



Preparing for Automated Vehicles at the City of Toronto

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City of Toronto and AVs

The City of Toronto does not have an official policy or position on automated and/or autonomous vehicles.

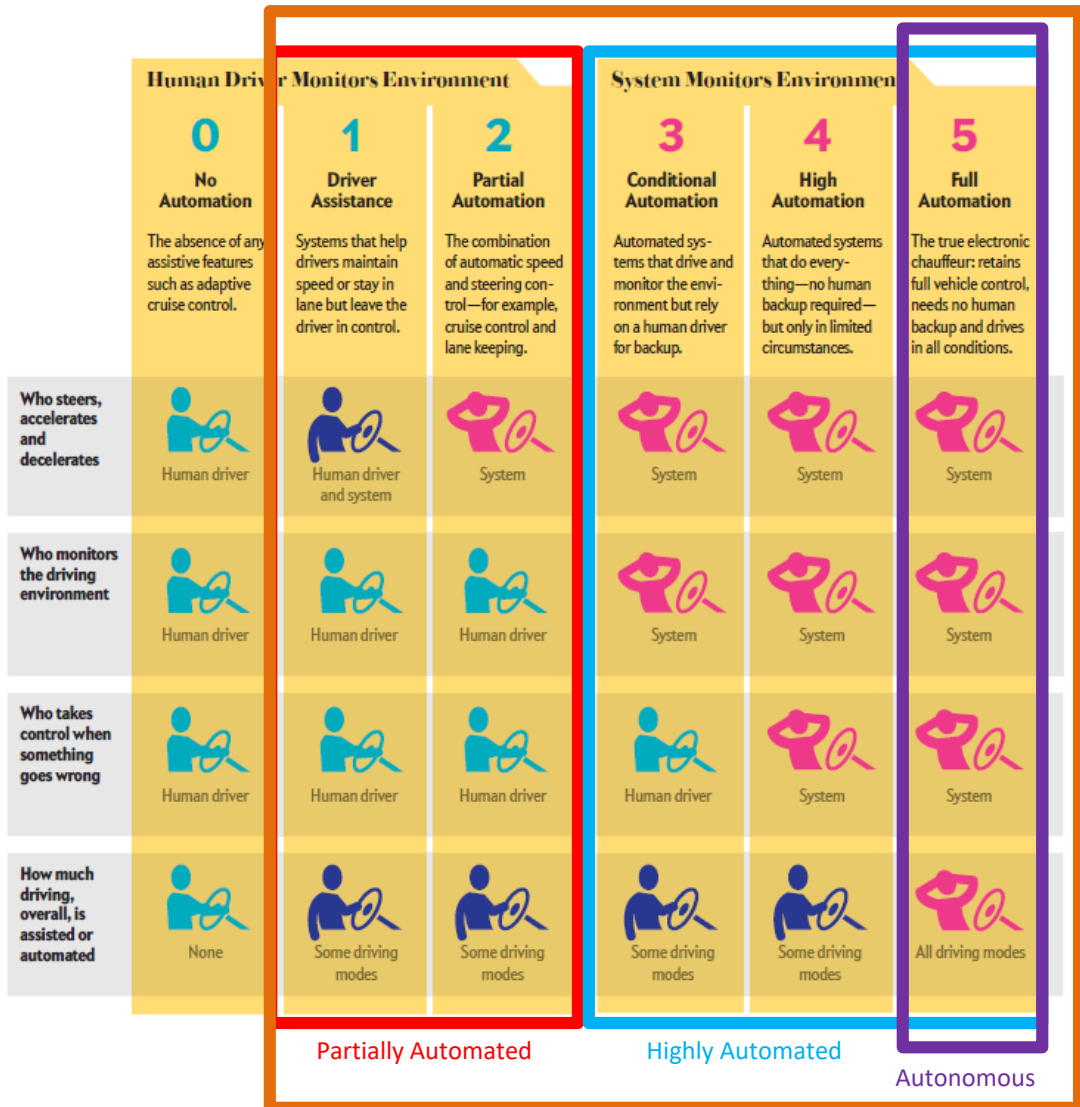
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What is an Automated Vehicle?

Automated vehicles are those in which at least some aspects of a safety-critical control function (e.g., steering, throttle, or braking) occur without direct driver input.

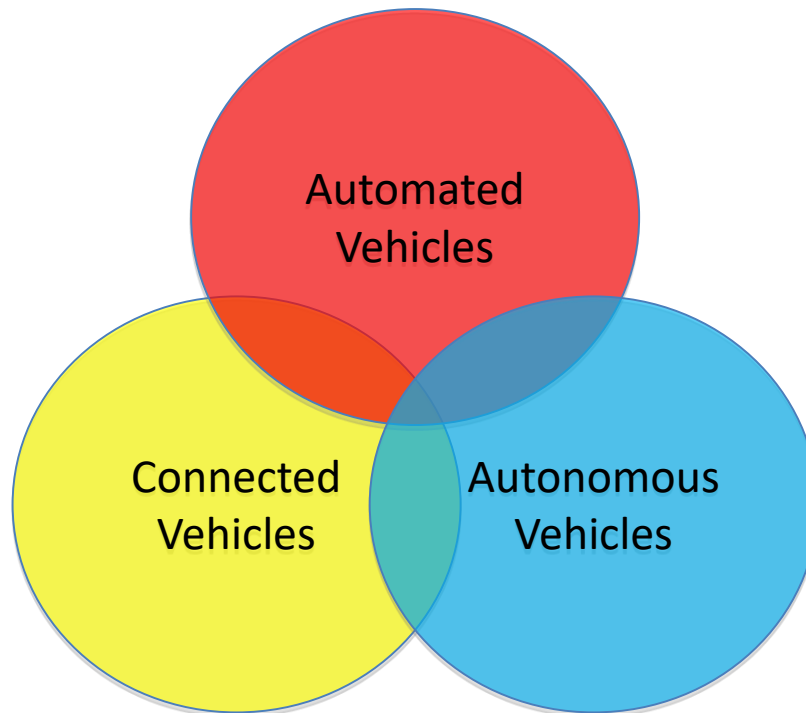
- Source: NHTSA Preliminary Statement of Policy Concerning Automated Vehicles (May 30, 2013)
- Vehicles can be partially or fully automated. This scale from the Society of Automotive Engineers illustrates the differences.



Automated

What is a Connected Vehicle?

Connected vehicles communicate with other vehicles (“v2v”), infrastructure (“v2i”), or more through various technologies and networks (“v2x”).



Vehicles may be automated, connected, or autonomous, or any combination thereof.

When Will AVs Arrive on City Streets?

- Partial automation is already here (see next slide).
- Reports on commercial availability of fully automated passenger cars varies, with some companies predicting product availability as early as 2018.
 - Traditional automakers (Ford, GM, Volvo, etc.) and technological companies (Google/Alphabet, Uber, Apple, etc.) are working to develop fully automated vehicles. While automakers are introducing partial automation incrementally, technology companies are more focused on fully autonomous vehicles.
- Widespread adoption has been predicted by the U.S. Department of Transportation and McKinsey & Company to occur between 2030 and 2040.

Evolution or Revolution?











Evolution

- An extension of early features like cruise control, lane centering; step through levels of automation
- Driven by existing automobile manufacturers
- Iterative integration of hardware and software
- Direct to consumer market
- Already here

Revolution

- Redesign of automobile control; jump to SAE automation level 4 or 5
- Driven by technology and transportation network companies; some automobile manufacturers
- Direct to consumer and service replacement markets
- A few – or many – years away

Industry Timelines – Passenger Vehicles

Manufacturer	2016	2017	2018	2019	2020-25	2025-30	2030-35	2035-40	2040+
 Audi	2		3		3+	4			
 BMW	2				4				
 Ford				2	4				
 HONDA	2				3				3-4
 KIA					3		4		
 Mercedes-Benz	2								
 NISSAN	2		3		4				
 TESLA	2		4						
 VOLVO  UBER	2	4							

Source: Mashable

Uncertainties

- Technological application and extent of adoption/availability
- Extent of disruption to current business models
- Changes to public and private sector roles
- Public acceptance
- Impact on transportation system and demand



Photo Credit: Ohio State University

Uncertainties – Passenger Use

- Walker Smith: “Everything somewhere, or something everywhere?”
- Geography: Asia vs. Europe vs. North America (USA)
- Transition period – how long, and how functional?
- Automation Myths (“Our Robots, Ourselves” by David A. Mindell)
 - The Myth of Linear Progress
 - Is Level 5 even possible? US NTSB Chair says no.
 - The Myth of Replacement
 - Leader-follower systems and platooning
 - Human control removed in space; standby remote taxi drivers? Copilots?
 - The Myth of Full Autonomy
 - Human action removed in time

Uncertainties – Business Models

- Which applications have the strongest business case?
 - Local freight (personal deliveries)
 - Long-distance freight (trucking)
 - Local passenger (urban)
 - Private ownership
 - Shared/fleet ownership
 - Long-distance passenger (expressway/interurban)
 - Closed environments (campus, industrial site)
 - Service vehicles (road maintenance, waste collection)
 - Novelty (Segway!)

Uncertainties – Public and Private Sector

- Transportation network companies and transit
- Connected vehicle infrastructure
- Maintenance of existing public assets (traffic control devices)
- Mapping, work zones, and incident reporting
- Data collection and analysis
- Provision of public information and routing
- Traffic management and rules of the road

Uncertainties – Partial Automation Safety

- Misuse of the technology
 - Level 2 used as Level 3 or 4 or 5
- Driver inattentiveness
- Human factors
 - Transitioning from automation to manual driving
 - Fighting for control
 - Disabling features



Public Opinion

TRANSFORM

Are GTHA Residents Ready for Autonomous Vehicles?

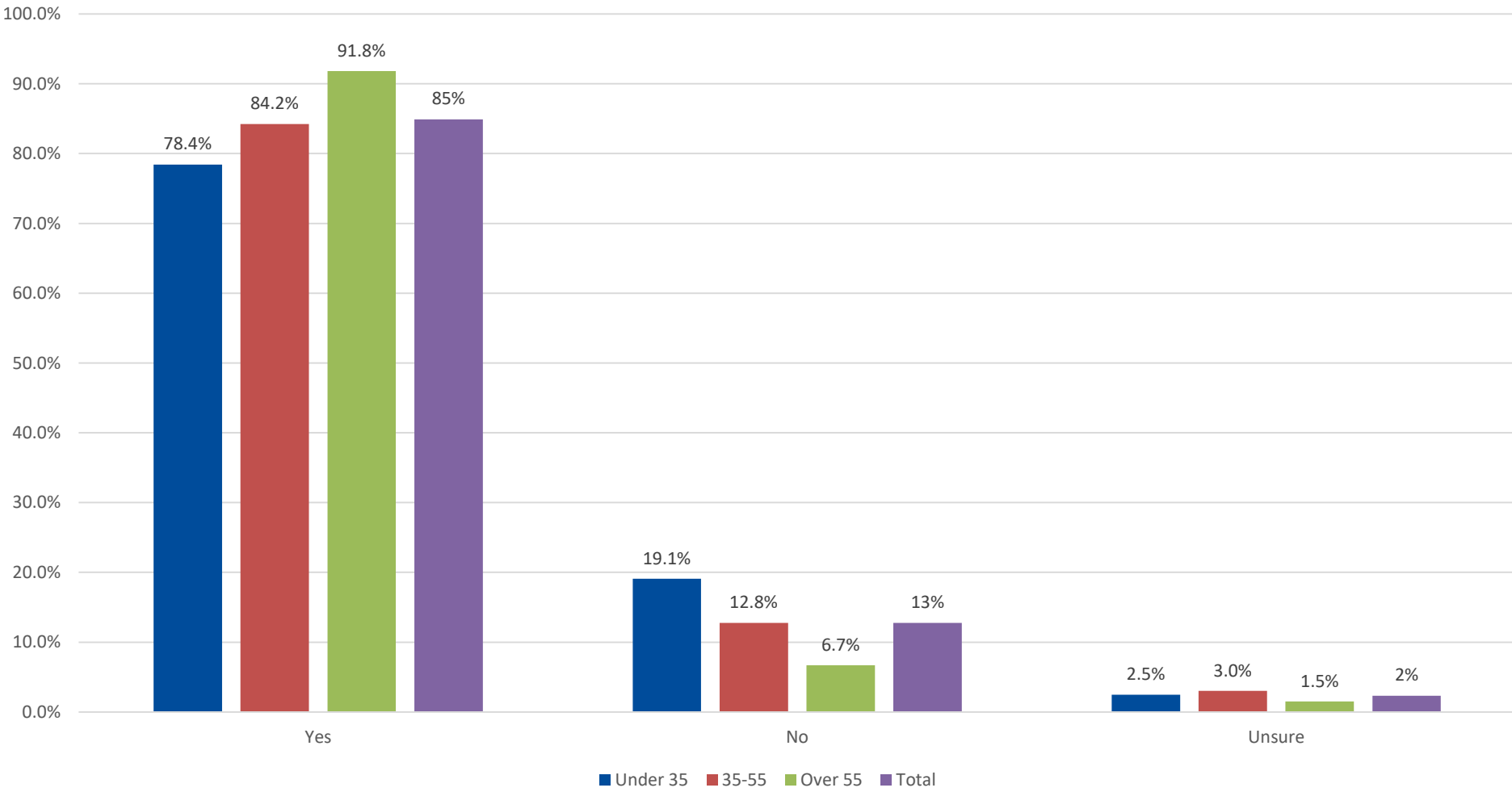
Survey Overview
November 24, 2016

Sweet, Matthias; Laidlaw, Kailey; Olsen, Tyler

Transportation and Land Use Research
Laboratory at Ryerson University

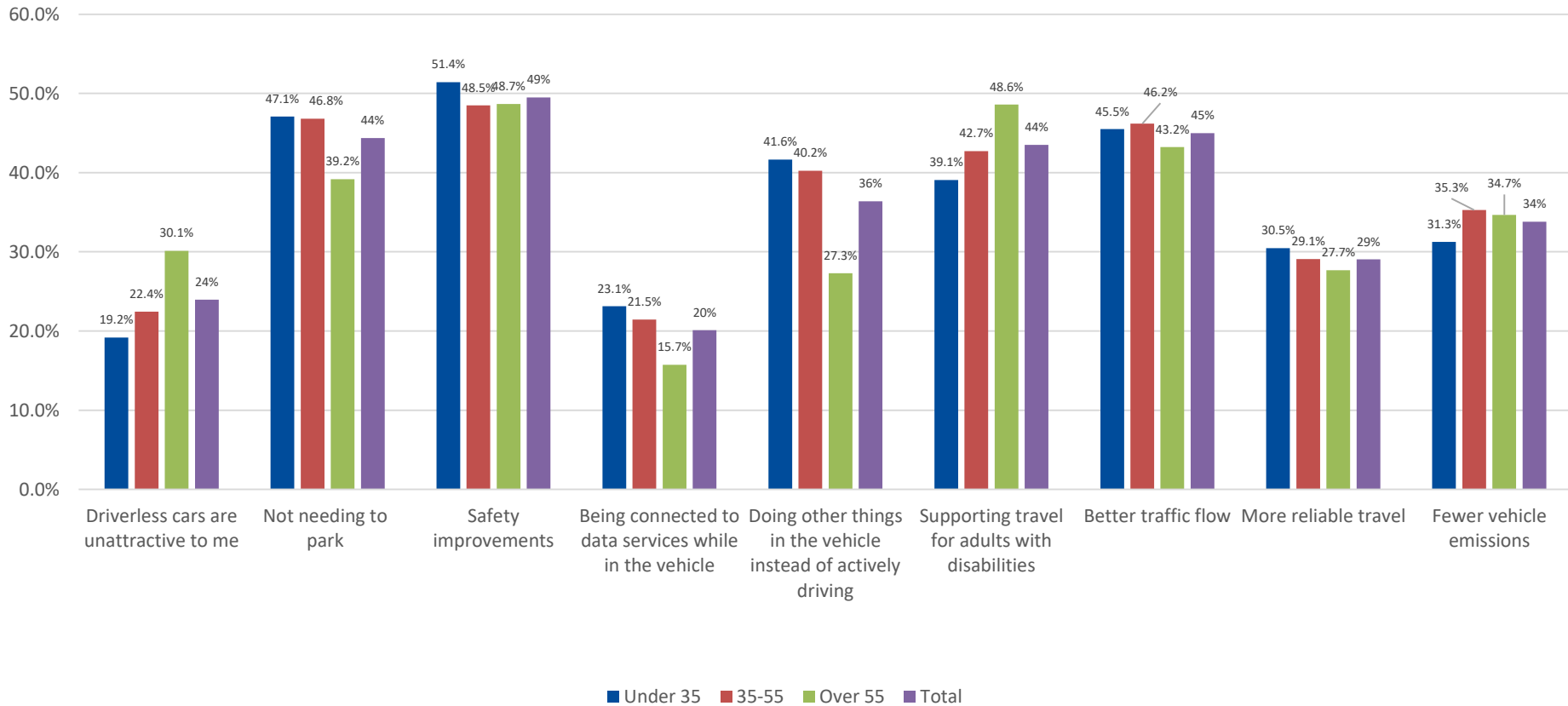


I have heard of a driverless car before today

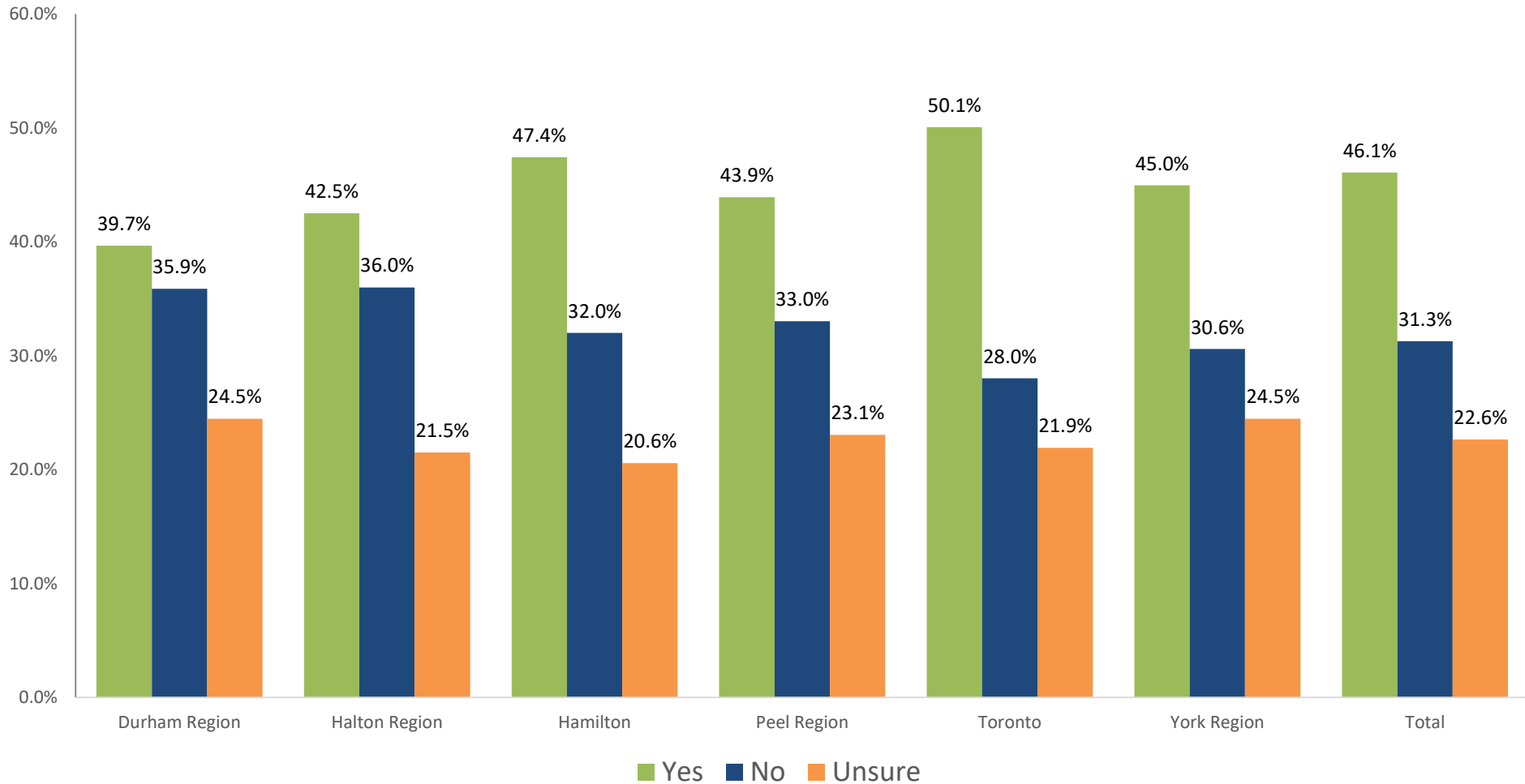


Which of the following potential benefits of driverless cars are most attractive to you?

AV Attractiveness (% Of Respondents that said Yes)



Suppose using a driverless vehicle does not enable you to go faster, but enables you to now use that travel time for other activities while traveling. Would you be likely to travel further to work (e.g. for a better job or less expensive housing)?



Jurisdictional Considerations



Source:



What is the Status of AVs in Ontario?

- The 2014 mandate letter from the Premier to the Minister of Transportation called for the establishment of a regulatory framework for autonomous vehicles.
 - <http://www.ontario.ca/page/2014-mandate-letter-transportation>
- The Ministry of Transportation of Ontario has established a 10-year pilot testing framework starting January 1, 2016.
 - <http://www.ontario.ca/laws/regulation/r15306>
- The Province has established a Connected Vehicle/Autonomous Vehicle (CVAV) Program worth \$1 million to...“(encourage) business and academic institutions to develop and commercialize innovations in connected and autonomous vehicle technologies, with a focus on projects that show a strong potential for commercialization.”
 - <http://www.oce-ontario.org/programs/industry-academic-collaboration/cvav-research-program/how-it-works>
- The 2016 mandate letter from the Premier to the Minister of Transportation called for the establishment of a Centre of Excellence for autonomous vehicles by 2018.
 - <https://www.ontario.ca/page/september-2016-mandate-letter-transportation>

What is the Status of AVs in Canada?

- No other testing frameworks
- Transport Canada? Connected vehicles?
- Follow US developments? US DOT AV Policy released in September
- Increased municipal interest – Edmonton, Calgary, Vancouver reports
- Industry associations – NACTO, TAC, OGRA, CUTA, ITS, etc.

What is the Status of AVs in Toronto?

- No official position
- City Council direction to report
- Staff discussions and strategizing
- Academic partnerships
- Networking with other cities
- Research and exploratory projects



City of Toronto and AVs: Impacts



...more?

- Transportation Services
- City Planning
- Municipal Licensing & Standards
- Economic Development & Culture
- City Clerk
- Information & Technology
- Engineering & Construction Services
- Legal Services
- Public Health
- Financial Planning
- Revenue Services
- Fleet Services
- Equity, Diversity & Human Rights
- Employment & Social Services
- Office of Emergency Management
- Solid Waste Management
- Environment & Energy
- Toronto Fire Services
- Toronto Paramedic Services
- Toronto Building
- Toronto Transit Commission
- Toronto Parking Authority
- Toronto Police Services

City Council Direction – Public Works and Infrastructure Committee

May 16, 2016 – PW13.14

- The Public Works and Infrastructure Committee requested the General Manager, Transportation Services, to report back to the Public Works and Infrastructure Committee no later than the fourth quarter of 2016 with recommendations on how the City of Toronto might prepare for the introduction of automated and autonomous vehicles. The report should outline the following:
 - a. Specific actions planned by Transportation Services to prepare for automated and autonomous vehicles over the next two years;
 - b. An overview of potential implications that could be experienced by other divisions as a result of vehicle automation, and where possible, options for mitigating impacts; and
 - c. An overview of the public's potential acceptance of automated and autonomous vehicles, and how it compares to other jurisdictions.

City Council Direction – Executive Committee

September 22, 2016 – EX17.29 (was MM20.8)

- City Council request the City Manager and the General Manager, Transportation Services to enter into dialogue with the Government of Canada, the Government of Ontario, other municipalities, academic institutions and private sector groups within the City of Toronto to work towards the establishment of a multi-jurisdictional task force with a mandate to prepare for the introduction and extensive use of automated vehicles by private users, the public and private sector entities.

City of Toronto and AVs - Staff Approach



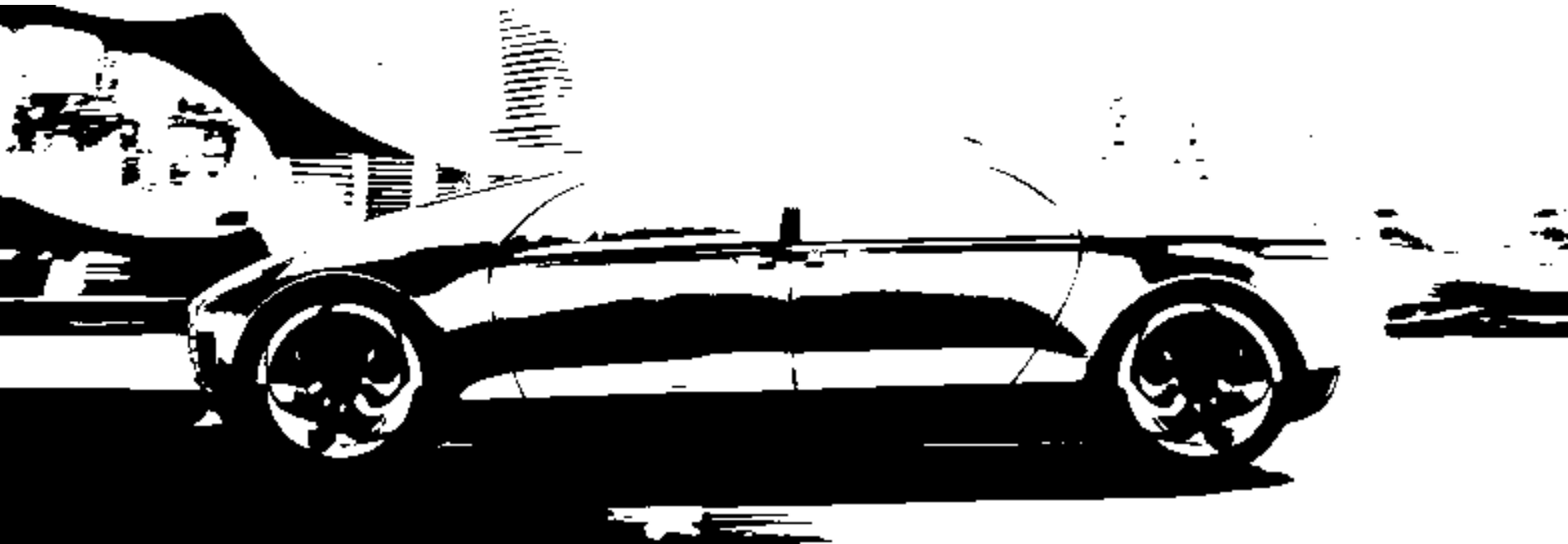
Acceptance Spectrum

AVs and the City of Toronto

Are AVs coming? When?

- Automated and autonomous vehicles (AVs) will have a noticeable presence in the transportation system within the next ~~2~~ years.

5-10



AVs and the City of Toronto

Do AVs require action? When?

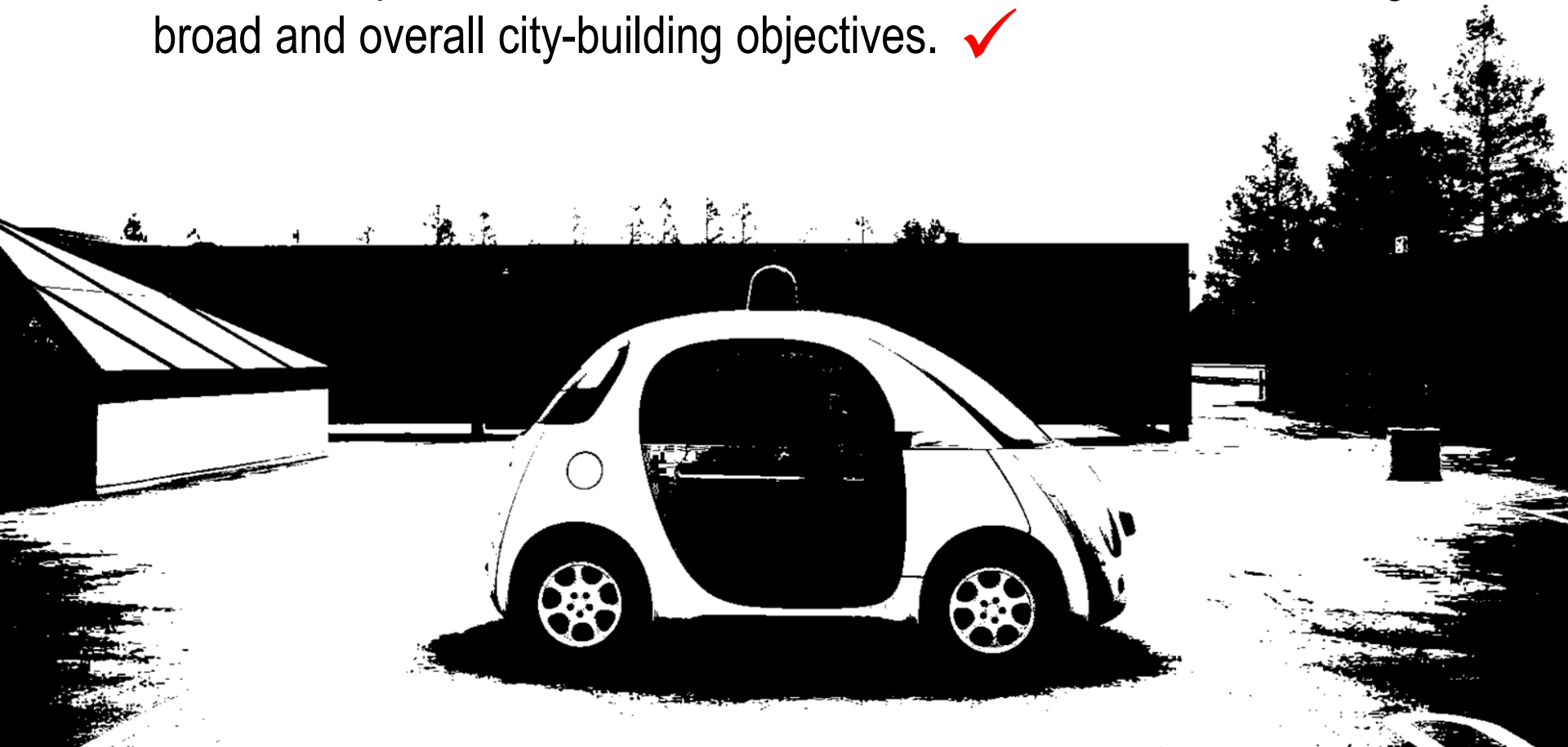
- Need to prepare for the arrival of AVs – now. ✓



AVs and the City of Toronto

Are AVs an opportunity? How?

- Need to be proactive to ensure that AVs serve to advance existing broad and overall city-building objectives. ✓



AVs and the City of Toronto

Will AVs create change? To what extent?

- No consensus.



City of Toronto and AVs - Timeline



- Jan 2014 – Monitor AV developments, identifying industry stakeholders
- Dec 2014 – Establish dialogue with other municipalities (NACTO, Canadian cities)
- Mar 2015 – Workshop: Stakeholder education (CAVCOE)
- Jul 2015 – Presentation: City of Toronto Senior Management Team
- Jul 2015 – AV Working Group (Transportation Services)
- Sept 2015 – Extensive review (University of Toronto)
- Oct 2015 – “Driving Changes” (University of Toronto)
- Dec 2015 – Workshops: Stakeholder engagement (University of Toronto)
- Feb 2016 – Outreach to senior governments
- Jun 2016 – AV Working Group (Interdivisional)
- Jul 2016 – Workplan for Transportation Services
- October 2016 – Temporary staff position (Project Lead)
- Fall 2016 – GTHA public opinion research (with Metrolinx and Ryerson University)
- Fall 2016 – Transportation scenario development (Ryerson University)
- Winter 2017 – Review of historical trends and factors in automobility (University of Toronto)
- Spring 2017 – Report to Public Works and Infrastructure Committee and City Council

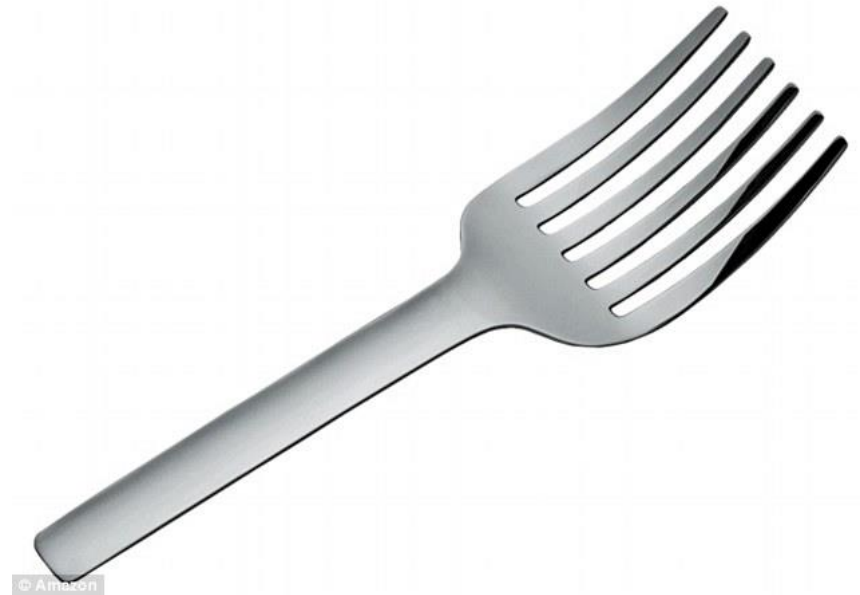


PREPARING FOR AUTONOMOUS VEHICLES

Divisional Workplan 2016-2018

Purpose of the Plan

- Navigate uncharted and changing landscape
- Lay the groundwork for moving ahead, without predetermining the answers.
- Be as technologically agnostic as possible.
- Determine the role of a municipal transportation department, while taking a leadership role amongst the rest of the City of Toronto.
- Prepare a foundation for automation, identifying opportunities to integrate AVs.



Three Goals

1. Leadership and Engagement

- To demonstrate leadership in guiding and influencing the arrival of AVs on Toronto's streets.

2. Preparation

- To prepare for the arrival of AVs no matter when and how they are introduced and adopted.

3. Integration

- To begin to integrate AV-supportive measures into the operations of Transportation Services.

Goal 1: Leadership and Engagement

Objectives	2016	2017	2018
1.1 Internal			
1.1.1 Establish Transportation Services as the lead division for AV knowledge, preparedness, and coordination.			
1.1.1.1 Monitor developments in technology and policy, and share knowledge with other divisions.			
1.1.2 Establish an interdivisional working group to serve as a forum for discussion, collaboration, and coordination on AVs with representatives from key impacted City Divisions.			
1.1.1.2 Identify potential opportunities and implications of AVs and potential mitigating options for other divisions.			
1.1.1.3 Lead the creation of the City's corporate vision and approach to AVs.			
1.1.1.4 Develop a SWOT analysis and workplan for all City divisions to prepare for AVs.			
1.1.3 Provide opportunities for City staff to learn about AVs.			

Goal 1: Leadership and Engagement

Objectives	2016	2017	2018
1.2 External			
1.2.1 Establish the City of Toronto as an international leader in municipal/local government AV preparedness.			
1.2.2 Establish a single point of contact for external agencies to engage with Transportation Services on AVs.			
1.2.3 Develop a communications strategy which includes key messages for all divisions, a public web space on toronto.ca, designation of spokespersons, and identification of key audiences to reach. “Break the glass” plan.			
1.2.4 Influence and guide the development and implementation of AVs by undertaking the following actions:			
1.2.4.1 Engage partner organizations and industry associations to jointly monitor and consider undertaking AV standards and policy development.			
1.2.4.2 Continue dialogue and partnerships with the Ministry of Transportation and Transport Canada to ensure consultation, coordination, and collaboration.			
1.2.5 Conduct a stakeholder mapping exercise to assess stakeholder interests and positions on vehicle automation.			

Goal 2: Preparation

Objectives	2016	2017	2018
2.1 Improve Understanding and Clarity			
2.1.1 Create and maintain a common lexicon of terms and concepts for consistent understanding among municipal partners.			
2.1.2 Identify and understand the broad range of potential opportunities and implications of AVs and in relation to achieving the city's Strategic Plan.			
2.1.3 Define the interests of Transportation Services in vehicle automation across all Divisional functions.			
2.1.4 Undertake public opinion research to assess and establish baseline attitudes toward AVs, expectations of government, and how AVs may influence travel behaviour and modal choice in the GTHA.			
2.1.5 In partnership with the Organization for Economic Cooperation and Development's International Transportation Forum, undertake a modelling exercise to further develop and refine potential scenarios.			
2.1.6 Develop detailed scenarios – ranging from no change, to a completely new transportation paradigm – for consistent forecasting and planning pathways; use these scenarios on a scale of possible to probable.			

Goal 2: Preparation

Objectives	2016	2017	2018
2.2 Prepare a Foundation			
2.2.1 Improve the management and function of traffic control elements			
2.2.1.1 Develop asset management systems for signage and pavement markings.			
2.2.1.2 Review and consider the need for pavement markings on local streets.			
2.2.1.3 Improve the visibility of traffic control devices under all weather conditions.			
2.2.2 Research and investigate the potential costs and benefits, as well as methodologies and technologies, for broadcasting traffic signals.			
2.2.3 Research and investigate the potential role and implications of the introduction of non-passenger AVs.			
2.2.4 Work with mapping providers to investigate the potential for AV-supportive mapping to be conducted in Toronto, and determine the appropriate role for Transportation Services and the City.			
2.2.5 Begin to engage with technology providers, automobile manufacturers, and transportation network companies to discuss municipal preparations and potential pathways.			
2.2.6 Assess which parts of the Municipal Code could relate to AVs.			

Goal 3: Integration

Objectives	2016	2017	2018
3.1.Internal			
3.1.1 Assess potential opportunities and impacts of AVs in all Transportation Services topic-specific strategic plan updates, such as:			
3.1.1.1 Congestion Management Plan, HOV Network Plan, Transportation IT Strategic Plan			
3.1.1.2 Complete Streets Guidelines, Curbside Management Strategy, Road Safety Plan, Wayfind Strategy, Cycling Network Plan, Walking Strategy			
3.1.2 Identify when AVs would need to be considered for new fleet procurement.			
3.1.3 Develop an AV-specific Open Data strategy for Transportation Services, including existing and potential data sources that could support the use of AVs.			

Beyond Transportation: Preparing for AVs

Built Environment

- How might AVs influence or change the Official Plan, Zoning Bylaw, and Building Code?
- How will AVs impact the design of our streets, and be balanced against competing uses?
- Could AVs support City objectives such as improving safety for vulnerable road users and reducing environmental impacts?
- How will AVs impact parking?

Mobility

- Can AVs better support social equity? Access to employment?
- Will AVs contribute to “hypermobility” and greater sprawl, or encourage more density and livability?
- How will AVs impact transit services? When should we consider this in our long-term planning and modeling?
- Will AVs support a growth in electric vehicles? Other fuels?

Beyond Transportation: Preparing for AVs

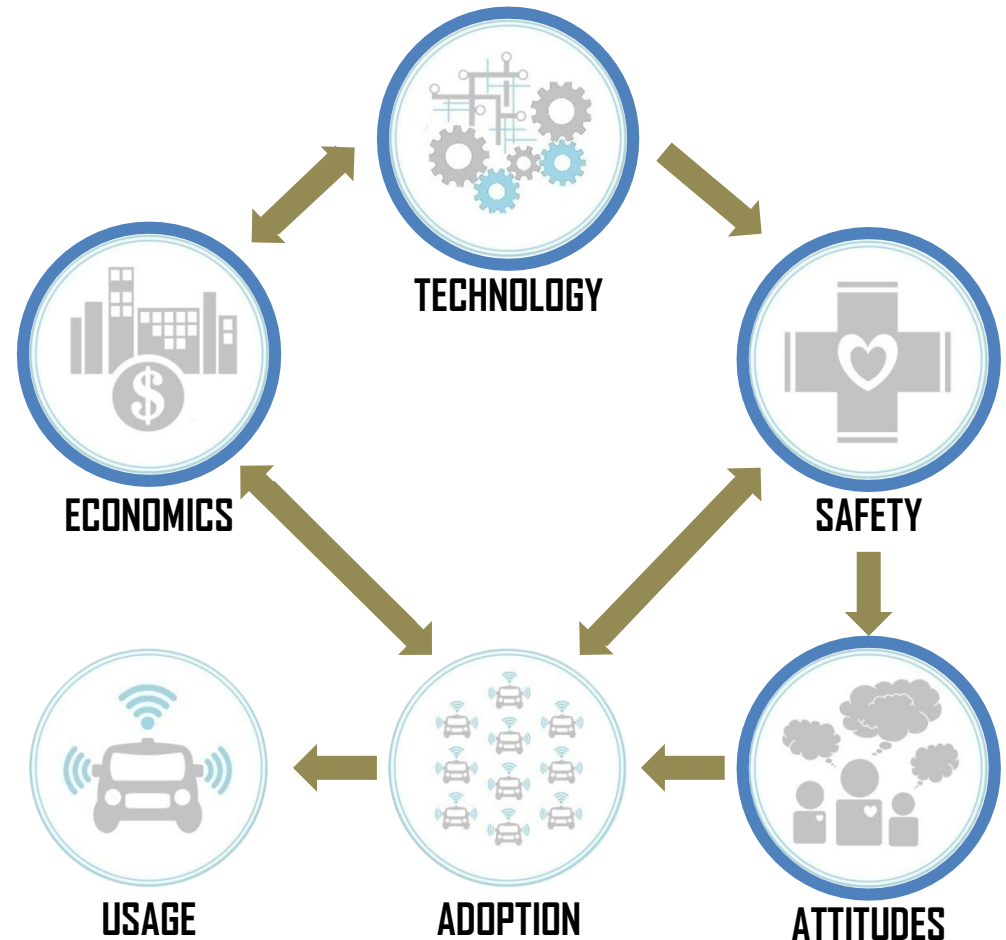
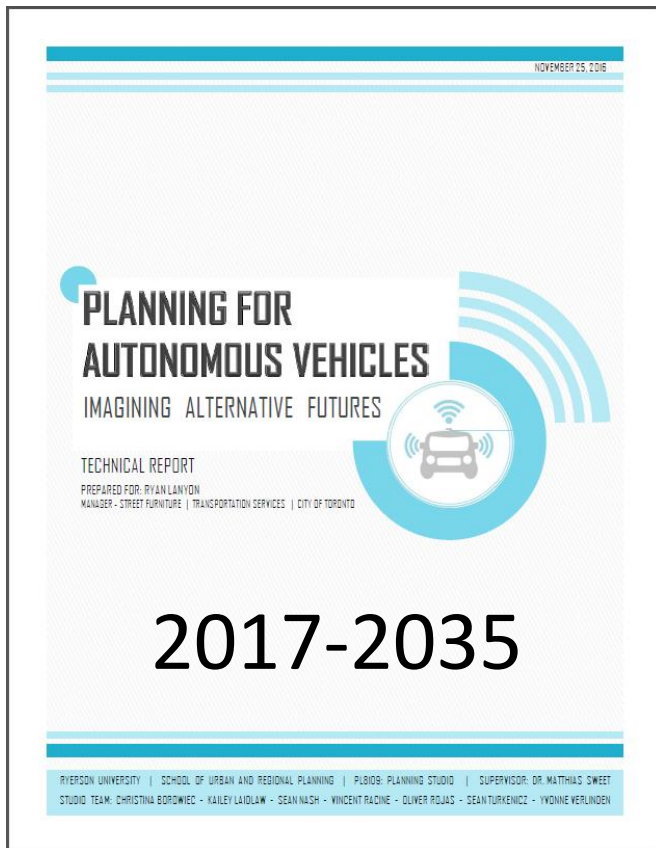
Information and Data

- What data is the City interested in, and how will our role change?
- If data is private, do we risk losing control over mobility planning?
- How do we maintain security and enforcement?
- Will the public understand the data that will be collected, and the implications of it?

Economic Impact

- How proactive does the City want to be in demonstrating leadership in AV adoption?
- Should the City manage or champion change?
- How can the City balance being a leader with the associated financial costs?
- How could falling transportation costs affect other sectors?
- How will AVs affect municipal revenue streams?

Imagining Alternative Futures (Ryerson U)

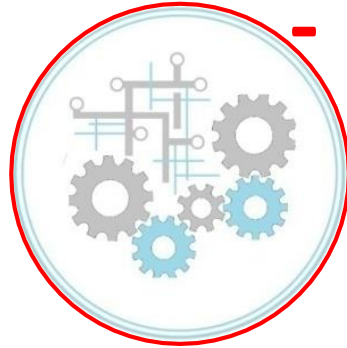


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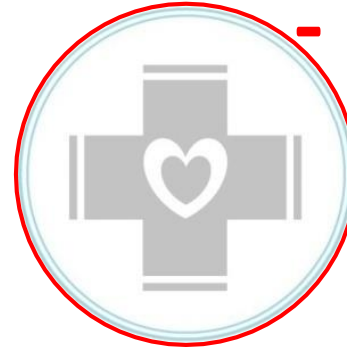
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ATTITUDES



TECHNOLOGY



SAFETY



ECONOMICS

2



ATTITUDES



TECHNOLOGY



SAFETY



ECONOMICS

Imagining Alternative Futures (Ryerson U)

3



ATTITUDES



TECHNOLOGY



SAFETY



ECONOMICS

4



ATTITUDES



TECHNOLOGY



SAFETY



ECONOMICS

Looking Back: First Auto Uses (U of T)



1876: First 1-cylinder engine



1891: First Truck



1908: Model-T is introduced



1914: \$5 Workday



1914-1918: WW1



1933: Drive-In movies invented

1885: Benz Velo



1894: World's first Car Race

1906: San Francisco Earthquake



1913: First Snow Plow

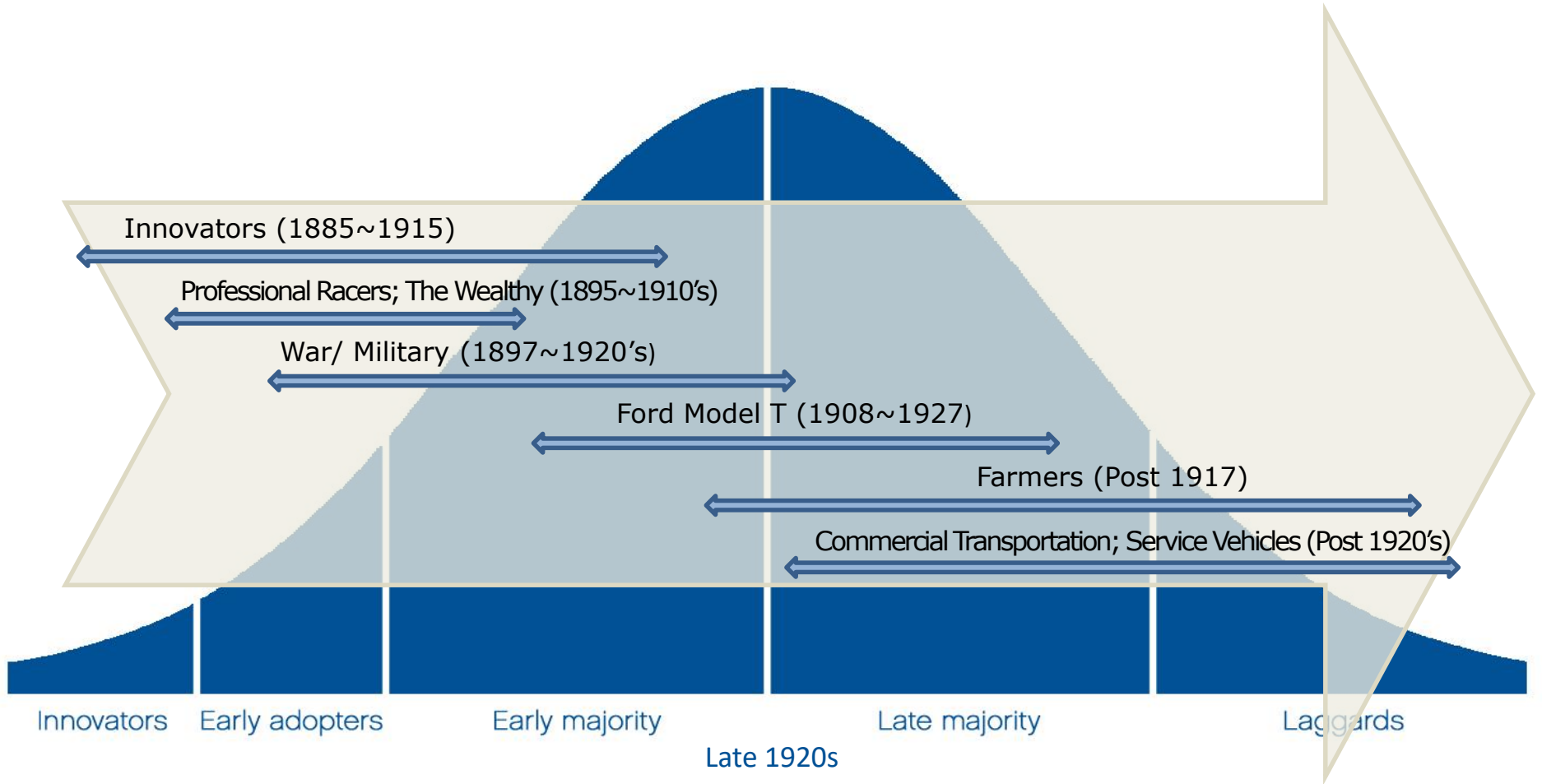
1917: Model-F Tractor



1920s: Buses emerge



Early Adoption of the Automobile





Questions?

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