AUTOMATED VEHICLES

The Implications of Automated Vehicle Technology on the Driving Environment

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Automated vehicle (AV) technology has the potential to substantially change the driving environment and perform functions traditionally managed by drivers. As the technology becomes more advanced, more driving functions will be automated. This could encompass everything from braking to advanced steering maneuvers. AV technology can enhance road safety and provide benefits to drivers. However, these benefits are only achievable if drivers understand the limits of specific technologies and the implications of those technologies on driving.

To demonstrate, the National Highway Traffic Safety Administration (NHTSA) and the Society of Automotive Engineers (SAE) International have identified several levels of vehicle automation. For more detailed definitions of the levels of automation, see the **Introduction to the Use of Automation in Vehicles** fact sheet:

- **Level 0 – No automation:** Vehicle has no automated functions.
- **Level 1 – Driver assistance:** Vehicle has some limited automation (e.g., steering or acceleration/braking support, but not both simultaneously) in certain conditions.
- **Level 2 – Partial automation:** Vehicle can automate certain combinations of functions (e.g., steering and acceleration/braking support) in certain conditions.
- **Level 3 – Conditional automation:** Vehicle can assume the complete driving task in limited conditions, and the driver must be ready to resume driving at any point.
- **Level 4 – High automation:** Vehicle can perform all the driving tasks in specific driving conditions and environments.
- **Level 5 – Full automation:** Vehicle can handle all driving tasks without human input, in all types of driving conditions and environments.[1]

Each level of technology has specific implications for the driving environment. Currently, some automated Level 1 and 2 vehicle technologies are already available and widely used, such as adaptive cruise control and blind spot detection systems. However, mass market deployment of Level 3 vehicles, the first of which are only now launching in limited quantities and in specific markets for

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real world evaluation, is still several years off. Level 4 or 5 personal vehicles are likely a decade or more into the future. This fact sheet contains a brief overview of some common questions regarding the implications of AV technologies on the driving environment.

Questions & Answers

Does AV technology have the potential to improve road safety?

Yes. It is anticipated road safety will improve with increasing levels of vehicle automation. However, drivers must understand they continue to play an important role in the driving task for the foreseeable future. Vehicles with conditional automation (Level 3) or lower require an attentive driver who is prepared to take over the driving task when prompted. It is essential drivers do not rely on these technologies in ways they were not designed to be used and/or attempt to use them in conditions in which they cannot reliably function. In some respects, these potential improvements in road safety are already evident from Advanced Driver Assistance Systems (ADAS) and Levels 1 and 2 automation.[2] Implications of vehicles with high or full automation (Level 4 or 5) on road safety are unknown, but many experts believe these technologies will help reduce instances of driver error and improve road safety.[3]

Do I have to pay attention when using AV technology?

Yes. Vehicles with driver assistance or partial automation (Level 1 and 2) require the driver to remain attentive and engaged in the driving task and monitor the environment at all times. Level 3 vehicles will require drivers to be ready to resume driving at any point should the system hand over control in the event of an unexpected hazard or road/traffic conditions that the system cannot safely manage.[4] At Level 4, the system would likely not require human intervention, but once the operational limits were reached, the system may bring the vehicle to a controlled stop in a safe area or, should it require assistance, potentially relinquish control to a remote human driver if no driver were present or if the driver were unable or unwilling to take control. Level 5 automation is theoretically the only level of automation that requires no human intervention. Levels 3, 4 and 5 are still in development. However, the first Level 3 vehicles have just launched in limited quantities and in specific markets for real world evaluation. The mass market deployment of Level 3 vehicles is still several years off. Level 4 or 5 personal vehicles are likely a decade or more into the future.

Will AV technology enable vehicles to communicate with one another?

Possibly. AV technology at or above Level 3 automation will likely incorporate some degree of communication and connectivity. This feature will allow vehicles to communicate with one another and share relevant data about the roadway (i.e., vehicle-to-vehicle communication). It is also anticipated these vehicles may include elements of vehicle-to-environment interconnectivity, enabling them to communicate with surrounding transportation infrastructure (e.g., stop signs, traffic lights).[5] This information would be shared through the use of wireless communication and sensor detection technologies.[6]

Can AV technology be compromised by cyberattacks?

Likely. Cyber-vulnerability may exist in any vehicle, regardless of automation level. As vehicles incorporate greater connectivity, wireless connections provide hackers with greater opportunities to remotely access some vehicle functions. Therefore, vehicles with conditional automation (Level 3) or higher using connectivity through wireless communication are theoretically a potential target for cyberattacks.[7] Public Safety Canada has developed a National Cyber Security

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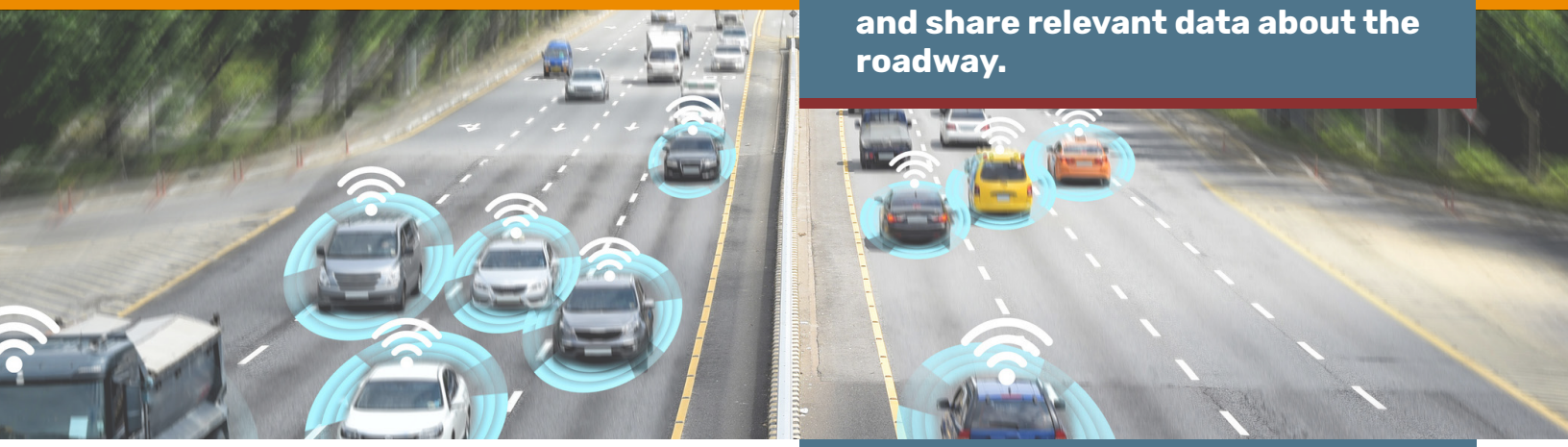
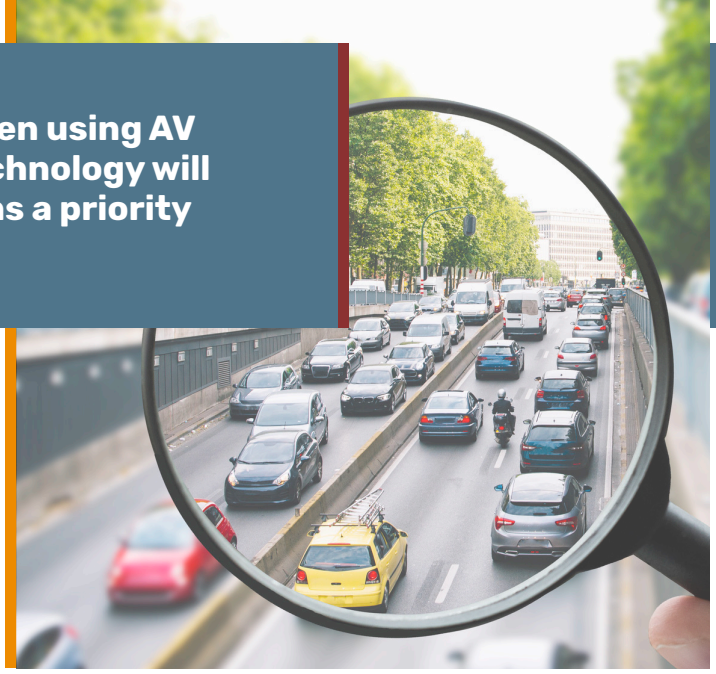


Research to study driver behaviour when using AV technology and understand how AV technology will influence the road environment remains a priority need.



Strategy,[8] which provides an overarching vision and direction for cybersecurity in Canada. Building on the Strategy, Transport Canada published Canada's Vehicle Cyber Security Guidance [9] which provides a set of technology-neutral guiding principles to support industry in incorporating vehicle cybersecurity best practices. For more on cybersecurity, see **Cybersecurity & Automated Vehicles** fact sheet.

Will AV technology impact roadway design and infrastructure?

Yes. Although the physical design of roads may remain largely the same, it is anticipated infrastructure design may change with future vehicle connectivity. Integration of smart infrastructure equipped with communication systems is likely, making it possible for vehicles to communicate with surrounding transportation infrastructure (i.e., vehicle-to-environment interconnectivity). For example, traffic signals may shift from highly visible light signals to more subtle forms of signalling, where the primary purpose is to send an electronic signal to communicate right-of-way to the vehicle's automated system.[10]

Will all AV technology be uniform in their design?

No. Currently, vehicles with Level 1 and 2 automation have certain variations in the functionality of their features. For example, a Forward Collision Warning system can also be called Pre-Crash Warning, Collision Mitigation Braking, Predictive Forward Collision Warning, and other names. The function and capacities of these systems can vary greatly, despite a common purpose to prevent a forward collision. With increasing levels of automation, it is anticipated this variability will continue, and manufacturers will not be uniform in their design. Although AV technology should be capable of similar functions, how the technology is integrated into a user-friendly system is likely to vary. Manufacturers will be pioneering new automated functionality using different underlying technology, possibly resulting in different automated features. To facilitate interoperability and consumer familiarity across systems, a balance is needed between industry trade secrets and open innovation of new automated technology.

How long will it take for AVs to influence the level of road safety?

It is estimated any new vehicle feature takes 10-12 years for full integration into the vehicle fleet on the road, with several models of the technology being developed throughout this process.[11] As a larger proportion of the vehicle fleet on the road includes AV technologies, greater gains in road safety may be achieved with fewer collisions resulting from human error.

Conclusion

Advances in AV technology have the potential to substantially change the driving environment. Research to study driver behaviour when using AV technology and understand how AV technology will influence the driving environment remains a priority need. Further, the influence of automation will be dynamic since continuous technological improvements will influence road safety in a number of ways. In response to these changes, it may be difficult for drivers to determine how they should behave when using this technology. It is essential that drivers maintain their core driving capabilities and use this technology to assist, but not replace, their role as a driver. For the foreseeable future, drivers remain the primary controller and must be prepared to assume the driving task when prompted. Vehicles requiring no human input are decades away and face many technical and logistical challenges before they are available to the public for purchase.

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[1] Robertson et al. 2016; NHTSA 2017; Transport Canada 2019; SAE 2016
[2] Rosen 2013; Tengs et al. 1995; Vaa et al. 2007
[3] Utriainen, & Pöllänen 2020; Tengs et al. 2020
[4] Robertson et al. 2016; Merat et al. 2014
[5] Englund et al. 2016
[6] Olia et al. 2018
[7] Petit & Shladover 2014
[8] Public Safety Canada 2018
[9] Transport Canada 2020
[10] Englund et al. 2016
[11] Milakis et al. 2017

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Traffic Injury Research Foundation

The vision of the Traffic Injury Research Foundation (TIRF) is to ensure people using roads make it home safely every day by eliminating road deaths, serious injuries and their social costs. TIRF's mission is to be the knowledge source for safer road users and a world leader in research, program and policy development, evaluation, and knowledge transfer. TIRF is a registered charity and depends on grants, awards, and donations to provide services for the public. Visit **www.tirf.ca**.

Traffic Injury Research Foundation (TIRF)
171 Nepean Street, Suite 200, Ottawa, ON K2P 0B4
Email: tirf@tirf.ca ISBN: 978-1-989766-20-0

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