16 July 2018

Attn: Automated Vehicle Team
National Transport Commission
Level 3/600 Bourke Street
MELBOURNE VIC 3000

Comments on National Transport Commission Regulatory Impact Statement: "Safety Assurance for Automated Driving Systems: Consultation Regulation Impact Statement "

The University of New South Wales Research Centre for Integrated Transport Innovation (rCITI) is pleased to make this submission to the National Transport Commission, outlining its views on selected aspects of the Regulatory Impact Statement titled "Safety Assurance for Automated Driving Systems: Consultation Regulation Impact Statement "

The views contained in this submission are primarily those of rCITI's Professor of Human Factors, Prof. Michael Regan, and pertain to Human Factors-related issues. Our comments are set out in the appendix to this document and relate mainly to the following three questions raised by the NTC in seeking feedback on the RIS:

- To what extent has the consultation RIS fully and accurately described the problem to be addressed? Please provide detailed reasoning for your answer.
- What other factors should be considered in the problem statement?
- To what extent have the community and industry expectations of a regulatory response been accurately covered?

Where appropriate, evidence is provided to support our views.

We thank the NTC for this opportunity to comment on the RIS and for granting us an extra week to prepare our response.

Kind regards

Michael Regan PhD

Professor of Human Factors
Research Centre for Integrated Transport Innovation (rCITI)
School of Civil and Environmental Engineering

UNSW SYDNEY NSW 2052 AUSTRALIA
E: m.regan@unsw.edu.au
CRICOS Provider Code 00098G

APPENDIX

Comments on National Transport Commission Regulatory Impact Statement: "Safety Assurance for Automated Driving Systems

Section	Page	Comment
1.1 Introduction – What are Automated vehicles?	p. 4	This definition of an automatic vehicle is insufficient and vehicle-centric. An automated vehicle is one that is capable of automating, partly or fully, the following driving functions normally performed by human drivers: route finding, route following, velocity control, collision avoidance, adherence to traffic laws and vehicle monitoring (e.g. of internal warnings; speedometer) (Brown, 1986). A fully automated vehicles must be able to perform safely all of these functions, not just those sub-functions alluded to in the RIS.
1.2.2 Benefits and risks of automated vehicles	p. 5	It is stated: "Human error and dangerous human choices cause up to 94 per cent of serious crashes" It should be pointed out that not all human errors occur as a consequence of fundamental human information processing limitations. Many human errors are "design errors"; errors that are induced by poor vehicle design, poor road design, or poor design of training and licensing systems that expose drivers to otherwise avoidable error (see, for example, Noy, Shinar and Horrey, 2017) Estimates of the role of human error in road crashes are, therefore, likely to be over-estimates.
1.2.2 Benefits and risks of automated vehicles	p. 5	It is stated: "Automated vehicles will reduce human errors or potentially eliminate them completely. " It is overly optimistic to think that automated vehicles will eliminate road fatalities, due primarily to human error, for the following reasons: • Error is often cited by Police as a crash cause by default when there is no direct evidence of vehicle or infrastructure failure (Noy et al, 2018). The impact of human error in crash causation may, therefore, be overstated. • As noted, many human errors attributable to drivers are design-induced errors. This may also lead to an over-estimation of the likely impact of automated vehicles in overcoming human errors. • It cannot be assumed that automated vehicle

		technologies will themselves be error free; that their decisions will be flawless. The recent Tesla crash suggests otherwise.
		
		• It is not known whether driverless vehicles will be able to replicate the largely crash-free performance of human drivers.
		
		• Will the algorithms that drive automated vehicles be able to cover all potential crashes? In traffic, drivers' decisions are often governed by their assumptions concerning the expected behaviours of other drivers. Will AVs be able to "read the minds" of other road users? (Noy et al., 2018)
		
		• Will AVs be able to cope safely with poorly designed legacy infrastructure that is known to induce human error in manually-driven vehicles?
		
		• Will a new category of design-induced errors - "vehicle errors" - occur because of poorly designed software algorithms or poorly designed connectivity between vehicles, infrastructure and other "Things"?
		
		• Will new types of crashes emerge? E.g.
		    • from inadequate transfer of control between vehicle and human?
		    • from software bugs and failures
		    • from mixing autonomous and non-autonomous vehicles? e.g. people taking advantage of autonomous vehicles?
		
		• Will self-driving vehicles try to minimise injuries just to their occupants, or minimise harm overall to all parties in a crash? If the former is so, more people might be killed and injured
		
		• Drivers cooperate to avoid crashes most of the time – will driverless vehicles be able to cooperate as well as humans?

1.2.2 Benefits and risks of automated vehicles	p. 6	It is stated: "However, these expected benefits will be predicated on consumer uptake of automated vehicles, which is currently uncertain. " There exist some important national Australian data and findings, not cited in this report, that are relevant to the issue of likely consumer uptake of automated

<table>
<tr>
<td></td>
<td></td>
<td>

vehicles in this country - for example the published report by the Australian Driverless Vehicle Initiative (ADVI) on the findings a survey of more than 5,000 Australians who provided their opinions about automated vehicles (see Regan et al, 2017). Other recent surveys, also undertaken in Australia, are also relevant here (e.g. Kaur & Rampersad, 2018). The following are some key findings deriving from the ADVI study relevant to this RIS (p. 4):

- “Most Australians are aware of automated vehicle functions, but very few have experienced them.
- The community has concerns about many issues relating to fully-automated cars.
- Less than half of all respondents are willing to pay more for fully-automated cars than for their existing car.
- Most agree that there are many potential benefits from fully-automated cars.
- Most people are comfortable with automated cars controlling most driving functions.
- People are least comfortable with automated cars changing lanes by themselves and following cars ahead too closely.
- People are more comfortable about taking control than giving control to partly-automated cars.
- Most people would like to drive a fully-automated car manually, from time to time.
- Less than half of people think that fully-automated cars could be safer than a car driven manually by a human.
- Females and males think differently about fully-automated cars, on some issues.
- People in different Australian States and Territories think differently about automated cars”

The finding that most people would like to drive a fully-automated car manually, from time to time, is an interesting finding which may have important regulatory implications for driver training and licensing if vehicle manufacturers choose to produce AVs that

</td>
</tr>
</table>

		can be driven manually to satisfy customer demands.
2.3.1 Evidence that lack of confidence in ADS safety may reduce or delay their uptake	p. 20	Reference is made to a 2014 study by US researchers Schoettle and Sivak that surveyed 505 Australians. It would seem more appropriate here to be citing more recent national data obtained from a representative sample of more than 5000 Australians undertaken by Australian researchers and academics (see Regan et al; 2017).
4.3.1 Safe system design and validation processes	p. 34	The applicant should also be required to explain how the safety of occupants will be maintained in the event that the ADS is disengaged.
4.3.7 Human-Machine Interface	p. 35	A recent literature review undertaken by Prof Regan for VicRoads revealed no industry or government guidelines specifically for HMI design for highly automated vehicles. Design of the HMI for automated vehicles is a complex topic, and we recommend that further consultation with local and international HMI experts be undertaken in formulating principles-based criteria for HMI design and evaluation. We do not believe the principles currently outlined by the NTC are sufficient, and cannot ascertain from where they derive. They appear to be prescriptive in some cases where this may not be appropriate (e.g. in stating that the ADS's state of operation should be communicated by the HMI via an external communication interface.) We note, here, a peer-reviewed journal article by Debernard et al. (2016) that offers a number of high-level principles for optimizing interactions between the automated vehicle and the human driver to optimize safety which are relevant here: "Principle 1: The driver should know the maximum autonomy level of the vehicle as well as the external and internal conditions that allow it to enter the autonomous mode. Principle 2: The driver must know which tasks the autonomous system is capable of performing, under which conditions it can perform them, and how it will perform them. The driver should know what general functions are allocated to the autonomous system. Principle 1: The driver should know the maximum autonomy level of the vehicle as well as the external and internal conditions that allow it to enter the autonomous mode. Principle 2: The driver must know which tasks the autonomous system is capable of performing, under

		which conditions it can perform them, and how it will perform them. The driver should know what general functions are allocated to the autonomous system. Principle 3: The driver must know how the system prioritizes its behaviour when multiple options are possible. Principle 4: In the autonomous mode, the driver must be informed that the system will control the vehicle by following accepted driving practices and traffic laws (predictability of the behaviour of the vehicle). Furthermore, the driver must be able to detect the actions (e.g., lane change) being performed by the vehicle and understand them. Principle 5: In the autonomous mode, the driver must be able to perceive the intention of the system (the manoeuvre it intends carrying out), why, how, and when this manoeuvre will be carried out. Principle 6: In the autonomous mode, the driver should know each manoeuvre that could possibly interrupt the current one. This information will help him/her avoid being surprised or frightened by what is happening. Principle 7: In the autonomous mode, the driver should know how a given manoeuvre is being carried out or why a particular behaviour of the vehicle is observed. Principle 8: In the autonomous mode, the driver should have a sufficient understanding of what the autonomous vehicle perceives to realize its analyses and to make its decisions. The driver must be confident that the autonomous vehicle has the right information to make the right decisions and if not, he/she must be able to take control. Principle 9: It is important that the driver knows the boundaries of vehicle sensors, given that he/she can see information that the sensors may not receive. Principle 10: The driver should know what the current mode is, in order to avoid any mode confusion. Principle 11: The driver should clearly know how to migrate from one mode to another. Principle 12: The driver should know when and where the autonomous mode will be available to drive the vehicle.”
4.3.7 On-Road Behavioural	p. 35	The functions required to drive a vehicle manually were defined earlier in this submission. These are the

Competencies		functions that need to be automated, partly or fully, by technology. The applicant must, therefore, be able to (a) define the behavioural competencies required by the vehicle in order to safely perform these functions, (b) demonstrate that the vehicle possess these competencies in order to safely perform the required functions, and (c) provide documentation outlining the process for assessing and testing the ADS's behavioural competencies.
4.3.11 Education and training	p. 36	We cannot tell from where these education and training considerations derive. The Austroads report by Cunningham, Regan and Catchpole (2016) outlines recommendations for education and training of drivers of automated vehicles. These were derived from a review of the literature and expert consultations, and vary depending on the level of vehicle automation (e.g. SAE Levels 2,3,4 or 5). We suggest that the NTC refer to the Austroads report in framing these principles-based criteria for driver education and training. Driver licensing is used to regulate drivers' understanding of road laws and competency in operating specific vehicle types. There is currently no licensing system for ADSs, and we can see nowhere in the report any principles-based criteria pertaining to licensing. The Austroads report by Cunningham, Regan and Catchpole (2016) outlines recommendations and considerations for the licensing of drivers of automated vehicles. These were derived from a review of the literature and expert consultations, and vary depending on the level of vehicle automation (e.g. SAE 2,3,4 or 5). We recommend that the NTC refer to the Austroads report in framing principles-based criteria for driver licensing.
Appendix A.1 (Design Risks)	p. 67	An important risk for partially automated vehicles, not included, is a poorly designed human machine interface that fails to facilitate safe operation of the vehicle
Appendix A.3 (Operational/Use Risks	p. 69	Some other Human Factors-related risks, commonly cited in the literature (see, for example, Cunningham and Regan, 2015), include: • Under-trust of the automation e.g. driver takes back manual control of vehicle, even though the vehicle is more capable of avoiding a collision than the driver (this is a major problem in commercial aviation). • Over-trust, or "complacency" - when humans trust the automation more than is warranted • Misuse - a lack of understanding of the capabilities and limitations of vehicle automation may result in drivers falsely

		assuming that the vehicle is more capable than it is • Abuse - inappropriately high levels of trust in a system might encourage drivers to deliberately use the system beyond its operational envelope or operational design domain. The recent Tesla crash was a good example of this. • Skill loss - gradual loss of skill will result if drivers have not been in control of the system for prolonged periods of time, because of automation. • Cooperation - It is important to ensure that highly automated and connected vehicles do not overlook important information and communication channels that exist presently to eliminate traffic conflicts and crashes.
Appendix C.1.3 – Human-Machine Interface	p. 79	See comments for Section 4.3.7 above.
Appendix C.1.11 Education and Training	p. 84	See comments for Section 4.3.11 above.

References

Cunningham, M., Regan, M**.,** Catchpole, J., & Ballingall, S. (2016). Registration, licensing, and CTP insurance issues associated with automated vehicles. For: *Austroads*. Australian Road Research Board: Sydney.

Brown, I. (1986). Functional requirements of driving. Paper presented at the Berzelius symposium on Cars and Causalities, Stockholm, Sweden.

Regan, M., Cunningham, M., Dixit, V., Horberry, T., Bender, A., Weeratunga, K., Cratchley, S., Dalwood, L., Muzorewa, D & Hassan, A. (2017). Preliminary findings from the first Australian National Survey of Public Opinion about Automated and Driverless Vehicles. Australian Driverless Vehicle Initiative: Adelaide: ADVI. ISBN: 978-1-876592-85-1

Cunningham and Regan (2015). Autonomous Vehicles: Human Factors Challenges and Opportunities. In t*he Proceedings of the Australasian Road Safety Conference*, Gold Coast, Australia, October 14-16.

Debernard, S, Chauvin, C, Pokam, R & Langlois, S 2016, ‘Designing the human-machine interface for autonomous vehicles’, *IFAC – Papers Online*, vol. 49, no. 19, pp. 609-14.

Kaur, K & Rampersad, G. (2018). Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars. *Journal of Engineering and Technology Management. 48*, 87-96**.**

Noy, I. Y., Shinar, D & Horrey, W.J (2018). Automated driving: Safety blind spots. *Safety Science, 102,* 68-78