/AV strategy, with collaboration from industry, academia and all orders of government, would help map out the steps needed to ensure a policy framework that helps achieve this ambition.

Beyond this report, more work remains in exploring the policy implications of AI for Canada's automotive sector, particularly in the development and deployment of CV/AVs, and in identifying policy options that address the ethical, socioeconomic and technical challenges while securing Canada's position as a global leader in this space.

# APPENDIX A: SYMPOSIUM AGENDA

9:00 **Registration and Networking**

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9:30 **Welcome and Introduction**

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9:35 **PANEL—Setting the Stage**

**Panelists:** **Ted Graham**, Head of Open Innovation, General Motors  
**Gonen Hollander**, Chief Operations Officer, Acerta Analytics Solutions  
**Dan Mathieson**, Mayor, City of Stratford

Moderator: **David Fransen**, PPF Fellow

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10:00 – **BREAKOUT SESSIONS—PARTS I—IV**

3:15 **Group 1: Canada’s AI Economic Ecosystem (Academia, SMEs & MNEs)**

How to strengthen and integrate the AI ecosystem to advance automotive innovation?

Facilitator: **David Fransen**, PPF Fellow

**Group 2: Brain Gain vs. Brain Drain**

How to identify, attract and retain the talent and skills needed to advance AI and CV/AVs in Canada?

Facilitator: **Kelly Nolan**, Founder, Talent Strategy Institute

**Group 3: AI for Social Good**

How to address privacy, data sharing, security and ethical considerations to break down barriers to consumer adoption of AI applications to CVAVs?

Facilitator: **David Ticolli**, Distinguished Fellow, Innovation Policy Lab, Munk School on Global Affairs, University of Toronto

**Group 4: Leadership Areas for Automotive AI**

What are the most promising areas where Canada can best develop global leadership in AI and CV/AVs?

Facilitator: **Raed Kadri**, Director, Automotive Technology and Mobility Innovation, Ontario Centres of Excellence

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3:30 **Plenary**

Each facilitator has 5-7 minutes to convey the key points discussed throughout the day at their table, followed by questions and comments from the larger group

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4:15 **Closing Remarks**

**Charles Vincent**, Director General, Automotive, Transportation, and Digital Technologies at Innovation, Science and Economic Development

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4:20 **Conclusion**

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## APPENDIX B: PARTICIPANTS

### **Jahan Ali**

CEO  
MobileLIVE

### **Rodrigo Arancibia**

Director,  
Innovation, Science and Economic  
Development Canada (ISED)

### **Namir Anani**

President & CEO  
The Information and Communications  
Technology Council (ICTC)

### **Tom Bedford**

Manager, Automotive Manufacturing &  
Technology  
Ontario Ministry of Economic  
Development & Growth

### **Olivia Bechthold**

Manager  
MC2

### **Jean-François Champagne**

President  
Automotive Industries Association

### **Todd Deaville**

Corporate Engineer and R&D  
Magna International

### **Ron Di Carlantonio**

CEO  
iNAGO Inc.

### **Maria Fleming**

Analyst  
Innovation, Science and Economic  
Development Canada (ISED)

### **Drew Fagan**

Fellow  
Public Policy Forum

### **David Fransen**

Fellow  
Public Policy Forum

### **Garth Gibson**

President & CEO  
Vector Institute

### **Tanya Gracie**

Policy Lead  
Public Policy Forum

### **Ted Graham**

Head of Open Innovation  
General Motors (GM)

### **Sheryl Groeneweg**

Director General  
Innovation, Science and Economic  
Development Canada (ISED)

### **Ismail Hamieh**

Research Council Officer  
Automotive and Surface  
Transportation  
National Research Council (NRC)

### **Doug Heintzman**

MI Board Director  
MaRS Innovation

### **James Hinton**

Associate  
Bereskin & Parr LLP

### **Gonen Hollander**

Chief Operating Officer,  
Acerta Analytics Solutions

### **Julie Irvine**

Manager  
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### **Raed Kadri**

Director  
Ontario Centres of Excellence

### **Kosta Kalogiros**

Associate  
McCarthy Tétrault LLP

### **Neda Navan**

Associate Director, Urban Systems  
Sidewalk Labs

### **Neil Kochhar**

Manager/Senior Policy Advisor  
Transport Canada

### **Andre Leduc**

Vice-president, Government Relations  
& Policy  
Information & Technology Association  
of Canada

### **Sheldon Levy**

CEO  
NEXT Canada

### **Dan Mathieson**

Mayor  
City of Stratford

### **Alec Nicholls**

Senior Director  
Innovation, Science and Economic  
Development Canada (ISED)

### **Kelly Nolan**

Founder  
Talent Strategy Institute

### **David Paterson**

Vice-President, Corporate Affairs  
General Motors (GM)

### **Denise Rollin**

Project Administrator  
Public Policy Forum

### **Sherry Shannon-Vanstone**

President & CEO  
TrustPoint Innovation

### **Ray Tanguay**

Former Automotive Advisor

### **David Ticoll**

Professor  
University of Toronto

### **Jeff Walker**

Chief Strategy Officer  
Canadian Automotive Association

### **Charles Vincent**

Director General,  
Innovation, Science and Economic  
Development

