

Robot, take the wheel

Public policy for automated vehicles

BY NOAH ZON & SARA DITTA

Mowat Centre

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An aerial night photograph of a city, likely New York City, showing a complex highway interchange with multiple overpasses and ramps. The city lights are visible in the background, and the highway is illuminated with streetlights. The overall scene is a dense urban environment at night.

Overview

Automated vehicles present a potentially revolutionary change to the way that we move people and goods. This technology is already developing quickly. Today, many vehicles offer a significant array of computer-assisted driving features. Meanwhile, fully-automated vehicles are being developed and tested both by traditional auto manufacturers and new entrants. Automated vehicles could be ready for public roads within five to ten years. Before they reach our roads, governments need to consider potential policy implications and develop a framework that balances the many interests and issues at play.

This report provides an overview of automated vehicle technologies and the range of near- and long-term policy implications that they present. The goal is to provide policymakers with an on-ramp toward understanding the opportunities and challenges that come with this disruptive technology, as well as to provide a framework to chart a path forward.

Introduction

A century ago, Ford Model Ts began rolling off assembly lines and into our cities and towns, bringing with them significant changes to how and where we live, work and play. While the automobile had been around as a technology for decades, few could predict how the wide availability of cars would ultimately shape our cities and our behaviours through the creation of highways, suburbs and office parks – all enabled by the mass availability of cars.

Today, we appear to be at the cusp of a similarly significant transformation, with implications as far-reaching as the widespread adoption of the car. Automakers, robotics experts and software makers are actively testing fully-automated vehicle technology. This testing can take place on public roads in Ontario as of January 1, 2016 – the first jurisdiction in Canada to allow for this experimentation.

While the pace of technology development and adoption is difficult to predict, these vehicles may be ready for our roads within a few years. But before they hit the streets, we will face a whole host of questions about how to update our public policy framework to adapt to these new technologies. For example, one of the main ways that we currently keep our roads safe is through rules around who can drive (e.g., licensed and sober adults, without visual impairment). However, driver licensing is moot if we don't rely on manual control. The policy implications go well beyond the safety of our roads or liability and insurance for accidents. The widespread adoption of automated vehicles (or AVs) could also have major impacts on the shape of our cities and public infrastructure, environmental impacts, accessibility and inclusion, economic growth and productivity, privacy, and public finance.

While there is still a long way to go in creating a driverless future, the regulatory and policy barriers may outweigh the technological hurdles. Without a new policy framework, we will exacerbate the challenges presented by this change and fail to realize potential benefits. Preserving the status quo is not a realistic option. There are, however, many questions about the right approach for government in response to this significant turning point in transportation.

This report is designed to provide policymakers with a better understanding of automated vehicles and the most important policy implications that they present, including both how we prepare for these vehicles on our roads and their broader social, economic and environmental impacts. Given the long road ahead, this report will also present recommendations for governments on how to move forward.

A Driverless Future?

HISTORY OF AUTOMATED VEHICLE DEVELOPMENT

The development of automated vehicle technology has quickly transformed from science fiction to impending reality. The rapid pace of change underscores why policymakers need to start working actively now to avoid unintended consequences of outdated policy.

In 2004, the U.S. Defense Advanced Research Projects Agency (the military agency that served as a driving force behind the development of the Internet) issued an open “Grand Challenge” to researchers and engineers to demonstrate their best fully-automated vehicle on a 150-mile course.¹ In that first year, the most successful team managed seven miles of the course, but, by the next year, five teams completed the entire course.² This exponential pace of development has only continued – Google’s self-driving cars alone have completed more than 1.6 million kilometres of test driving, and they are joined by a number of carmakers that are actively

testing cars that obey traffic rules and respond to changing conditions safely and effectively.³ Today, Formula E racing is developing a series where fully-automated vehicles will race, pass each other and navigate complex courses at very high speeds.⁴

While Google and other companies focus on developing fully-automated technology, a number of automakers opt for more incremental approaches by progressively introducing more automated features in their cars. For example, some Nissan cars have the capacity for fully-automated highway driving, with city driving expected within two or three years.⁵ Likewise, over the next two years, General Motors and Toyota will introduce increasingly complex and integrated driver assistance systems that combine sensors and automated control, with Toyota aiming to ultimately reach a fully driverless vehicle by 2020.⁶ GM has also made a significant investment in ride-hailing company Lyft, investing \$500 million with a focus on automated vehicles.⁷

The rapid pace of change underscores why policymakers need to start working actively now to avoid unintended consequences of outdated policy.

1 Fagnant, D. and Kockelman, K. July 2013. “Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations for Capitalizing on Self-Driven Vehicles.” http://www.caee.utexas.edu/myaccess.library.utoronto.ca/prof/kockelman/public_html/TRB14EnoAVs.pdf

2 Ibid.

3 Google Self-Driving Car Project. <https://www.google.com/self-drivingcar/>. Accessed January 15, 2016. Google refers to “over 1 million miles” but we are proudly Canadian.

4 Fung, B. November 27, 2015. “The next frontier in Formula racing: Driverless Cars.” *The Washington Post*. <https://www.washingtonpost.com/news/the-switch/wp/2015/11/27/the-next-frontier-in-auto-racing-driverless-cars/>

5 Hickman, H. August 26, 2015. “What’s Next for Driverless Cars?” *Agenda - World Economic Forum* <https://agenda.weforum.org/2015/08/whats-next-for-driverless-cars/>

6 Roberts, D. October, 7, 2015. “The biggest challenge for driverless cars: getting rid of the drivers.” *Vox* <http://www.vox.com/2015/10/7/9471393/driverless-cars-challenges;>

BBC News. October 7, 2015. “Toyota promises driverless cars on roads by 2020.” <http://www.bbc.com/news/technology-34464450>

7 Fitzpatrick, A. January 4, 2016. “Why General Motors Is Investing \$500 Million in Lyft.” *Time*. <http://time.com/4166130/general-motors-lyft/>

Auto parts manufacturers are also quite active in automated vehicle development, ranging throughout the supply chain.⁸ Self-parking has become a common feature on even relatively modest vehicles. However, the final steps in the automation process — those that remove the driver from the equation (and perhaps from the vehicles) altogether — are the most daunting in terms of technology,⁹ trust¹⁰ and policy.

8 Ticoll, D. October 2015. "Driving Changes: Automated Vehicles in Toronto." *University of Toronto Transportation Research Institute*. pg. 4

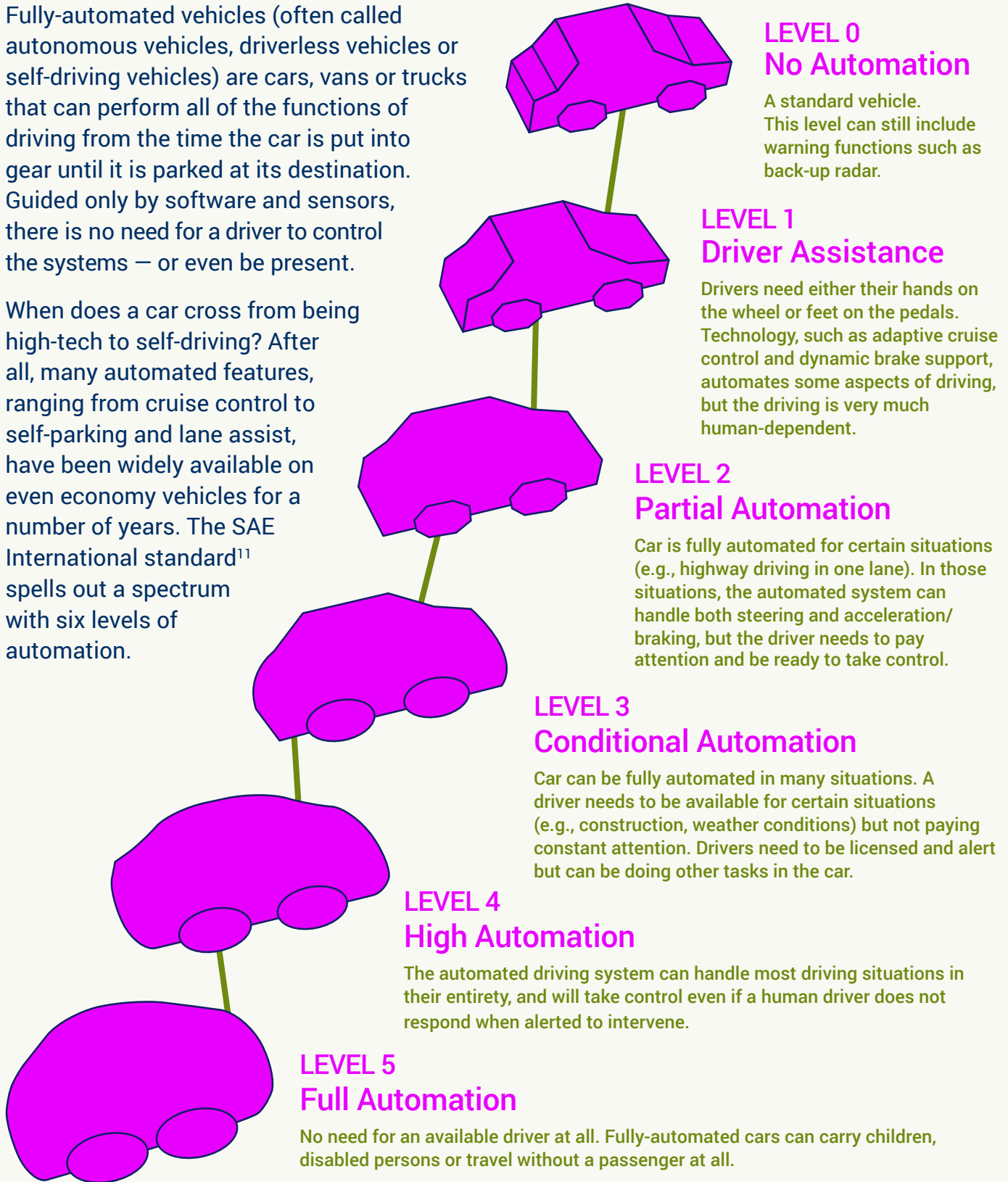
9 Urmson, C. "How A Self-Driving Car Sees the Road." *TED*. <https://youtu.be/tiwVMrTLUWg>

10 Schoettle, B. and Sivak, M. July 2014. "A Survey of Public Opinion About Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia." *University of Michigan Transportation Research Institute*.

What is an Automated Vehicle?

Fully-automated vehicles (often called autonomous vehicles, driverless vehicles or self-driving vehicles) are cars, vans or trucks that can perform all of the functions of driving from the time the car is put into gear until it is parked at its destination. Guided only by software and sensors, there is no need for a driver to control the systems – or even be present.

When does a car cross from being high-tech to self-driving? After all, many automated features, ranging from cruise control to self-parking and lane assist, have been widely available on even economy vehicles for a number of years. The SAE International standard¹¹ spells out a spectrum with six levels of automation.



There is a significant gulf between complete automation and cars with very high levels of automation – both in terms of the technology and in terms of policy implications.

11 SAE International. Levels of Driving Automation, SAE International Standard J3016. http://www.sae.org/misc/pdfs/automated_driving.pdf

INITIAL APPLICATIONS

Fully-automated vehicle technology is currently being tested in real-world settings, especially with industrial vehicles. Self-driving tractors are already relatively common.¹² With high labour costs in oil sands mining, Suncor is making a major investment in fully-automated heavy trucks,¹³ joining mining operations in Australia and elsewhere.¹⁴

The other pioneering industry is public transit, where driverless shuttles will be on the roads of Sion in Switzerland next year.¹⁵ Meanwhile the CityMobile2 is testing low-speed transit AVs in a number of European cities.¹⁶ The Chinese bus company Yutong is also experimenting with a fully-automated city bus in mixed traffic.¹⁷ The potential to run automated public transit at lower speeds and/or in dedicated lanes also makes this potential application easier to introduce.¹⁸

12 Peterson, A. June 22, 2015. "Google didn't lead the self-driving vehicle revolution. John Deere did." *The Washington Post*. <http://www.washingtonpost.com/blogs/the-switch/wp/2015/06/22/google-didnt-lead-the-self-driving-vehicle-revolution-john-deere-did/>
13 Morgan, G. June 8, 2015. "How Canada's oilsands are paving the way for driverless trucks – and the threat of big layoffs." *Financial Post*. <http://business.financialpost.com/news/energy/how-canadas-oilsands-are-paving-the-way-for-driverless-trucks-and-the-threat-of-big-layoffs>

14 The New Scientist. July 25, 2012. "Robots move into the mining business." <https://www.newscientist.com/article/mg21528756-200-robots-move-into-the-mining-business/>

15 Bolton, D. November 9, 2015. "Driverless buses set to hit public roads for the first time in Switzerland next year." *The Independent*. <http://www.independent.co.uk/life-style/gadgets-and-tech/news/driverless-autonomous-self-driving-buses-switzerland-sion-world-first-time-a6727016.html>

16 Fagnant and Kockelman, 2013. pg. 2

17 Walker, A. October 12, 2015. "5 Cities With Driverless Public Buses On The Streets Right Now." *Gizmodo*. <http://gizmodo.com/5-cities-with-driverless-public-buses-on-the-streets-ri-1736146699>

18 Grush, V. and Niles, J. September 2015. "A Comment from Grush Niles." Appendix C in *Building our Tomorrow: The Future of Ontario's Infrastructure* by Michael Fenn. Residential and Civil Construction Alliance of Ontario. http://www.rccao.com/news/files/RCCAO_Future-of-Infrastructure_Sept2015.pdf pg. 161

While there is good reason to believe that transit and industrial settings will be early adopters of fully-automated vehicles, it's important to keep in mind that it is very difficult to predict the paths that AVs may take to our roads. Commercial vehicles tend to have higher turnover, and adoption of AVs in commercial settings will be considered under a different calculus than passenger vehicles.¹⁹

One obstacle for automated vehicle adoption today is cost – on-board technology today would put AVs out of reach for most consumers. However, two factors could quickly change that calculation. The first is that there are indications that the expensive LIDAR units, which enable cars to "see" the world around them using lasers, could soon become far more affordable.²⁰ The second is the potential to offer fully-automated vehicles as a transportation-as-a-service model, allowing for fleet-style ownership, which could drastically accelerate the rate at which AVs end up on our streets.²¹

In considering the pathways²² that this technology might take to our roads, it is important to be aware of the distinction between automated vehicles and connected vehicles. While both of these approaches can get to essentially the same place (a combination of sensors and software moving the driving functions out of the human driver's hands), they accomplish this in different

19 Burgess, M. July 28, 2015. "Autonomous commercial vehicles will shape our jobs and lives." *Factor*. <http://factor-tech.com/feature/autonomous-commercial-vehicles-will-shape-our-jobs-and-lives/>

20 Metz, C. September 3, 2015. "Laser Breakthrough Could Speed the Rise of Self-Driving Cars." *Wired*. <http://www.wired.com/2015/09/laser-breakthrough-speed-rise-self-driving-cars/>

21 Godsmark, P., Kirk, B., Gill, V. and Flemming, B., 2015. "Automated Vehicles: The Coming of the Next Disruptive Technology" *Conference Board of Canada*.

22 For a more detailed discussion of possible adoption pathways and other policy considerations in a Toronto context, see Ticoll, D. October 15, 2015. "Driving Changes: Automated Vehicles in Toronto" <http://www1.toronto.ca/City%20of%20Toronto/Transportation%20Services/Ts%20Publications/Reports/Driving%20Changes%20%28Ticoll%202015%29.pdf>

ways. Connected vehicles navigate safely and avoid obstacles by communicating with other vehicles on the road, with traffic infrastructure, or with a wide variety of objects connected to the “internet of things.”²³ These models are variously called “vehicle-to-vehicle” (V2V), “vehicle to infrastructure” (V2I) or “vehicle to everything” (V2X) connected vehicles.

These vehicles can be automated with less sophisticated technology on board (increasing the likelihood of retrofitting cars already on the road). However, they may depend on establishing common standards,²⁴ equipping a critical mass of other vehicles on the road with the technology and/or investing substantially in connected traffic infrastructure to pave the way. By comparison, some automated vehicle models are not “connected” in this sense, and would have all of the necessary components to be fully automated on board.²⁵ The balance between these different technology approaches could call for different responses from governments.

EXISTING POLICY ENVIRONMENT

Today, the legal and regulatory environment around automated vehicles is unclear. Policy frameworks are built on the concept of full-manual control of vehicles, with specific rules about following distance and requirements for hand position that are predicated on our current technology.²⁶ There are rules built into the Geneva Conventions on Road Traffic dating back nearly a century that specify that “every driver shall at all times be able to control his vehicle or guide his animals,” which means that the fear of runaway oxcarts carrying bales of hay to market could block our use of sophisticated software and robotics today.²⁷ None of our road rules envision the possibility that a car could be on the road without an available, licensed, capable driver. This is already emerging as a tension in regulation – the California Department of Motor Vehicles’ draft rules require that a human be available and able to take control. The development seems to block the design approach being piloted by Google, which removes the steering wheel and brakes altogether.²⁸

As of January 2016, Ontario is the first jurisdiction in Canada to establish a pilot program to test fully-automated vehicles on public roads.²⁹ Ontario joins a handful of U.S. states (Nevada, California, Florida and Michigan), which have approved some limited pilot testing of automated vehicles on public

23 Azmat, M. June 16, 2015. “Future Scenario: Self Driving Cars - The Future has Already Begun.” Conference Paper, Presented May 7, 2015, Austria. http://www.researchgate.net/publication/278329250_Future_Scenario_Self_Driving_Cars_-_The_future_has_already_begun

24 Fagnant and Kockelman, 2013.

25 Walker Smith, B. January 1, 2014. “A Legal Perspective on Three Misconceptions in Vehicle Automation.” *Road Vehicle Automation Lecture Notes in Mobility*, Springer, p.85 http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2459164

26 Walker Smith, B. 2014. “Automated Vehicles Are Probably Legal in the United States.” *Texas A&M Law Review* 411. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2303904

27 Ibid, pg. 428

28 Kerstetter, J. December 17, 2015. “Daily Report: Google’s Lousy Time at the D.M.V.” *The New York Times*. http://bits.blogs.nytimes.com/2015/12/17/daily-report-googles-lousy-time-at-the-d-m-v/?_r=0

29 Government of Ontario. October 13, 2015. “Ontario First to Test Automated Vehicles on Roads in Canada.” <https://news.ontario.ca/mto/en/2015/10/ontario-first-to-test-automated-vehicles-on-roads-in-canada.html>

roads. These pilots generally require a fully-licensed driver available to take control and, in some cases, involve additional insurance and/or data sharing.³⁰ The U.S. National Highway Traffic Safety Administration announced in January 2016 that it would develop advisory guidance for industry and a model state policy towards fully-automated vehicles, alongside a proposed \$4 billion, ten-year investment by the Obama administration to support pilots and testing.³¹ The UK has also earmarked GBP 40 million to support three pilot projects, as part of efforts to make the region a testing ground.³² All of these pilots require a licensed driver available at the wheel.

None of our road rules envision the possibility that a car could be on the road without an available, licensed, capable driver.

While the number of pilots testing for safety is increasing, other issues are largely ignored. Governments around the world have given little consideration to the broader social, economic and environmental implications of

automated vehicles, and how to create policy frameworks that maximize opportunities and minimize challenges. In a study of the long-term transportation system plans of 68 major U.S. cities, the National League of Cities found that only six per cent had built in consideration of the potential effects of automated vehicle technologies.³³ The decisions that we make today – in infrastructure, in planning and in policy – will have a great deal of influence over how well this technology serves our lives and our communities.

30 Texas is an exception to the requirement for licensed drivers in vehicle. See Davies, A. December 17, 2015. "California's New Self-Driving Car Rules Are Great for Texas." *Wired*. <http://www.wired.com/2015/12/californias-new-self-driving-car-rules-are-great-for-texas/>

31 U.S. Department of Transportation. January 14, 2016. "Secretary Foxx Unveils President Obama's FY17 Budget Proposal of Nearly \$4 Billion for Automated Vehicles and Announces DOT Initiatives to Accelerate Vehicle Safety Innovations." <https://www.transportation.gov/briefing-room/secretary-foxx-unveils-president-obama%E2%80%99s-fy17-budget-proposal-nearly-4-billion>

32 Scott, M. June 10, 2015. "Britain Offers Itself as a Proving Ground." *New York Times* <http://bits.blogs.nytimes.com/2015/06/10/britain-offers-itself-as-a-proving-ground/>

33 DuPuis, N., Martin, C. and Rainwater, B. 2015. "City of the Future: Technology & Mobility." National League of Cities. <http://www.nlc.org/Documents/Find%20City%20Solutions/Research%20Innovation/City%20of%20the%20Future/City%20of%20the%20Future%20FINAL%20WEB.pdf>



Policy Implications

The arrival of automated vehicles has potentially transformative implications for a wide range of policy areas extending well beyond the rules of the road. While many of these implications depend on how the technology evolves and on how it is adopted by consumers, we can identify a number of areas where policymakers should begin to build the arrival of automated vehicles into their planning. The ability to proactively develop sound, flexible public policy frameworks in these areas could be the difference between whether or not AV technology brings significant economic, social and environmental benefits. While it is nearly impossible to predict the path of technology innovation or consumer adoption in automated vehicles, public policy decisions can be instrumental both to making automated vehicles possible on our roads and to ensuring that this technology is used in a way that is consistent with the public interest.

We highlight eight different dimensions of the public policy environment surrounding automated vehicles. For each, we identify: the key issue, the main opportunities and challenges, and some questions for policymakers going forward.

1] SAFETY

+ What's the key issue?

Despite significant improvements in safety, every year approximately 2,000 Canadians are killed in car accidents, with many more injured and significant economic costs incurred.³⁴

The vast majority of these accidents can be attributed to human, rather than mechanical, error and automated technology presents an opportunity to avoid them.

+ Opportunities and challenges

Automation and additional technology can dramatically reduce the risk of car accidents. The crash avoidance features (e.g., automatic braking, collision warnings) available today in many vehicles contribute to much safer roads, and are now being taken into account in National Highway Traffic Safety Administration

(NHTSA) crash safety ratings.³⁵ Because automated systems have greater awareness – they don't fail to pay attention, get inebriated or misjudge distances – they have the potential to be far safer than human drivers, avoiding accidents caused by impaired or distracted driving. In all of Google's considerable testing, its automated vehicles were involved in 14 collisions, but none had the automated vehicle at fault.³⁶

This raises one of the most challenging aspects of road safety policy for automated vehicles – not how to handle the self-driving vehicles, but how to handle the human-driven ones. In the interim, this issue is largely focused on the

34 Godsmark, P., Kirk, B., Gill, V. and Flemming, B., 2015. "Automated Vehicles: The Coming of the Next Disruptive Technology" *Conference Board of Canada*.

35 Oremus, W. September 8, 2015. "The Big Problem With Self-Driving Cars." *Slate*. http://www.slate.com/articles/technology/future_tense/2015/09/toyota_intelligent_cars_the_automaker_thinks_it_can_fix_the_major_problem.html; <http://bits.blogs.nytimes.com/2015/06/10/tipping-point-in-transit/>; Davies, A. December 9, 2015. "The Feds Are Changing Crash Testing to Get Us Self-Driving Cars." *Wired*. <http://www.wired.com/2015/12/the-feds-are-changing-crash-testing-to-get-us-self-driving-cars/>
36 Urmson, C. July 16, 2015. "The View from the Front Seat of the Google Self-Driving Car, Chapter 2." *Medium*. https://medium.com/@chris_urmson/the-view-from-the-front-seat-of-the-google-self-driving-car-chapter-2-8d5e2990101b

challenges of mixed traffic — human drivers will respond differently to a situation than automated systems, making it more difficult to design safer systems. In the longer-term, we ultimately face the question of whether allowing people to manually operate vehicles makes sense, given the public health and safety implications when automated systems are demonstrably safer.³⁷ At higher (but not complete) levels of automation, designers face the challenge of an “uncanny valley” where the human driver might only be controlling the vehicle 25 per cent of the time, leaving a paradox where the safety technology creates the danger of inattentive and inexperienced drivers.³⁸

This question has to be considered not only in comparison to today’s drivers, but in a future state where drivers’ skills are far less honed, as they defer to an increasing array of automated systems. As journalist Dave Roberts asks: “can we trust human drivers who are inattentive 75 per cent of the time to pay attention the right 25 per cent of the time, and to make the right decisions?”³⁹

While these systems offer promise of significantly improved safety, they bring new kinds of safety challenges that must be managed. The most prominent of these challenges is cybersecurity and the risk of hacking.⁴⁰ This has, in fact, been the primary focus of early legislative efforts in the U.S. on automated vehicles.⁴¹ On the one hand, framing car hacking as an issue of automated vehicles

in particular is a bit of a red herring — we have seen that the roughly 200 million internet-connected vehicles⁴² today are themselves prone to hacking before we introduce any automated functions,⁴³ and the prospect of actually disrupting a vehicle’s controls would take a complex and sophisticated attack.⁴⁴ Nonetheless, as automated vehicles evolve, cybersecurity will become an increasingly prominent dimension of road safety. Perhaps more dangerous (if less compelling a threat) is the risk of flawed software leading to malfunction — something that anyone who has tried to update their operating system recently could understand.

+ Key questions moving forward

The fundamental question about road safety policy in a world of automated vehicles comes down to how to rebuild the regulatory framework. As it stands, the basic building block of our policy to keep roads safe focuses on licensing human drivers. This is an ineffective way to manage safety in automated vehicles. If the focus of regulation shifts from drivers to vehicles, how will we ensure that regulations are dynamic and responsive? Automated vehicles produce a significant amount of performance data — how can this measurement contribute to road safety, and how will it interact with cybersecurity protections and privacy safeguards?

37 Roose, K. October 5, 2015. “Driving should be illegal.” *Fusion*. <http://fusion.net/story/207965/driving-should-be-illegal/>

38 Roberts, D. 2015

39 Ibid.

40 Perloth, N. June 10, 2015. “Traffic Hacking: Caution Light is on.” *The New York Times*. <http://bits.blogs.nytimes.com/2015/06/10/traffic-hacking-caution-light-is-on/>

41 Fung, B. July 21, 2015. “The government push to regulate driverless cars has finally begun.” *The Washington Post*. <https://www.washingtonpost.com/blogs/the-switch/wp/2015/07/21/the-push-to-regulate-driverless-cars-has-finally-begun/>

42 Hardy, Q. June 10, 2015. “A Dialogue of Car and Highway.” *The New York Times*. <http://bits.blogs.nytimes.com/2015/06/10/a-dialogue-of-car-and-highway/>

43 Thierer, A. and Hagemann, R. September 2014. “Removing Roadblocks to Intelligent Vehicles and Driverless Cars.” *Mercatus Center*. <http://mercatus.org/sites/default/files/Thierer-Intelligent-Vehicles.pdf>

44 Fagnant and Kockelman, 2013.

2] ACCESSIBILITY

+ What's the key issue?

By eliminating the need for drivers, automated vehicles could expand mobility for people who cannot currently drive due to disability, age or other barriers.

+ Opportunities and challenges

One of the most interesting opportunities of fully-automated vehicles is the ability to extend mobility to people who cannot drive cars. In initial promotional videos for its self-driving car pilot, Google pointedly had a visually-impaired passenger test out the technology. The NHTSA highlighted this potential to expand mobility as a key policy priority from its perspective on autonomous vehicles.⁴⁵

One of the biggest challenges for governments and regulators will be the balance between expanding accessibility and ensuring safety. At what point can we be confident that it is not necessary to have an available backup driver as a redundant control system? Until we remove this need, the ability to promote accessibility of transportation is significantly constrained.

Potential shifts in vehicle ownership models towards transportation-as-a-service also raise new challenges about how to ensure accessibility, especially for those who might need additional accommodations (such as wheelchair ramps or lifts). Without some proactive policy responses, automation of transportation could risk widening rather than shrinking the mobility gap for some persons with disabilities.

+ Key questions moving forward

How can we promote expanded mobility at interim levels of automation? While Level 5 automation offers a number of possibilities, how can policy and regulation help capture the benefits of expanded mobility at intermediate levels of automation?

What are the appropriate expectations for fleets to support accessibility? Will there be requirements for vehicles or response times?

How can governments best protect vulnerable passengers? For example, what are the safeguards that we would need to have in place if we were to have children traveling unaccompanied in an automated vehicle?

By eliminating the need for drivers, automated vehicles could expand mobility for people who cannot currently drive due to disability, age or other barriers.

45 National Highway Traffic Safety Administration. 2013. "Preliminary Statement of Policy Concerning Automated Vehicles." http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf

3] ENVIRONMENT AND URBAN PLANNING

+ What's the key issue?

Automated vehicles provide an opportunity to reconsider land use and urban space in light of their potential impact on congestion and the reduced need for parking lots. They also could yield significant benefits for the environment through greater efficiency and fuel savings.

+ Opportunities and challenges

A major opportunity associated with automated vehicles is the potential to reclaim space that is currently devoted to parking and for other similar purposes. Indeed, one study of a Brooklyn neighbourhood found that 64 per cent of local traffic and 45 per cent of all traffic involved cars searching for a place to park.⁴⁶ Another study estimated that approximately one-third of land in some cities is dedicated to providing parking.⁴⁷ With automated vehicles, the need to park near one's destination may be removed if models favour limited car ownership and the ability of cars to drive to specific locations once they are no longer needed. In light of this potential, there are already calls for governments to reduce parking requirements for new developments.⁴⁸

As a result, automated vehicles offer an opportunity to reconsider the urban landscape through significant changes in transportation planning. City planners will potentially have many spaces that could be reclaimed for various purposes, including parks and

new real estate. Meanwhile, road systems could be completely altered, such as around intersections, to improve efficiencies.⁴⁹

Automated vehicles are also expected to provide fuel savings and emissions reductions. Indeed, the technology could potentially improve fuel economy through more smooth acceleration and deceleration.⁵⁰ However, the degree of impact will be difficult to determine until technology direction and consumer use is more clearly defined.⁵¹ For instance, automated vehicles could end up being less environmentally beneficial if they promote more travel and decrease public transit use. A study for the City of Toronto projected nearly three times as many vehicles on the road if automated vehicles are primarily individually-owned compared to a utility-style on-demand model.⁵² Nevertheless, studies have suggested that use of automated vehicles could reduce greenhouse gas emissions by around 90 per cent, if they run on electricity and are shared-use vehicles.⁵³

+ Key questions moving forward

To what degree should governments start reconsidering zoning laws to take into account potential future uses of space? Can governments incentivize approaches to automated vehicles that ensure the greatest environmental gains?

46 Transportation Alternatives. February 2007. "No Vacancy: Park Slope's Parking Problem and How to Fix it." <http://transalt.org/sites/default/files/news/reports/novacancy.pdf>

47 Bilton, N. July 7, 2013. "Disruptions: How Driverless Cars Could Reshape Cities." *The New York Times*. <http://bits.blogs.nytimes.com/2013/07/07/disruptions-how-driverless-cars-could-reshape-cities/>

48 Kiger, P. October 2, 2015. "Imagining the Driverless City." *Urbanland: the Magazine of the Urban Land Institute*. <http://urbanland.uli.org/infrastructure-transit/imagining-driverless-city/>

49 Thierer and Hagemann, 2014.

50 Anderson, J. Kalra, N., Stanley, K., Sorensen, P., Samaras, C. Oluwatola, O. 2014. "Autonomous Vehicle Technology: A Guide for Policymakers." *RAND corporation*. http://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-1/RAND_RR443-1.pdf

51 Litman, T. December 10, 2015. "Autonomous Vehicle Implementation Predictions: Implications for Transport Planning." *Victoria Transport Policy Institute*. <http://www.vtpi.org/avip.pdf>

52 Ticoll, 2015. pg. 21.

53 Greenblatt, J. and Shaheen, S. July 21, 2015. "Automated Vehicles, On-Demand Mobility, and Environmental Impacts." *Current Sustainable Renewable Energy Reports*. <http://link.springer.com/article/10.1007/s40518-015-0038-5>

4] ECONOMIC GROWTH AND LABOUR MARKETS

+ What's the key issue?

Major economic growth potential is connected to automated vehicles through the creation of new markets, opportunities to revamp land use and reductions in costs associated with automobile crashes. However, the growth of automated vehicles would also lead to significant disruptions in the labour market.

+ Opportunities and challenges

Automated vehicles have the potential to create new markets while encouraging others to evolve. However, some could be completely destroyed by the influx of automated vehicles, particularly those reliant on car accidents.

In general, a significant market saturation of automated vehicles could yield billions of dollars in economic benefits. A UK study projected that automated vehicles could result in a one per cent growth in GDP by 2030,⁵⁴ while a U.S. report suggested that they could provide benefits to the economy between \$25 billion and \$189 billion based on how fully the vehicles penetrate the market.⁵⁵

The potential to reduce crashes will also lead to cost savings. A U.S. study estimated that the economic costs of automobile crashes in 2010 was \$242 billion due to factors including lost productivity, increased congestion, workplace losses, property damage and emergency services.⁵⁶ Congestion, in particular, could be significantly reduced through vehicles with high

levels of automation by improving traffic flow and thereby reducing delays. In just the Greater Toronto and Hamilton area, congestion costs have been pegged at \$6 billion per year.⁵⁷

The impact on jobs will also be significant. While automated vehicles should generate new jobs, it would also remove the need for many other professions that rely on driving – including the more than 300,000 truck drivers⁵⁸ and more than 50,000 taxi drivers⁵⁹ in Canada, as well as those who operate public transportation vehicles. There are also jobs in the insurance and legal industries that are based on the ramifications associated with automobile accidents.

Ontario, in particular, may be well positioned to take advantage of the market opportunities associated with automated vehicles, given its background in the auto sector combined with high-tech companies in Waterloo, Ottawa and Toronto. Indeed, more than 100 companies in Ontario are reportedly involved in products and services that could support the development of automated vehicles.⁶⁰

+ Key questions moving forward

How will governments make up for the labour disruptions that would occur due to automated vehicles? What can governments do to encourage innovation and incentivize development of automated vehicles?

54 KPMG UK. March 2015. "Connected and Autonomous Vehicles – The UK Economic Opportunity." https://www.kpmg.com/BR/en/Estudos_Analises/artigosepublicacoes/Documents/Industrias/Connected-Autonomous-Vehicles-Study.pdf

55 Fagnant and Kockelman, 2013.

56 Blincoe, L.J., Miller, T.R., Zaoshnja, E. and Lawrence, B.A. May 2015. "The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (Revised)." National Highway Traffic Safety Administration. <http://www.nrd.nhtsa.dot.gov/pubs/812013.pdf>

57 Dachis, B. July 2013. "Cars, Congestion and Costs: A New Approach to Evaluating Government Infrastructure Investment." *C.D. Howe Institute Commentary* 385. https://www.cdhowe.org/pdf/Commentary_385.pdf

58 Gill, V. and Macdonald, A. February 21, 2013. "Understanding the Truck Driver Supply and Demand Gap and Its Implications for the Canadian Economy." *Conference Board of Canada*. <http://www.conferenceboard.ca/topics/energy-enviro/truckdrivers.aspx>

59 Xu, L. March 2012. "Who Drives a Taxi in Canada." *Citizenship and Immigration Canada, Research and Evaluation Division*. <http://www.cic.gc.ca/english/pdf/research-stats/taxi.pdf>

5] INSURANCE AND LIABILITY

+ What's the key issue?

The shift to automated vehicles could completely transform the auto insurance business by reducing risk, but raises new questions about liability that must be clarified before AVs will be adopted.

+ Opportunities and challenges

The safety potential of automated vehicles promises far fewer crashes – meaning there is less risk to insure. While this could drastically shrink the auto insurance business, it should mean benefits for consumers.⁶¹ It also means that with drivers not in control, we are likely to see an end to premium prices differentiated based on age and gender and the elimination of costly long-term penalties for past accidents.⁶²

In the face of this transformation, we must sort out the tricky questions of who is in fact liable in the case of an accident (and in turn who needs to be carrying insurance). Some AV makers have cited current liability laws as a major barrier to getting automated vehicles to market.⁶³ Will it be the original manufacturer? The current owner? Third-party companies who may make changes to the vehicle or its software? While Volvo has stated that it will assume responsibility for any accident caused

by a design flaw in its automated vehicles, there will still be debate about the origins of a fault in an accident.⁶⁴

These challenging questions are made more murky by the ethical questions raised about how automated vehicles should be programmed to behave in the situations where there is no way to avoid at least some serious harm. Should they prioritize the safety of their own passengers, or should they aim to minimize the number of people harmed, even at the risk to their own passenger?⁶⁵ These ethical questions have amplified the questions of liability that could hamper vehicles from getting to market. The moral debate around automated vehicle accidents could perversely get in the way of the goal of making auto accidents very rare.

+ Key questions moving forward

How should car insurance regulatory requirements be adjusted for automated vehicles? What is the appropriate role for government in ensuring the availability of insurance for automated vehicles? To what degree should this issue be left to insurance markets, carmakers, and the tort system to sort out?

60 Flavelle, D. October 13, 2015. "Ontario sees driverless cars as road ahead." *The Toronto Star*. <http://www.thestar.com/business/2015/10/13/driverless-cars-coming-to-ontario-roads.html>

61 Jain, N. O'Reilly, J. and Silk, N. June 19, 2015. "Driverless Cars: Insurers Cannot be Asleep at the Wheel." *Bank Underground - Bank of England*. <http://bankunderground.co.uk/2015/06/19/driverless-cars-insurers-cannot-be-asleep-at-the-wheel/>

62 Ibid.

63 Geeting, J. February 10, 2014. "It's an Automatic." *NextCity*. <http://nextcity.org/features/view/driverless-cars-city-design-mobility-urban-planning>

64 Charlton, A. October 9, 2015. "Volvo: We will be responsible for accidents caused by our driverless cars." *International Business Times*. <http://www.ibtimes.co.uk/volvo-we-will-be-responsible-accidents-caused-by-our-driverless-cars-1523260>

6] GOVERNMENT FISCAL POSITION

+ What's the key issue?

The adoption of automated vehicles – and the resulting changes to driving patterns, safety and land use – could have significant implications for government revenue and expenditure.

+ Opportunities and challenges

The most significant potential impact of automated vehicles on government fiscal positions comes from safer and more efficient roads. About seven per cent of vehicle crash costs in the U.S. are borne by government, a figure likely significantly higher in Canada given our public health care system.⁶⁶ The Brookings Institution highlighted further opportunities for savings from congestion, better use of infrastructure and other benefits.⁶⁷

The adoption of automated vehicles also presents the potential, if indirectly, for increased government revenue. The Conference Board of Canada estimated that five billion hours of time could be freed to more productive uses, when people can spend time doing things other than controlling their vehicle.⁶⁸ The use of public and private land could also be reallocated to more productive uses – a study in Lisbon estimated that 20 per cent of curb-to-curb street area could be re-allocated from on-street parking to

other uses,⁶⁹ and others have estimated trillions of dollars worth of real estate could be opened for development.⁷⁰

There are of course some smaller, but notable, lost revenue from fewer traffic tickets or reduced gas taxes, and reduced sales of vehicles. Parking is also a significant revenue source for many cities.⁷¹ In light of these changes, it is important to closely monitor at which level of government increased costs are borne and which level of government gains from the savings. This is particularly important in Canada given the common mismatch between the level of government responsible for delivering a public service and the government(s) with available revenue.

+ Key questions moving forward

Should governments move away from fuel taxes and traffic fines towards vehicle-miles-travelled taxes to smooth revenues?⁷²

How can different levels of government rebalance given the shifts of costs and revenues that might come from automated vehicle adoption?

65 Buchanan, B. October 30, 2015. "Should we trust driverless cars to keep us out of danger?" *World Economic Forum - The Agenda*. <https://agenda.weforum.org/2015/10/should-we-trust-driverless-cars-to-keep-us-out-of-danger/>

66 Desouza, K. and Fedorschak, K. July 7, 2015. "Autonomous vehicles will have tremendous impacts on government revenue." *Brookings Institute TechTank*. <http://www.brookings.edu/blogs/tech-tank/posts/2015/07/07-autonomous-vehicle-revenue>

67 Ibid.

68 Godsmark et. al, 2015.

69 Masterson, S. May 13, 2015. "The Sharing Economy: How shared self-driving cars could change city traffic." *OECD Insights*. <http://oecdinsights.org/2015/05/13/the-sharing-economy-how-shared-self-driving-cars-could-change-city-traffic/>

70 Geeting, 2014.

71 Anderson et. al, 2014.

72 Thierer and Hagemann, 2014.

7] INFRASTRUCTURE

+ What's the key issue?

The rise of automated vehicles forces major changes and a redefinition of the role of infrastructure – potentially replacing existing systems with costly smart infrastructure that can communicate with these vehicles.

+ Opportunities and challenges

It is clear that with updated modes of transportation through emerging technologies, infrastructure too will be affected. As it stands, there are several types of automated vehicles being developed – some of which have no communication with infrastructure and could operate within the existing system, while others would rely on significant communication with surrounding infrastructure.

Therefore, the degree to which infrastructure will be impacted remains unclear – which adds to difficulties for governments looking to incorporate the rise of AVs in infrastructure planning decisions. As the new federal government has promised significant new investments in large-scale and long-term infrastructure, decisions made now will impact what Canada's infrastructure resembles in decades to come. Infrastructure could quickly become outdated if it doesn't involve at least some consideration of emerging trends such as automated vehicles. One potential approach, suggested by the Conference Board of Canada, would require that major projects involving long-term investments by the federal government undergo an audit on the impact of automated vehicles on the infrastructure.⁷³

The way government approaches infrastructure will too likely evolve in light of emerging technologies such as automated vehicles. For instance, public infrastructure typically has a long life cycle, but that approach may need to change with smart infrastructure because the pace of technology innovation is so fast and not conducive to decades-long life cycles.⁷⁴

However, the major challenge is that the costs are significant to overhaul existing infrastructure to create a smart system capable of consistent vehicle-to-infrastructure communication. Such a move will be particularly difficult in periods of fiscal uncertainty. As a result, infrastructure planning is likely to be only marginally affected in the short-term by low-cost interventions. Nevertheless, governments in some jurisdictions have indicated a willingness to make changes to infrastructure, if guidance is provided.⁷⁵ In the short-term, there is the potential to implement lower-cost modifications to infrastructure, such as changes in signage, while other elements could be part of long-term planning.

+ Key questions moving forward

Should policymakers start taking automated vehicles into consideration now as new infrastructure investments are being made? What can be incorporated into infrastructure in the short- and long-term? Do governments need to change their longstanding approaches to infrastructure development and maintenance in light of emerging technologies?

74 Vock, D. January 15, 2015. "7 Ways Self-Driving Cars Could Impact States and Localities." *Governing*. <http://www.governing.com/topics/transportation-infrastructure/gov-driverless-cars-impact-states-localities.html>

75 Proceedings - Automated Vehicle Symposium 2014. [https://higherlogicdownload.s3.amazonaws.com/AUVSI/3a47c2f1-97a8-4fb7-8a39-56cba0733145/UploadedFiles/AVS%202014%20Proceedings%20-%20Final%20\(Dec%202014\).pdf](https://higherlogicdownload.s3.amazonaws.com/AUVSI/3a47c2f1-97a8-4fb7-8a39-56cba0733145/UploadedFiles/AVS%202014%20Proceedings%20-%20Final%20(Dec%202014).pdf)

73 Godsmark et. al, 2015.

8] DATA AND PRIVACY

+ What's the key issue?

Automated and connected vehicles will produce significant amounts of sensitive data about people's lives and movements. This raises significant ethical questions about how this data can be used and by whom.

+ Opportunities and challenges

The adoption of connected and automated vehicles could produce significant amounts of data about how people are moving throughout cities. This aggregated data could be extremely useful to public transit agencies and urban planners to better understand city needs and patterns.⁷⁶ The aggregated data can also be useful to carmakers to continue to improve performance and safety, including for vehicles already on the road.

With all this data being captured, it will be essential to put in place appropriate safeguards for privacy. Will marketers be able to capture this data to provide micro-targeted ads based on a person's travel patterns? Will users' privacy be protected in shared vehicles? In any case, it will be essential to make sure that the terms of engagement for personal data is made very clear to consumers, in language they can understand and with provisions for some consumer choice.⁷⁷

The proliferation of vehicle data also raises some important questions for law enforcement. Under what conditions should law enforcement agencies gain access to personal travel

data?⁷⁸ These law enforcement questions in fact go beyond the collection of data: should police be able to take control of an automated vehicle remotely and, if so, under what circumstances?⁷⁹

+ Key questions moving forward

What are the appropriate standards of privacy and for data-sharing for autonomous vehicles?⁸⁰ How can we ensure that standards remain agnostic to the way that the technology develops?

What are the reasonable expectations of privacy for travel data and how can this privacy be safeguarded?

How can governments capitalize on the aggregated data generated by widespread adoption of connected/automated vehicles?

76 Hong, Q., Wallace, R. and Krueger, G. April 2015. "Connected vs. Automated Vehicles as Generators of Useful Data." *Center for Automotive Research*. <http://www.cargroup.org/?module=Publications&event=View&pubID=117>

77 Thierer and Hagemann, 2014.

78 Weaver, J.F. July 27, 2015. "The Fourth Amendment and Driverless Cars." *Slate*. http://www.slate.com/articles/technology/future_tense/2015/07/fourth_amendment_and_autonomous_vehicles_should_cops_need_a_warrant_for.html

79 Hollywood, J., Woods, D., Silbergliitt, R., and Jackson, B. 2015. "Using Future Internet Technologies to Strengthen Criminal Justice." *RAND Corporation*. http://www.rand.org/content/dam/rand/pubs/research_reports/RR900/RR928/RAND_RR928.pdf

80 Fagnant and Kockelman, 2013.

Moving Forward

While automated vehicles raise challenging questions that will demand significant attention from policymakers and the public, there are also some common themes across the diverse array of issues identified that speak to the fundamental challenge that automated vehicles pose. It is not simply that the way people and goods are transported will be different – the nature of the changes ahead includes particular wrinkles that shape the ability of governments to respond and the policy toolkit available to act.

One common tension that cuts across each of these policy fields is the endemic uncertainty associated with technology-driven change. While there is pressure for governments to begin crafting policy responses, it is unclear just which technology pathway will gain momentum and still less clear which business models and behaviours will shape adoption patterns.

Another consistent dimension is the way that change driven by technology is ultimately experienced as economic transformation. This goes beyond the immediate impacts, for example, of those who drive for a living or those producing the vehicles, sensors and software that make automated vehicles possible. Removing the human effort from mobility has the potential to unleash significant productivity increases but also change the spatial organization of the economy, as urban parking area is given over to new uses and the time cost of commuting is drastically reduced. Like all economic change, this may create new industries but will also require structural adjustments. Therefore, policymakers will need to maximize access to new opportunities and provide assistance to those facing dislocation.

There is a role for public policy on automated vehicles to create a clear and stable operating environment that encourages innovation. This role can include a combination of removing regulatory barriers and providing more proactive support, such as facilitating the development of shared standards, and connecting research and development opportunities across the automotive, infrastructure, robotics and information technology sectors.

There is also a role for public policy to maximize the opportunity to support other policy priorities. There is an opportunity to avoid the mistakes that came with the last transportation revolution, which left us with significant economic and environmental challenges from congestion and sprawl. The policy environment that governments create for automated vehicles should take into account the costly lessons of the last half-century of car-oriented development.

These policy challenges are very much cross-cutting in nature, spanning across levels of government, across geographic boundaries and across different government departments. In many cases, the same policy tool or legislation is used to address many similar issues. This dynamic demands that policymakers place a strong emphasis on collaboration within and across governments as well as with industry to ensure a response that is consistent and coherent.

With the need in many cases for a significant rebuild of the regulatory framework, governments will also need to prioritize. It is not possible to simultaneously manage large numbers of cross-cutting and diverse policy

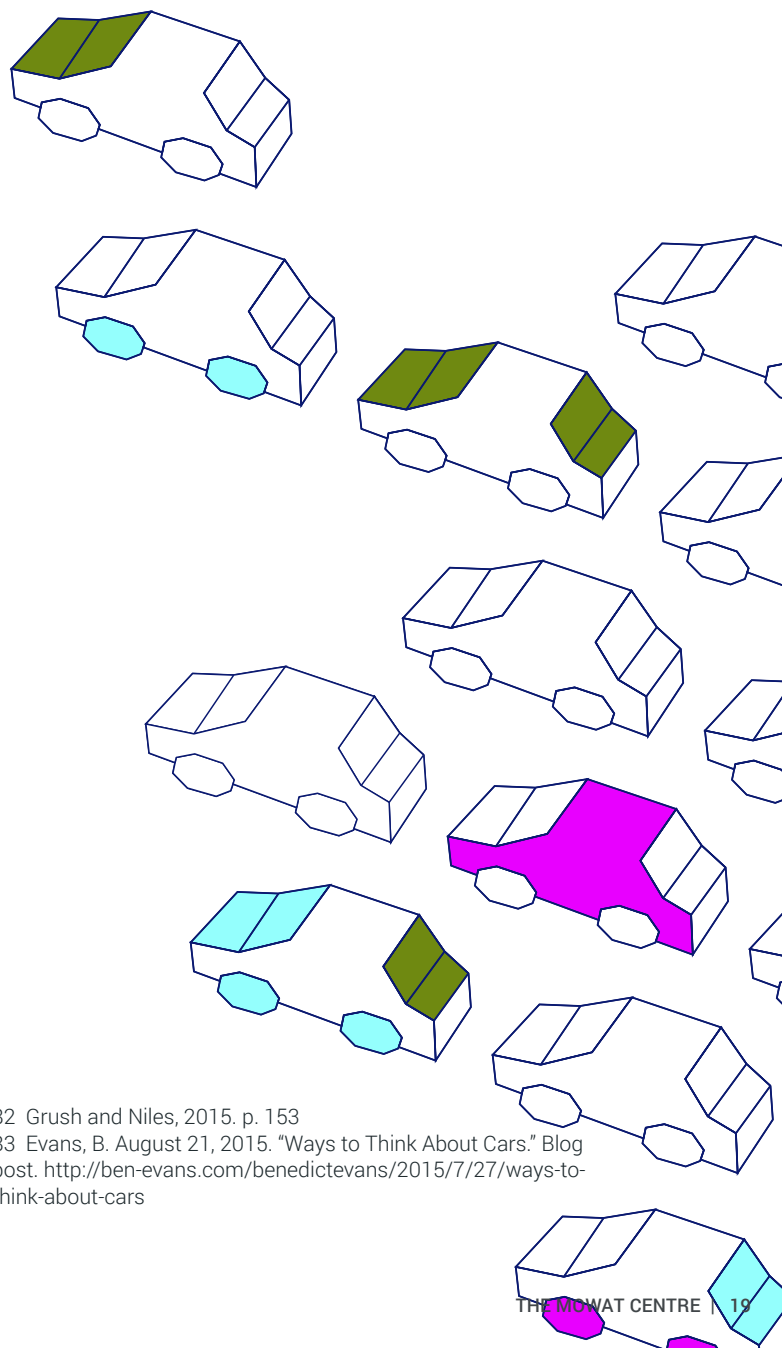
overhauls, but policymakers will need to ensure that they move at a consistent pace with other jurisdictions and that the sequencing does not leave an outdated regulatory framework as an avoidable hurdle. For example, automated vehicles would still be held back from deployment in an instance where questions surrounding safety and infrastructure are addressed but there is a lack of clarity around insurance requirements and liability.

Additionally, if we retain the idea that all cars on the road need a licensed driver with adequate vision and with full attention to driving, we will not be able to expand mobility to people who can't drive today – we'll only make it more safe and comfortable for those who can already drive.

Overall, automated vehicles will call for some significant changes in a range of policy areas – and that's the point. Without a meaningful move away from the status quo, there are real constraints on the potential benefits that we can get from automated vehicles.

The long-term implications and the need for scenario planning is another common factor in each of these policy dimensions. While the lock-in effects are more significant and concrete for infrastructure than for insurance, for example, we know that policy and regulation is likewise challenging to change, especially to match the iterative nature of technology change. While a year can seem like a lifetime in technology development, it can also be seen as “lightning fast for federal regulators.”⁸¹

And yet arguably the long-range planning for the next 20 years will be entirely different from any long-range planning exercise in recent memory.⁸² This is especially true if we look beyond the direct effects to the second-order changes – as Carl Sagan said, “it was easy to predict mass car-ownership but hard to predict Wal-Mart.”⁸³ To guide this work, policymakers should start by re-establishing the core principles behind the policy framework – such as promoting mobility, safety, accessibility, innovation and economic growth.



81 Downes, L. 2015. “Fewer, Faster, Smarter.” *Democracy*. <http://democracyjournal.org/magazine/38/fewer-faster-smarter/>

82 Grush and Niles, 2015. p. 153

83 Evans, B. August 21, 2015. “Ways to Think About Cars.” Blog post. <http://ben-evans.com/benedictevans/2015/7/27/ways-to-think-about-cars>

Recommendations

While the public policy response to automated vehicles is racked with uncertainty and complexity, there are nonetheless some recommendations that we would make to governments about how to approach policymaking for automated vehicles:

STAY TECHNOLOGY AGNOSTIC

Policymakers should resist the temptation to embrace a particular vision of how automated vehicles might come to market. In addition to the range of scenarios explored in this report, there are a number of ways that “intelligent vehicle” technology might develop and commercialize.⁸⁴ The difference between these scenarios is significant for all of these policy areas – as illustrated by the three potential vehicle ownership scenarios explored by David Ticoll’s study for the City of Toronto.⁸⁵ Policymakers can’t be expected to accurately predict how this will play out, and they should avoid that altogether by designing policy in a way that focuses on the public interest while remaining as technology agnostic as possible.

Being technology agnostic goes beyond avoiding the more outright “picking winners” by subsidies or procurement. It also requires being cautious to avoid more implicit and often unintentional choices in the design of regulation and infrastructure. This need to be technology agnostic can come into tension with a desire to be proactive, especially in infrastructure design. However, it can be managed by concerted efforts to make room for a variety of technology options in designing policy. To make this possible, governments will need regular lines of communication with industry to understand the full spectrum of technology under development and emphasize multi-use infrastructure and standards.

84 Thierer and Hagemann, 2014.
85 Ticoll, 2015.

BUILD AVENUES FOR CROSS-SECTOR AND INTERGOVERNMENTAL COOPERATION

Cooperation among jurisdictions and harmonization of regulatory requirements is important to build consumer trust, and to pave a pathway for technology to reach market. This is especially true for smaller jurisdictions in Canada, which often don’t have the market size to draw manufacturers to design products specifically for them. Regulators need to strike a balance between the advantages of the “laboratory of federalism”⁸⁶ approach that promotes the necessary innovation in response to a new trend and the risk of disparate rules in different provinces and states making testing and production more onerous, and deterring investment.⁸⁷

This can be balanced by regular cooperation at various levels of government. Within jurisdictions, there is opportunity for constructive cooperation with industry, which shares an interest in a clear operating environment. An example of this cooperation in practice can be found in Sweden, where Volvo is working with the government around its planned automated vehicle pilot testing.⁸⁸ Within countries – especially federal states such as Canada and the U.S. – federal government organizations such as NHTSA or Transport Canada can act as convenors and

86 Anderson, et. al, 2014.
87 Fagnant and Kockelman, 2013.
88 Geeting, 2014.

clearing houses for cooperation. The ongoing review of the Canada Transportation Act could be an opportunity for the federal government to take steps in this direction.

At an international level, there are proposals to update the 1968 Vienna convention on road traffic to create some consistent international expectations.⁸⁹ There are also efforts toward industry-driven international cooperation through SAE international, the global association of automotive and aerospace technical experts.⁹⁰

This cooperation can take a number of forms, ranging from informal information-sharing to developing common standards (for example for V2V or V2X communication protocols). Whatever form it takes initially, policymakers would be wise to establish these networks of cooperation now so that the communication channels are in place as the complexity of the automated vehicles policy agenda continues to increase.

EMPHASIZE TRANSPARENCY AND TRUST

One of the biggest hurdles to modernizing our policy framework – and to widespread consumer adoption of a technology that could make our world safer and more efficient – will be trust. Much of the work of building consumer trust in the technology rests rightly with the companies developing and selling automated vehicle technology. However, it would be a mistake to overlook the role that government policy plays in either building trust or engendering risk aversion towards a technology.

Given the unfamiliar territory that we will venture to over the next few years, it is even more important for policymakers to be transparent in not only sharing data on the results of their pilots, but also in the rationale and context for policy decision-making. It is important for citizens to understand – and weigh in on – the principles that are driving policy decisions. From the business perspective, whenever there are technology and regulatory changes that could have significant implications for incumbents and new entrants, it is important to guard against any suspicion of unfair dealing.⁹¹

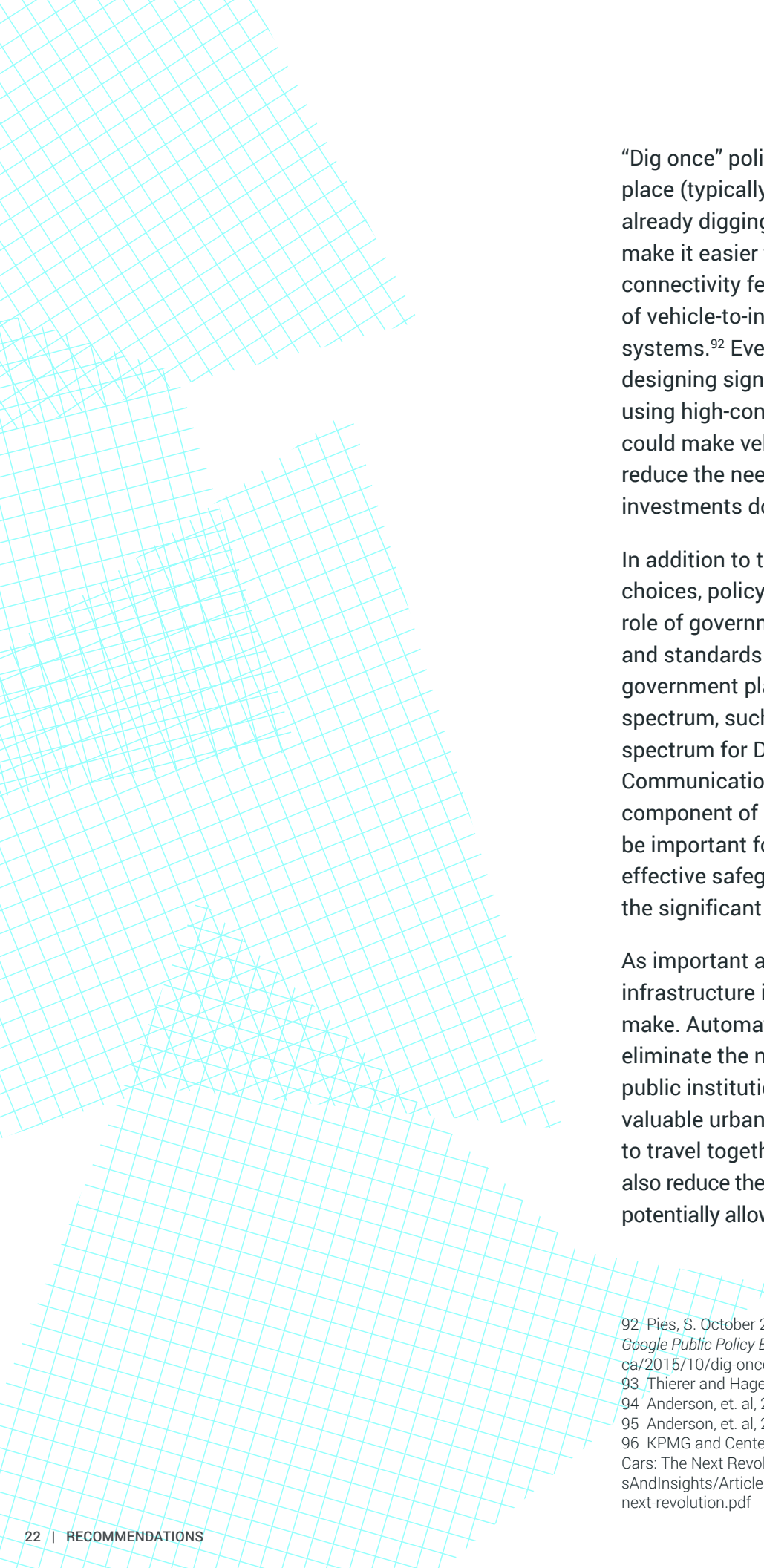
Greater transparency and open policy-making will also lead to better results. Policy changes in response to automated vehicles need to effectively take into account just how citizens plan to integrate this technology into their lives and businesses. It is important for governments to get a steady stream of feedback to inform and refine policy design.

INVEST IN MULTI-USE INFRASTRUCTURE

Infrastructure and transportation are deeply intertwined. The choices that governments make around public infrastructure will make a big difference in how automated vehicles become part of how we move around our cities and regions. While governments should avoid making premature investments related to a particular automated vehicle technology, they should consider making investments in supportive multi-use infrastructure that would support automated vehicles.

89 Weiner, G. and Walker Smith, B. "Automated Driving: Legislative and Regulatory Action." http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action
90 SAE International.

91 Johal, S. and Zon, N. February 17, 2015. "Policymaking for the Sharing Economy: Beyond Whack-a-Mole." <http://mowatcentre.ca/policymaking-in-the-sharing-economy/>. pg. 22



“Dig once” policies that put extra conduit in place (typically for broadband) when we are already digging up streets and highways could make it easier to add “smart infrastructure” connectivity features that could form the basis of vehicle-to-infrastructure communications systems.⁹² Even simple tweaks such as designing signage in consistent forms and using high-contrast paint for road markings could make vehicle sensors more effective and reduce the need for more costly infrastructure investments down the road.⁹³

In addition to these physical infrastructure choices, policymakers should consider the role of government in setting both regulations and standards around data.⁹⁴ For example, government plays an essential role in managing spectrum, such as the electromagnetic spectrum for Dedicated Short-Range Communication that may become an essential component of automated vehicles.⁹⁵ It will also be important for governments to establish effective safeguards for personal privacy given the significant amount of data captured.

As important as these choices are the infrastructure investments that we don’t make. Automated vehicles could reduce or eliminate the need for parking structures at public institutions, saving money and unlocking valuable urban space. By allowing vehicles to travel together more closely, they could also reduce the need for additional roads and potentially allow for more narrow lanes.⁹⁶

92 Pies, S. October 27, 2015. “Dig Once, Gain Broadband Later.” *Google Public Policy Blog*. <http://googlepublicpolicy.blogspot.ca/2015/10/dig-once-gain-broadband-later.html>

93 Thierer and Hagemann, 2014.; Anderson, et. al, 2014.

94 Anderson, et. al, 2014.

95 Anderson, et. al, 2014., pg. xxi

96 KPMG and Center for Automotive Research, 2012. “Self-Driving Cars: The Next Revolution.” <https://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/Documents/self-driving-cars-next-revolution.pdf>

Conclusion

In the next few years, a number of jurisdictions will likely join Ontario, Nevada, California, Florida and others in allowing for pilot testing of automated vehicles on their roads. This is a welcome development, but it is important that proactive policymaking for automated vehicles doesn't end there. That only a handful of jurisdictions have managed to take even this modest step does not inspire confidence about our preparedness for widespread consumer adoption of automated vehicles. Consumers, however, are not interested in waiting for government to be ready for them to use new technologies. Transformative change may come quickly, so it is important for governments to begin actively preparing for automated vehicles today across a range of public policy areas.

The role of policymakers in the face of a potentially transformative technology like automated vehicles is a delicate one. On the one hand, there are risks of acting too quickly. It is important to avoid implicitly endorsing a particular technology, introducing a mandate for underdeveloped technology,⁹⁷ or prematurely regulating automated vehicles out of existence.⁹⁸ On the other hand, governments cannot afford to simply wait and see what happens, as market failures may prevent the technology from reaching market in an optimal way to improve mobility, safety, accessibility, economic opportunity and environmental sustainability. Governments also can't abdicate their own decision-making to international standards – they need to ensure that they have policy and regulations in place for unique local needs (including practical challenges like snowy-weather testing⁹⁹ and local policy priorities).

Consumers, however, are not interested in waiting for government to be ready for them to use new technologies.

While many governments today are wrestling with questions about licensing for taxi and limousine drivers and rules for UberX drivers, they may soon need to deal with the far more complex issue of removing drivers from the equation completely. Governments can't once again afford to be caught flat-footed by a technology change. Policymakers should begin working today to craft a public policy framework that ensures that we capture the significant opportunities that automated vehicles could bring to improve our lives, while managing the risks involved with the change.

97 Anderson, et. al, 2014.

98 National Highway Traffic Safety Administration, 2013.

99 Ticoll, 2015, pg. 39

