ENHANCED SERVICE DELIVERY & ORGANIZATIONAL CAPACITY

Public Service Vehicles

AV technologies are being developed not only for the passenger and freight sectors, but also for the delivery of public services. Many companies are exploring how automation can contribute to improved traffic safety, worker conditions, service delivery, and a lower environmental impact. For example, self-driving waste collection trucks could make driving safer in urban areas, with sensors that continuously monitor the vehicle's vicinity and automatically stop if an obstacle is in its path.[123] The City of Toronto is looking to make the most of developments such as these to improve safety and public service delivery for its municipal vehicles.

Additional Research & Future-Proofing

The City of Toronto recognizes that there are many uncertainties around the timelines, business models and impacts of driving automation systems. Studies and modelling exercises can be undertaken to explore a range of scenarios, increase the knowledge of City staff, and begin to generate policy options in areas where changes are not expected to occur in the short term. Furthermore, the *Automated Vehicles Tactical Plan* is scheduled to be reviewed again in three years to stay current with developments around AV technology.

Tactical Plan Governance

Open government requires well-managed and accessible information in order to function. With vast new data streams, emerging from AVs and the infrastructure that supports them, developing tools to manage this new information pipeline and extract useful performance indicators will move the City towards successful execution of this Tactical Plan. Ultimately, a robust data governance framework can improve service delivery, build public trust and confidence in government, and enhance civic engagement through transparency, participation, accountability and accessibility.

Guiding Policies and Strategies:

Public Service Vehicles

Congestion Management Plan (2016-2020):[101]

> *Incident & Event Response – Strengthen relationships among key agencies – e.g., Transportation Operation Centre (TOC), emergency services, towing industry, road maintenance, etc. to improve coordination, reduce response and clearance times, and improve safety of field personnel*

Consolidated Green Fleet Plan 2014-2018:[124]

The goal of the Consolidated Plan is to choose vehicles, equipment, fuels, and practices that consume less fuel and emit less GHG and air pollution, meet the City Fleets' operational requirements, are sustainable, and are economically viable.

Fleet Services Review - Strategy for the Fleet Services Division (selected initiatives):[125]

Improve data collection and performance indicator based reporting

Develop a long-term plan to improve aging infrastructure and space adequacy

Continue to address environmental needs at all City-operated fuel sites

Additional Research

Toronto Official Plan (2015):[2]

5.4 MONITORING AND ASSESSMENT

1. Appropriate targets and indicators will be established to serve as a basis for assessing progress toward achieving the objectives of this Plan. Progress will be assessed periodically and will be informed by analyses of:

a) the social, economic, environmental and fiscal trends affecting the City, the region, the province and the country;

b) population, employment and housing trends;

c) changing travel patterns;

d) changes in the legislative environment; and

e) social and physical infrastructure improvements required and provided to serve growth in population and employment.

Tactical Plan Governance

Open Data Master Plan, 2018-2022:[105]

To enable rapid, comprehensive, and high-value open dataset releases, the City of Toronto needs to focus on establishing an automated data release pipeline that enables internal partners to seamlessly identify, access, and push data to the Open Data catalogue. Decreasing the manual effort required to publish and update open datasets is essential for modernizing and scaling up the City's Open Data program. Real-time access to data in its original, unmodified, and disaggregated form with full transparency on its progress through the publication pipeline is the goal.

WHAT WE NEED TO DO

Develop an automated publication pipeline that includes privacy and security considerations

Make the publication pipeline public for progress tracking

Publish real-time open data streams from primary record repositories

Strategic Actions, 2013-2018:[126]

Enhance Performance Measurement

Develop and implement a "best in class" performance measurement and indicators system across the organization by the end of 2015 by:

Developing a Corporate Measurement and Indicators Framework with common language, standardized categories of performance measures and indicators, metadata standards, and processes to maintain and regularly update results.

Implementing regular web-based reporting to the public, staff and Council on how Toronto is progressing including related to quality of life.

Improving the City's capacity to compare its results over time, in relation to established targets, benchmarked to other cities, in Ontario, Canada and internationally and by neighbourhood.

PSV.1 Safety and Effectiveness

PSV.1.1 Road Safety

Proposed Tactic: Develop and implement policies that address potential safety issues and benefits from the use of automated fleet vehicles.

The City of Toronto's Driver/Operator Fleet Safety Policy on Safety & Compliance includes the following policy statement: "As employees of the City of Toronto, it is our duty to protect the interests of the residents of Toronto by carrying out our work in a safe and efficient manner, and to maintain good public relations with those who use the City roadways."[127]

AVs provide a new technology, and major change to existing vehicles/ equipment that can be harnessed for improvements to road safety.

Proposed progress to 2022: Research and learn about the safety impacts of integrating automation into City of Toronto fleet vehicles; and engage with relevant stakeholders to assess potential solutions – including availability of options, cost, liability and viability.

PSV.1.2 Vehicle Effectiveness

Proposed Tactic: Develop and implement a mechanism to review and enhance the cost and operational effectiveness of automated fleet vehicles.

A Fleet Services Review conducted from 2014- 2015, included an in-depth analysis of a few major fleet management functions, and provided recommendations for improvement.[125] A five-year business plan was developed to address certain aspects of Fleet Services' organizational and operational practices and procedures.

The City of Toronto's Fleet Services Division is actively pursuing enhanced cost and operational effectiveness in all of its initiatives as articulated in the Guiding Policies and Strategies section. This Plan will support the introduction of AV technology in contributing to the achievement of these goals.

Proposed progress to 2022: Engage and consult with industry stakeholders to assess the options available for procuring automated fleet vehicles. Assess the cost and operational effectiveness of these vehicles through stakeholder consultation.

PSV.1.3 Vehicle Security

Proposed Tactic: Develop and implement policies and mechanisms to safeguard the operation and data security of automated fleet vehicles.

AVs may be vulnerable to exploitation from a cybersecurity perspective by malicious actors. The third-party and cloud service providers through which vehicle-to-vehicle communications (V2V),

vehicle-to-infrastructure communications (V2I), and vehicle-to everything (V2X) communications could take place provide a multitude of entry points for a person or entity attempting to gain access.[128] For this reason, the City will ensure that, just like other vehicle types, public sector fleet vehicles will be protected from cybersecurity threats as automated and connected features are integrated into their operations.

Proposed progress to 2022: Research and learn about potential security issues associated with automated fleet vehicles. Engage and consult with stakeholders on safeguarding the operation and data security of these fleets, including coordinating with Provincial and Federal levels of government for direction on options, cost, liability and viability of vehicle security.

PSV.1.4 Vehicle Fueling

Proposed Tactic: Develop and implement a mechanism to provide fueling services for automated fleet vehicles.

The City of Toronto's Fleet Services Division is responsible for oversight of any fuel sites managed by the City's Divisions.[124] Regardless of the method of fuel for future AV fleet vehicles –whether they are green or fossil fuels – the City will need to manage the fueling services required to power these fleets.

In the past, the City's efforts under the Consolidated Green Fleet Plan (2014-2018) have proven successful – unless there was a cost or lack of infrastructure that they City could not manage. Alternative fuels that were tested to improve the environmental impacts of City Fleets were occasionally unsustainable due to a need for additional funding or facilities to accommodate it.[124]

Moving forward, the goal is to "choose vehicles, equipment, fuels, and practices that consume less fuel and emit less GHG and air pollution, meet the City's operational requirements, are sustainable, and are economically viable."[124] As AVs begin to meet and address some of these needs the City will need to ensure that it is considering fueling services to contribute to them.

Proposed progress to 2022: Analyze the existing fuel options available for public service vehicles. Research and learn about additional needs resulting from AVs and engage and consult with stakeholders on how to address this.

PSV.2 Service Delivery

PSV.2.1 AV Fleet - Transit

Proposed Tactic: Integrate automated vehicle technologies into the Toronto Transit Commission's vehicle fleet.

Multiple use cases have been envisioned for automated technology transit, incorporating various technology packages. For example, an SAE Level 1 or 2 transit bus ADAS could assistant

with: smooth acceleration and deceleration, automatic emergency braking and pedestrian collision avoidance, curb avoidance, precision docking, narrow lane/shoulder operations, and platooning. Higher level automation packages could be deployed in maintenance and yard operations, as well as shuttle, bus rapid transit and mobility-on-demand services (e.g., paratransit).[10]

Proposed progress to 2022: Research and learn about add-on safety features available for bus and streetcar fleets. Assess available options and select a solution that can be tested in the short-term. Continue to study automated vehicle technology that improves safety in Toronto's TTC vehicle fleet.

PSV.2.2 Non-Passenger AVs for City Services

Proposed Tactic: Support the research and development of non-passenger AVs that can provide municipal services.

Since many services provided by the City occur along fixed routes (e.g., snow clearing, street cleaning, waste and recycling collection), there could be an opportunity to deploy non-passenger AVs (NPAVs) to supplement the existing suite of City services. Non-passenger AVs (NPAVs) for City services Automating service vehicles to improve the safety and efficiency of public service delivery could consist of automating certain driving functions or deploying fully automated vehicles.

Toronto recently hosted the Institute of Navigation's (ION) 9th Annual Autonomous Snowplow Competition, in which teams of university and college students used high-performance autonomous vehicle guidance, navigation, and control technologies to design an autonomous snowplow vehicle capable of removing snow from predefined paths.[129] Such a technology could provide snow clearing services where current vehicles cannot reach, such as narrow sidewalks.

Building from the potential of this emerging technology and others, the City will support the research and development of non-passenger AVs that can provide new and improved City services.

Proposed progress to 2022: Assess potential non-passenger AV options available for City Services. Scope its viability, including an analysis of cost and operational effectiveness; and implement a solution for immediate City needs within the next three years. Test the success of an NPAV snowplow pilot.

PSV.2.3 Contracted Service Vehicles

Proposed Tactic: Manage the transition to AVs by ensuring long-term contracted services account for the ability to upgrade technology over the contract term. Develop and implement standards for the integration of partial automation into contracted services.

The City of Toronto's Fleet Services Review/ Strategy recommends subletting contracts for maintenance and repair, as well as better managing supplier contracts for improved performance standards.[125]

Recognizing that many of the City's services are provided via long-term contracts – the City will ensure that the transition to AVs is captured in these partnerships as well, by maintaining its ability to upgrade technology over the contract term, as well as developing and implementing standards for the integration of partial automation that will improve the delivery of contracted services.

Proposed progress to 2022: Research and learn about the potential options to integrate AV technology into contracted vehicles during the contract term. Identify any potential issues that may arise in integrated this technology into a new term; and engage and consult with relevant stakeholders to discuss barriers and opportunities.

PSV.2.4 Data Collection

Proposed Tactic: Develop and implement a mechanism to collect urban environmental data from automated fleet vehicles. This data collection should support improved road safety, traffic management, transportation planning, asset management and transportation network security, consistent with Privacy by Design principles.

Data can be collected from public service vehicles for increased integrity and accountability, including: collision reporting, accuracy data, data on the role of the vehicle vs. the driver, fuel data, and more.

This data will be used to improve for the overall improvement of service delivery through aspects of vehicle safety, traffic management, and asset management.

Proposed progress to 2022: Research and learn about the potential safety, traffic management, transportation planning, asset management, and network security improvements that could arise from AV fleet data collection. Engage and consult with stakeholders, including the Provincial and Federal governments, to assess how to integrate a data collection mechanism that is cost effective, and secure.

Additional Research

AR.1 Multimodal Level of Service

Proposed Tactic: Develop and implement a mechanism to establish performance measures that ensure efficient movement of people and goods in an automated vehicle environment.

Measuring the performance of a given street or network for all users can pose challenges for transportation planners. Traditionally, level of service (LOS) has been one of many tools that employed to assess traffic conditions in cities, measuring the delay experienced by motorists at a given intersection. However, as cities embrace a multimodal future, new performance measures are needed to assess conditions for all users – pedestrians, cyclists, transit, and vehicles (passenger and freight). These measures should capture potential benefits as well as risks.[130]

Pedestrian measures might include walkability ratings, minimal delay at crossings, foot traffic volumes and public life surveys. Cyclist measures could include travel time and delay, bicycle counts and the Bicycle Environmental Quality Index. Transit measures could include on-time performance, ridership per revenue hour, and average speed. Vehicle performance measures could focus on safety (i.e., rate of crashes, injuries, and fatalities) travel time, freight delivered by hour and time spent loading and unloading.[130] AVs provide an opportunity to reimagine how we assess the performance of city streets.

AR.2 Land Use Planning

Proposed Tactic: Research potential impacts of automated vehicles on land use planning regulations, standards, and guidelines.

AVs will change more than just transportation – having an impact on the structure of our streets, cities, towns and neighbourhoods. On the one hand, this technology could increase the use of personal vehicles, which would exacerbate sprawl, congestion and pollution. On the other hand, if used predominantly through shared modes, there may be a reduction in the need for parking and expansion of roads, and increased potential to repurpose public space for uses such as businesses, green space, and walking/ cycling infrastructure. [131]

Regardless of the direction this technology may take, what remains true is that the City of Toronto must prepare for these impacts by researching how land use planning regulations, standards, and guidelines may need to change in line with AVs.

AR.3 Parking Demand

Proposed Tactic: Research potential impacts of automated vehicles and emerging practices in updating parking demand forecasts and capacity requirements, as well as local parking authority services.

Research regarding the impact from AVs on parking often refers to predictions around more fleet-based shared travel, narrower vehicle sizes, and ultra-precise navigation technology - which would drastically reduce the need for parking.[132] A McKinsey & Company report predicted that by the middle of this century, driverless cars could cut the need for parking in the US by more than 61 billion square feet.[133]

Developers of projects being planned today already see parking garages as a changing investment, as more people are driven to places and events through private transportation companies like Uber or Lyft. These companies have increasingly shifted the priority for planners

from parking, to managing the competition for curb space. Designers have begun envisioning parking garages and lots as flexible structures that can be adapted for other commercial and residential uses.

By researching impacts from AVs on parking demand and capacity requirements, the City of Toronto will be able to make the investments needed ahead of time – saving future costs of converting this infrastructure if needed. This study will allow Toronto to prepare, regardless of the outcomes of AV integration.

AR.4 Strategic Foresight

Proposed Tactic: Research and forecast broader societal changes that could impact the transportation system.

Macro-level trends – demographic, immigration, political and consumer trends – have historically had a widespread effect on transportation systems. For example, the City's current transportation network emerged and evolved largely as a product of the post-World War II baby boom. The infrastructural legacy of that era had considerable influence on transportation technology and policy which followed.

The effects of these macro-level societal trends tend to manifest over decades, not months or years. As new generational cohorts continue to influence broader society, it will be important to consider their potential effects or influence in the context of an emerging new mobility system including AVs.

AR.5 Mobile Production

Proposed Tactic: Research potential impacts of AVs and mobile food preparation and manufacturing (e.g. 3D printing) and the City's ability to regulate these activities while taking place on moving vehicles.

Modern zoning, which separates land based on its use, emerged partly in response to the heavy industrial activities of the 19th- and 20th-century, where large industrial plants brought noise, pollution, smoke, odours and freight traffic to the city. The City of Toronto's current Zoning By-law 569-2013, for example, restricts all manufacturing and processing activities to Employment Industrial zones.[134]

However, emerging models of small-scale, light manufacturing and food-processing activities bear little resemblance to the production activities of the past. Multipurpose AVs are being developed, which can not only move people, goods but also serve as mobile spaces for businesses such as delivery vehicles where food is prepared en route or 3D printing workshops.[135]

While this model could open up new business opportunities for residents, it will need to be carefully monitored to ensure that commercial or light industrial uses do not pose a nuisance or hazard. The City of Toronto will explore the potential impacts of mobile production, and its role in regulating business activities which produce food, beverages, or other goods in limited quantities.

AR.6 Mobility Marketplace

Proposed Tactic: Research potential impacts of domination of the mobility marketplace by a small number of global providers and the City's ability to regulate or influence an appropriate level of competition and support for local companies.

The shift towards a mobility marketplace in which new platforms enable consumers to make choices that offer them the greatest value and convenience at the lowest price point is underway. Both the auto industry and newer entrants to the mobility field like Waymo, Uber and Lyft are investing heavily in developing their own mobility products and services.[136]

However, technology – in the form of algorithms, machine learning, and artificial intelligence (AI) – now play a significant role in many companies' business models. These technological advances which help to enable greater mobility choices could also lead to collusion between competitors and the formation of cartels among mobility service providers.[20]

As this marketplace changes, it will be essential to ensure Torontonians continue to have a wide range of mobility options. The City of Toronto aims to research how this will impact local businesses and residents especially if there is limited competition within the mobility marketplace.

Future-Proofing

FP.1 Travel Demand Modelling

Proposed Tactic: Research and develop tools to test emerging practices in updating travel demand models to accommodate AVs.

Travel Demand Models are computer programs which predict how people use transportation systems. They are used to test the implications of infrastructure (e.g. the addition of a new road or higher-order transit line), policy (e.g. changes to transit service levels or fare policies) or technology (e.g. AVs) changes on future travel patterns.

These predictions of future travel patterns are based on projected land use, demographics, and the region's existing travel patterns, through variables such as population, employment, households, current travel behaviour, and more. Outputs can include traffic volumes for various roadway segments, ridership on transit routes, and travel times.

A variety of modelling tools can be used to understand the impacts of automated and autonomous vehicles. A few potential changes that could be considered to expand AV modelling capabilities include changes to: vehicle ownership & availability, coordinated activity patterns, location choice and land use, mode share and network supply.[137]

This modelling exercise will improve the City's capability to predict travel behaviour changes associated with the introduction of AVs and the implications of possible AV-related policies.

FP.2 Building Standards

Proposed Tactic: Research and consider development of new or improved building standards that allow for flexibility in retrofitting buildings for future needs associated with AVs.

Land use and transportation patterns are inherently linked together; AVs could radically change both of these. As a result, the way we use buildings might change significantly. Some potential impacts to the future of building design with the introduction of AVs, including:[138]

- *'Smart' buildings that can communicate with vehicles*
- *Increased pick-up and drop-off at buildings that could impact building design*
- *Changes to utility infrastructure, including charging stations*
- *Minimized parking or flexible parking infrastructure for other uses. Design considerations could also include reducing sloped surfaces, ducting for future utilities, outside light for beautification, and designing for lower loads*
- *Consideration for CAV vehicle access*
- *Building exits and fire safety considerations*

These are just some of the impacts that the City of Toronto can begin researching through the Plan's Tactic on 'Building Standards."

FP.3 Planning and Investment

Proposed Tactic: Research emerging practices in updating forecasts and infrastructure investment decisions to accommodate future needs associated with AVs.

AVs will challenge the existing business models of transportation providers and infrastructure developers. This model includes public authorities incorporating fixed, physical infrastructure with no smart capabilities that can only be used by human-operated vehicles. This system limits the parameters of vehicle advancements, including traffic management improvements.[139]

Transportation-infrastructure providers will need to consider changes to infrastructure investment based on consumer attitudes related to AVs. With an uptake in AV use, highway authorities will need to understand how these vehicles see – whether that includes updating the maintenance of infrastructure or connected vehicle technology altogether. For Toronto, this is especially important as it pertains to inclement weather like snow or fog – and assisting these vehicles in "seeing" better by customizing infrastructure to improve its visibility for AVs. There is also an opportunity for infrastructure providers to share information through infrastructure for better travel and ease for all road users.

The City will research emerging practices in updating forecasts and infrastructure investment decisions to ensure that any future needs of AVs are addressed in the correct timeframe.

Tactical Plan Governance

GOV.1 Collection of Data from Third Parties

Proposed Tactic: Develop and implement a policy and mechanism to collect data from automated vehicles using the transportation system. This data should support improved road safety, traffic management, transportation planning, asset management and transportation network security, consistent with Privacy by Design principles.

Connected and autonomous vehicles will be a rich source of data due to their high-quality sensors, fast processing capabilities, and extensive travel. These vehicles will be able to collect everything from "hyper-local weather data, to the quality of road-side lighting," that can be shared with the appropriate parties in the network to assist in their day-to-day activities.[140]

The City of Toronto could potentially be informed when signage and infrastructure needs to be fixed, providing savings, faster response times, and greater public benefit. Regardless of how fast these vehicles are introduced however – data optimization will be needed to shape how this data is shared, impacted in large-part by operational and regulatory requirements from each level of government.

GOV.2 Data Tools

Proposed Tactic: Develop and implement robust tools to support new data streams from automated and connected vehicles.

AVs generate an immense amount of data – potentially several terabytes of data in eight hours of operation.[141] With such a large amount of data needing to be shared, these networks will demand faster and more flexible infrastructure and tools in place to adapt to unexpected problems.

Governments will need to invest in robust tools that can help reduce data delays, and minimize the reliance on network data centres, while maintaining the privacy and security of the public with communication through them.

When introducing regulation around AVs internationally, many jurisdictions required reporting on every disengagement, near-miss, or technological malfunction by these vehicles. Under the Province of Ontario's AVs Pilot Project (Ontario Regulation 306/15 of the *Highway Traffic Act*) collision reporting is also a requirement to receive a permit.[142]

For example, as a condition of receiving a testing permit, manufacturers could be required to record mileage driven and report on every incident wherein a human safety driver had to resume operation of a vehicle for safety reasons, providing a glimpse into AV testing and how the technology is performing. This transparency in reporting the successes – and failures – of AV technology is essential to bolstering public trust.

GOV.3 Monitoring Indicators

Proposed Tactic: Develop and implement robust indicators to monitor the transition from human-driven vehicles to automated vehicles as well as their associated impacts on the transportation system and delivery of City of Toronto services.

The Tactical Plan is based on available products, and predictions around when highly AVs will be introduced on Toronto's streets. It has been built with the understanding that there is still a lot of uncertainty within this industry – and that the City of Toronto should focus on taking action on items that are relevant in the short-term.

As this technology develops, impacts to the transportation system and delivery of City of Toronto services will emerge, and the City's predictions around what those may be, could change. As such, monitoring indicators are an important aspect of measuring the validity of this Plan. City staff will develop and implement indicators to monitor the transition from human-driven vehicles to AVs, as well as their associated impacts on our organization, to ensure that the Tactical Plan continues to develop with these changes.

REFERENCES

123 Volvo Group (2017) 'Volvo pioneers autonomous, self-driving refuse truck in the urban environment'. , 17th May. [online] Available from: https://www.volvogroup.com/en-en/news/2017/may/news-2561936.html

124 The City of Toronto and City of Toronto (2014) *City of Toronto Consolidated Green Fleet Plan 2014-2018*, Fleet Services. Adopted by City Council on June 10. [online] Available from: https://www.toronto.ca/wp-content/uploads/2017/11/9b29-fleet-services-consolidated-green-fleet-plan-2014-2017.pdf

125 City of Toronto (2015) *Fleet Services Review - Strategy for the Fleet Services Division*, Fleet Services. Adopted by Government Management Committee on September 17, 2015. [online] Available from: http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.GM6.1

126 City of Toronto (2013) *Strategic Actions, 2013-2018*, City Manager's Office. Adopted by City Council on October 8, 2013. [online] Available from: https://www.toronto.ca/city-government/accountability-operations-customer-service/city-administration/city-managers-office/key-intiatives/strategic-actions/

127 City of Toronto (2007) *Driver/Operator Fleet Safety Policy*, Fleet Services. [online] Available from: http://publiccommons.ca/public/uploads/fleet_safety_policy.pdf

128 Moysa, Geoff and Koczerginski, Mitch (2016) *The Cybersecurity Implications of Driverless Cars*, McMillan LLP. [online] Available from: https://mcmillan.ca/Files/196067_The_Cybersecurity_Implications_of_Driverless_Cars.pdf

129 Institute of Navigation (ION) (2019) 'The ION Autonomous Snowplow Competition'. [online] Available from: http://www.autosnowplow.com/welcome.html

130 National Association for City Transportation Officials (2013) 'Urban Street Design Guide: Performance Measures'. [online] Available from: https://nacto.org/publication/urban-street-design-guide/design-controls/performance-measures/

131 Union of Concerned Scientists (2017) *Maximizing the Benefits of Self-Driving Vehicles*, [online] Available from: https://www.ucsusa.org/sites/default/files/attach/2017/02/Maximizing-Benefits-Self-Driving-Vehicles.pdf?_ga=2.150812529.619532699.1553549501-26107014.1553549501

132 Jencek, Brian and Unterreiner, Jerome (2018) 'People-Driven Design: Planning for the Urban Future of Autonomous Vehicles'. *Urban Land*, 24th May. [online] Available from: https://urbanland.uli.org/planning-design/people-driven-design-planning-urban-future-autonomous-vehicles/

133 Bertoncello, Michele and Wee, Dominik (2015) 'Ten ways autonomous driving could redefine the automotive world'. *McKinsey Automotive & Assembly Insights*. [online] Available from: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world

134 Toronto, City of (n.d.) *Zoning By-Law 569-2013*, [online] Available from: https://www.toronto.ca/city-government/planning-development/zoning-by-law-preliminary-zoning-reviews/zoning-by-law-569-2013-2/

135 CNN (2018) 'SoftBank and Toyota want driverless cars to change the world'. *CNN Money*, 4th October. [online] Available from: https://www.nbc-2.com/story/39228097/softbank-and-toyota-want-driverless-cars-to-change-the-world

136 Copel, Noam (2018) 'Transportation Will Become a Giant Mobility Marketplace'. *Medium*, 17th May. [online] Available from: https://medium.com/davnetwork/transportation-will-become-a-giant-mobility-marketplace-833fc4b80e89

137 TRB Special Committee for Travel Forecasting Resources (2018) 'Autonomous vehicles: Modeling frameworks'. *TFResource*. [online] Available from: http://tfresource.org/Autonomous_vehicles:_Modeling_frameworks

138 Voll, Steven (2016) 'How connected, self-driving vehicles could change building design'. *Ideas*, 14th September. [online] Available from: https://ideas.stantec.com/blog/what-do-connected-and-autonomous-vehicles-mean-for-the-future-of-buildings

139 Bamonte, Thomas J. (2013) 'Autonomous Vehicles: Drivers of Change'. *TM&E*. [online] Available from: https://www.roadsbridges.com/sites/rb/files/05_autonomous vehicles.pdf

140 Marshall, Bryan (2018) 'Why smart transportation needs data sharing'. *Autonomous Vehicle International*, 21st December. [online] Available from: https://www.autonomousvehicleinternational.com/opinion/why-smart-transport-needs-data-sharing.html

141 Chala, Arjuna (2019) 'Autonomous Cars, Big Data, and Edge Computing: What You Need to Know'. *DZone*, 19th February. [online] Available from: https://dzone.com/articles/autonomous-cars-big-data-and-edge-computing-what-y

142 Ontario. Legislative Assembly (2015) *O. Reg. 306/15: Pilot Project – Automated Vehicles*, Made under Highway Traffic Act, R.S.O. 1990, c. H.8. Filed October 13. [online] Available from: https://www.ontario.ca/laws/docs/R15306_e.doc