Road Safety Benefits of Level 3 and Level 4 Connected and Automated Vehicles and Fleet Transition

David Young[a], Michael Nieuwesteeg[a], Paulette Ziekemijjer[a], Johan Strandroth[b], David Logan[c]

[a]Transport Accident Commission, [b] VicRoads SSRIP, [c] Monash University Accident Reserach Centre

Abstract

The road safety benefits of Connected and Automated Vehicles (CAVs) will likely be significant. However, there is much debate around the risk of trauma during the transition to this future. A topic that is the subject of the most divided opinion is if there is a need to transition through all the levels of automation. Some experts suggest that there is a need to 'skip' some levels (Noy, Shinar, & Horrey, 2018) while others have suggested all levels are required for the best outcome (Ma & Kaber, 2005). This research examines these two views using real world data.

Background

Since the first Connected and Automated Vehicles (CAVs) began testing there has been debate around the potential benefits or dis-benefits of their introduction (Marçal et al., 2017; Milakis, van Arem, & van Wee, 2017; Noy et al., 2018). One of the most debated subjects of the road safety impacts of CAVs is around road trauma during the transition to a 'fully' automated fleet.

The Society of Automotive Engineers (SAE) definitions for the levels of automation (SAEInternational, 2016) are the most widely used. The figure below is an illustrative example of these.

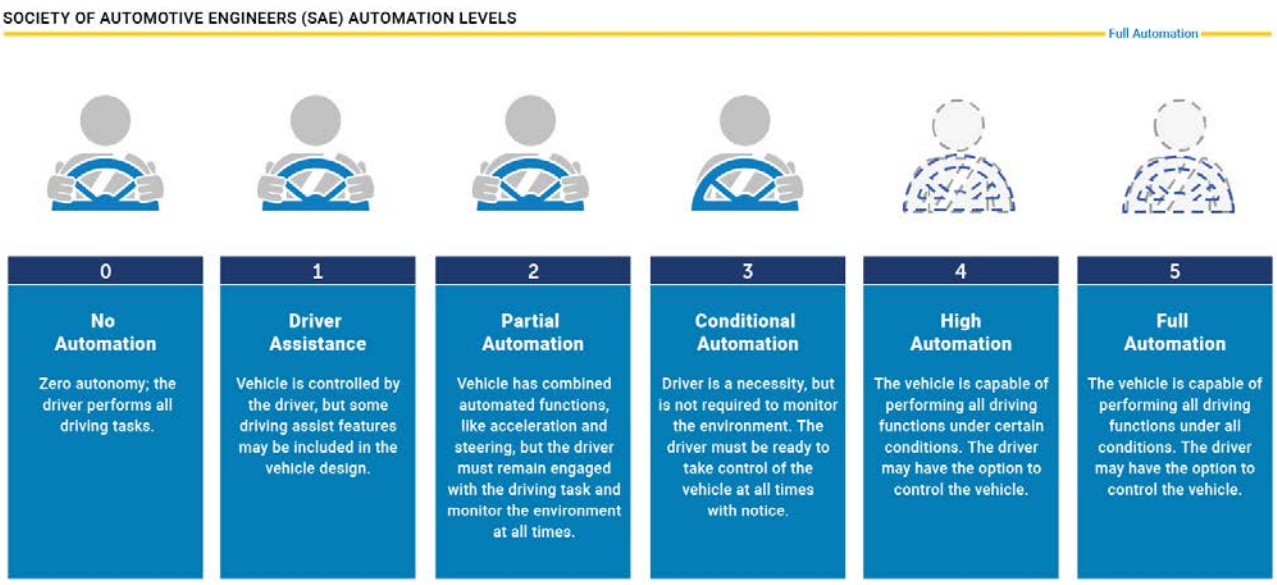

Figure 1. SAE Levels of Automation (NHTSA, 2018)

The Level 3, or conditional automation, stage of vehicle technology is the stage of most concern. At this level there is a need for drivers to intervene or take control of a vehicle in order to avoid or reduce the severity of some crashes (Noy et al., 2018). This research focusses on the question as to *whether we should allow Level 3 vehicles onto the road network or if restrictions should be put in place on the use of these vehicles?* The consequence of such an action being that the public would have to wait for Level 4 vehicles to realise road safety benefits. Some Original Equipment Manufacturers,

including Volvo, have already publicly stated they will skip Level 3 automation while others including Audi and BMW have announced the release or impending release of their Level 3 vehicles.

Currently little evidence based research has been presented. Researchers have instead presented subjective views as to what the likely road trauma benefits and dis-benefits of each path will be. This study aims to provide an evidence based estimate of road trauma outcomes of these two case. This is needed to inform the decision of vehicle safety advocates. The objective of this study is to be the first detailed assessment of road trauma which addresses this need.

Method

The TAC has access to a comprehensive database of crashes. This study makes use of this data to hypothesize the potential road safety outcomes for the two scenarios introduced above. The methodology for quantifying outcomes is as follows:

Qualitative review of crashes

A panel of road safety experts review crashes in the proposed data set using their understanding of crash causality and the likely systems present at Level 4 and Level 3. This review will identify which fatalities could have been prevented by the introduction of technology.

Comparison against research evidence

The outcomes of this assessment is compared against real world evidence of crash rates associated with automated vehicles.

Forecasting of scenarios

Timelines for the two transition cases are defined which include consideration of:

- Likely timeframe for introduction of level 3 and 4 technologies;
- Impact of vehicle turnover on introduction of vehicles into the fleet; and
- Potential sensitivity testing around the above factors;

Forecasting of benefits for each scenario

The outcomes of the assessments are overlaid to produce a theoretical estimate of the road trauma for the case where Level 3 is skipped or permitted.

References

Ma, R., & Kaber, D. B. (2005). Situation awareness and workload in driving while using adaptive cruise control and a cell phone. *International Journal of Industrial Ergonomics, 35*(10), 939-953. doi: https://doi.org/10.1016/j.ergon.2005.04.002

Marçal, R., Antonialli, F., Habib, B., Neto, A. D. M., Lima, D. A. d., Yutaka, J., . . . Nicolaï, I. (2017). *AUTONOMOUS VEHICLES: Scientometric and bibliometric studies.* Paper presented at the 25th International Colloquium of Gerpisa - R/Evolutions. New technologies and services in the automotive industry, Paris, France.

Milakis, D., van Arem, B., & van Wee, B. (2017). Policy and society related implications of automated driving: A review of literature and directions for future research. *Journal of Intelligent Transportation Systems, 21*(4), 324-348. doi: 10.1080/15472450.2017.1291351

NHTSA. (2018). Automated Vehicles for Safety. Retrieved 14/2/2018, 2018, from https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

Noy, I. Y., Shinar, D., & Horrey, W. J. (2018). Automated driving: Safety blind spots. *Safety Science, 102*, 68-78. doi: https://doi.org/10.1016/j.ssci.2017.07.018

SAEInternational. (2016). Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. In S. O.-R. A. V. S. COMMITTEE (Ed.), *SURFACE VEHICLE RECOMMENDED PRACTICE*: SAE International.