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INQUIRY INTO HEAVY VEHICLE SAFETY AND USE OF TECHNOLOGY TO IMPROVE ROAD SAFETY

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General comments

Enthusiasts claim that technological advances in heavy vehicle road transport promise to improve road safety by removing, reducing or compensating for weaknesses in human performance. Although this is a seductive and exciting prospect, our enthusiasm for technological solutions to safety issues needs to be tempered by serious consideration of the practicalities of road transport, and in particular:

i) *the ability of technologies now (and into the future) to perform to a high level of reliability and to perform as expected by the driver and other road users.*
Automated or assistive technologies must be 100 percent reliable, or as close to it as possible. Unreliable sensor and other technologies should not be added to vehicles. User expectations about the functioning of the technology must not be misled. For example, the use of the word 'Autopilot' in a level 2 Tesla vehicle was inaccurate and misleading to users. Germany banned the use of the word in advertising this vehicle. We must not emulate poor design and marketing practices that lead people to overestimate the capacity of technology.

ii) *the impact of technologies on the heavy vehicle driver's task.*
Technology must facilitate the driving task and benefit the driver. Assistive technologies that assume the role of controlling vehicle direction and speed and require the driver to simply monitor vehicle progress should not be used in heavy vehicles. It is well-understood that humans are not good at maintaining alertness in monotonous or unstimulating conditions. Driver fatigue is already a known high risk in heavy vehicle road transport. Technologies that require drivers to maintain alertness in even more monotonous conditions where they simply have to wait until called to resume driving require drivers to apply even more effort into staying alert and awake. This is not a benefit to the driver. Furthermore, the median time required for a driver to resume control of the vehicle when required has been reported to be just over 4 seconds (or 6 seconds if the person is engaged in another task when the take-over request is provided), and 50% of people responded more slowly (Eriksson & Stanton, 2017). This is far too slow for safety.

iii) *the impact of heavy vehicle transport technologies on other road users*.
Many technologies in heavy vehicles will require a trade-off for other road users and this needs to be included in assessing whether to allow use of the technology. For example, many autonomous vehicles currently being trialled are much slower than other vehicles due to the technology itself or caution on the part of the policy and decision-makers. Large differences in speed between vehicles can increase safety risk. Other drivers become frustrated when the slower vehicle impedes their path so take risky manoeuvres to try to avoid them.

It is our view that despite strong interest in the potential of technology, some serious issues with the introduction of technologies in heavy vehicle road transport have been not been well-considered.

A range of further issues are discussed below against the terms of reference. This is not a comprehensive summary of potential issues.

a) The management of heavy vehicle driver fatigue and other safety risks through in-vehicle technologies, including benefits, costs, availability and adoption by industry

In-vehicle technologies relating to heavy vehicle driver fatigue:

Driver fatigue is a serious problem for heavy vehicle drivers. The causes of the problem relate largely to their very long hours of work and too little opportunity for rest. Working hours regulations allow Australian truck drivers to work longer hours and require them to have less rest time than almost all other countries with similar industries to ours (USA, Canada, European Union, New Zealand). Drivers in Australia are encouraged to work long hours and forgo rest by the way they are most commonly remunerated: by kilometre travelled or by trip (e.g., Williamson and Friswell (2013)). It is also very common for drivers to not be paid for non-driving activities so contributing to the incentives to work the long hours they are permitted or even longer.

In this context, many technologies intended to aid fatigue management will not be effective and may even add to the problem. If heavy truck drivers have active and legal incentives to keep driving rather than to take the time needed for rest and recovery, implementing technology that monitors, detects and warns of fatigue will not be useful. It will only look at the symptoms of the problem; not deal with the heart of the fatigue problem. The issues relating to the causes of fatigue in heavy vehicle driving need to be addressed before considering the costs and benefits of such technology.

Even if we assume that action is taken to address these fundamental causes of fatigue for heavy vehicles, there are still many issues with in-vehicle technologies purported to manage driver fatigue that should be highlighted. These relate to different types of in-vehicle devices:

- Devices that attempt to detect or warn drivers of fatigue or drowsiness.
  There is good evidence that drivers are aware of the onset of fatigue and can respond to fatigue well before they become too drowsy to drive safely or fall asleep (Williamson, Friswell, Olivier, & Grzebieta, 2014). These warning devices therefore only tell drivers about their current state when he/she is already aware. No-one falls asleep without knowing they are tired and therefore are at higher risk of falling asleep. The challenge is to get drivers to respond to their experiences of fatigue early enough which these devices do not do. They activate late in the development of fatigue, often too late for the driver to find an appropriate place to stop.

  For heavy truck drivers this is particularly important because the size of the vehicle limits where they can stop, and they may have to continue driving for some time to find a place to pull over. In addition to not providing much advance-warning of the need to take action to manage fatigue, a monitor and alarm does not guarantee that drivers will pull off the road in response to the warning. Monitoring systems only identify a problem that already exists, and consequently should be used only as a last line of defence rather than as a preferred strategy for managing fatigue risk. Other approaches are required to manage the organisational causes of fatigue risk such as long working hours, insufficient sleep, and night work.

- Devices that aim to enhance driver alertness during driving.
  Some research (e.g., Atchley & Chan, 2011; Atchley, Chan, & Gregersen, 2014; Dunn & Williamson, 2012; Gershon, Ronen, Oron-Gilad, & Shinar, 2009; Neubauer, Matthews, & Saxby, 2014; Trumbo, Jones, Robinson, Cole, & Morrow, 2017) suggests that in-vehicle tasks in addition to driving (such as answering trivia questions, or doing mathematical problems) can, at least temporarily, boost alertness in drivers who are losing vigilance during a monotonous drive. This effect may be sufficient to assist drivers to maintain alertness until there is an opportunity for effective rest from driving. Further research is needed to confirm the value of such strategies however this approach could be one aspect of a fatigue management system.

- Devices that warn of driving performance effects of fatigue management.
  Lane departure warnings are currently the most widely implemented devices for warning drivers of the effects of fatigue on performance, on the basis that drowsy drivers are more likely to wander out of their lane. Other aspects of driving likely to be compromised by driver fatigue could also be employed, such as reaction time to infrequent events. These devices have the same limitations as the drowsiness monitoring devices of responding late in the process of increasing fatigue. Delayed detection of fatigue will leave little time for heavy vehicle drivers to find appropriate stopping places. On the other hand, these devices have the advantage of signalling adverse effects on driving and so have high validity for safety.

- Electronic Work Diaries provide a real-time record of driving hours.
  These devices are intended to be used to monitor hours of service. They could also provide automated warnings when hours of work breaches are imminent or have happened. A problem with these devices is that they cannot automatically log non-driving hours of work and rely on the enterer to input this information. Working hours logs are further undermined by rules in NSW (and now adopted by the National Heavy Vehicle Regulator) allowing certain work-related activities to be classified as non-work and to be undertaken during driver rest breaks (e.g., refuelling and washing the truck). Even if accurate, work hours logs are only a proxy for fatigue. A range of factors that are not logged can affect the adequacy of work hours as an index of fatigue likelihood – sleep amount and quality, time of day, physical and mental health, use of caffeine, medications, drugs, etc.

The emphasis of all these technologies is on detecting fatigue when it occurs (treating the symptom) rather than managing work to make it is less likely fatigue will occur (preventing the disease). The technologies also place the responsibility onto the driver even though there is evidence that management decisions (e.g., rostering, work planning) and industry practices (e.g., payment regimes; queuing and waiting) are predictors of heavy truck driver work, rest and fatigue. Technological solutions that do not take these contextual issues into account will, at best, only ever deal with secondary indicators of the problem of driver fatigue. They will not help to address the primary causes.

In-vehicle technologies relating to other risks to safety:

The NSW Centre for Road Safety (2017) compiled a list of in-vehicle and vehicle-related safety technologies that are available for heavy vehicles (including fatigue-related devices) together with an estimate of the percentage of crashes that could be prevented by many of these technologies (see Table 1). The source of the crash prevention estimates is not stated so it is not possible to assess the veracity of the estimates of effectiveness, but the list covers a large number of technologies. Some have quite strong evidence for efficacy at least in other types vehicles (e.g., Electronic Stability Control).

These in-vehicle technologies for other safety risks are likely to improve safety to differing degrees. The majority operate to mitigate the crash or its effects rather than preventing the crash in the first place. This, of course, will limit their effectiveness. The rate of penetration into the truck fleet and the ability to retrofit older vehicles will affect their impact.

Good road safety practice should include an analysis of the usability by heavy vehicle drivers and the effectiveness of each of these technologies. In lieu of such analyses and for the purposes of this submission, there are a number of principles of the design of in-vehicle technologies that need to be taken into account in evaluating them. The list is extensive but includes the following:

- In-vehicle technologies should ideally operate unobtrusively to the driver and should not surprise or confuse them.

- Technologies that only warn drivers should be kept to a minimum. Warnings should be specific to the information being conveyed, explain the meaning to the driver and be 100 percent reliable.

- In-vehicle technologies should keep the driver informed and 'in the loop' at all times. Where the technology requires the driver to take back control of aspects of the driving task, it should provide sufficient time for drivers to do so safely.

There is a range of other principles that should be employed to evaluate the usability of new technologies for heavy vehicles. Providing a list of available technologies to industry is a useful first step, but there is a strong need to provide guidance to industry on the usability and potential threats to safety arising from the design of each one. Currently this is not available, but we have several avenues through which this guidance could be provided.

The Australian New Car Assessment Program (ANCAP) already provides guidance on crashworthiness of vehicles. It would be possible to work with end-users at ANCAP and Global NCAP to develop an improved and practical design guideline and valid and practical assessment tools for assessing usability of new technologies in heavy vehicles. These design guidelines and assessment tools would be used by ANCAP and associated organisations internationally. Based on the success of the NCAPs worldwide in the last decade, this is a most effective way of providing information to purchasers and users of new technologies for heavy vehicles. It would also have the effect of gaining the attention of the driving public, vehicle designers and manufacturers to motivate them to incorporate usability design guidelines into new vehicles and any associated vehicle-based technologies.

Table 1: Heavy vehicle safety technologies listed in Centre for Road Safety (2017)

i) Crash Avoidance Technologies	***ii) Protective Technologies***
Electronic Stability Control (ESC) System	Suspension Seats with Integral Seat Belts
Trailer Roll Stability (TRS) System	Seatbelts for Buses
Autonomous Emergency Braking (AEB) System	Rear Underrun Protective Devices (RUPDs)
Autonomous Reverse Braking (ARB) System	Side Underrun Protective Devices (SUPDs)
Electronic Braking System (EBS)	Front Underrun Protective Devices (FUPDs)
Anti Jack-Knife Braking	Supplementary Restraint System (SRS) Airbag System
Electronic Brake Distribution (EBD) System	Rollover Side Curtain Airbag
Load-Proportioning Brake Valve (LPBV) System	Cabin Strength Standards
Adaptive Cruise Control (ACC) System	Seat Belt Wearing Monitors
Driver Fatigue Monitoring System	Automatic Brake Adjustment (ABA) Devices
Wheel Nut Indicators and Locks	Electricity Line Proximity Warning Devices
Wheel Nut	***iii) General Safety Technologies***
Antilock Braking Systems (ABS)	In-Cabin Noise Quality
Disc Brakes	Ride Quality
Lane Departure Warning System (LDWS)	Ergonomic Cabin Design
Daytime Running Lamps (DRL)	Tipping-Trailer Stability Protection System
Blind Spot Elimination / Enhanced Daytime Vision System	Tipper Safety Systems
Enhanced Night Vision (ENV) System	Intelligent Speed Adaptation (ISA) Warning System
Adaptive Headlamps	Fire Suppression Systems
Cornering Lamps	Automatic Incident Notification and Routine Event Reporting Systems
Light Emitting Diode (LED) Lighting	Wheel Temperature Monitoring
Emergency Stop Light	Visibility
Enhanced Vehicle Visibility Markings	Fresnel Lens
Tyre Pressure Management Devices	Mirrors
Tyre puncture prevention and tyre inflation	Onboard Weighing System
Rail Crossing and Road Hazards Radio and GPS Warning Systems	
High Intensity Discharge (HID) Headlamps with Levelling System	
Automatic Traction Control (ATC) System	
Reversing Safety Systems	
Spray Suppression Devices	
Roll Away Emergency Parking Brake System	
Alcohol Ignition Interlocks	

Other potential in-vehicle technologies for heavy vehicles

Data on the correlates of heavy truck crashes in NSW including an assessment of the contribution of truck driver fatigue are not routinely available on the TfNSW Interactive Crash Statistics website (http://roadsafety.transport.nsw.gov.au/statistics/interactivecrashstats/index.html). This makes it difficult to track factors that are contributing immediately to crash events in NSW and that might therefore be worthwhile targets for in-vehicle technologies.

b) The development of connected and automated vehicle technologies specific for the heavy vehicle industry and opportunities for further development in this area

Currently, technology does not support fully autonomous trucks on the road and it is unlikely fully autonomous truck technology will be available in the foreseeable future. Many fundamental issues with autonomous vehicle control are yet to be resolved satisfactorily. Indeed, the range of problems to be resolved has not been fully mapped and new situations that show the weaknesses of various technologies are regularly being identified (e.g., not 'seeing' a white truck crossing the road, not predicting kangaroo motion, etc). Computer and communications security for automated trucks is a further issue and one relevant to all fully and partially autonomous vehicles.

Partially autonomous vehicles where drivers might be relieved of driving duty for a period and then be asked to resume control at a later time create a number of different problems. People are not good at resuming control of a task when they have been uninvolved for a period of time. First, simply asking people to monitor the driving task when the vehicle is in control creates a significant problem for safety. Human factors research shows that people are poor at maintaining vigilance in situations where they are simply required to monitor. This is especially a problem in monotonous situations like highway driving. The decline in attention to the task under these conditions is not under voluntary control and occurs very rapidly. Second, when drivers have been out-of-the-loop in controlling the vehicle, they do not have an up-to-date understanding of the current task circumstances. This is particularly acute if the driver is required to assume control because there is a crisis that is outside the capacity of the technology. Research on time required for a driver to resume control of a vehicle indicates that it requires around four to six seconds on average, far too long for a driver to successfully take evasive action. Partially autonomous heavy vehicles therefore pose a range of risks arising from the need to switch between a human and non-human operator. In other tasks where human-automation systems have been studied, some researchers suggest that the best approach is to ensure a co-operative relationship between the automation and human operators with ongoing participation from both partners. Currently, however, attempts to design such a vehicle-driver interface have not been fruitful.

Truck platooning is another proposed method of increasing the role of automation in trucks. A lead truck driven by a person controls driverless or partially autonomous truck ‘drones’ which follow. Although demonstrations of platooned trucks, are increasing, there are many fundamental safety issues with their implementation on-road that are simply being overlooked. These include:

- The reliability and security of the inter-truck communications systems underpinning platooning. As for all new technologies, the reliability and security need to be very high, but this is especially the case when a string of very large vehicles are sharing the road with other road users. For example, what are the preventive or contingency plans for an event where control of a drone platoon vehicle fails or when the lead vehicle has a collision How will platooning systems deal with occasions when the conditions confronting the lead and drone trucks are different (e.g., if a drone is clipped by another passing vehicle, or has a major shift in freight, or blows tyres, or experiences a brake failure). Certainly, effective communication protocols to inform other nearby road users about a problematic or disintegrating platoon in the traffic stream would be necessary.

- A platoon will have to accommodate the needs of the driver of the lead vehicle in the same manner as a conventional truck.
  This means it needs to park along the route to allow the driver to eat, shower, sleep, etc. The length of a platoon will limit the places where it can pull over to park if there is only a single driver which could make it more difficult for such drivers to find rest stop parking when they need it to combat fatigue or to meet their working hours obligations. Currently, long roadtrains are limited to particular roads and regions and the same issues confronting these long trucks will apply to platoons with driverless drones. Many fuel stops and truck parking areas on high volume highways have not been designed to cater to long roadtrains or platoons. So, it is likely drivers will have to break and reassemble platoons to manoeuvre trucks individually into position for parking, refuelling or reforming the platoon, which is additional work time for lead drivers pulling driverless drones that needs to be accounted for.

- The interaction between platoons and other road users.
  It is not clear how platooned and non-platooned trucks will operate at the same time nor how each will interact with other road users. It is not clear whether other vehicles will be able to merge into a platoon if the travelling distance between the trucks has been mimimised. If drivers do not know whether the truck ahead is part of a longer platoon nor how long it is, they will not be able to make safe overtaking decisions. The nature of the platoon (length, number of vehicles) will have to be communicated to other road users using a standard, universally understood protocol which will require considerable public education. The problems posed by overtaking suggest that platooned vehicles should be used only on the highest quality roads or designated freight corridors.

- Crash statistics show that majority of heavy vehicle crashes where someone is killed and a substantial proportion of heavy vehicle crashes resulting in non-fatal injuries are caused by the behaviour of drivers in other, light vehicles.
  This means that platoons (and any autonomous technology) will need to be responsive to unexpected and dangerous behaviours by other road users. However, the momentum of trucks means their response to such behaviour will be relatively slow, so it remains to be seen how well automation technology can improve safety.

Overall, despite considerable media around claims that platooning of trucks will occur in the next few years, there are serious impediments in the transition to connected and automated heavy vehicles. These are unlikely to be removed easily and without a great deal of expense.

c) The role of compliance and enforcement in maintaining the safety of heavy vehicles on our roads

Encouraging compliance with safety rules and standards is often achieved through enforcement. Technology can enable enforcement agencies and regulators to gather and automatically process large amounts of data in real time on compliance and noncompliance with a range of issues such as vehicle condition and work history, loading and mass, and driver work management. In the heavy vehicle industry this can be extended to mandating use of black box and collision recording technology to enable greater understanding of crash circumstances and useful prevention strategies, whether vehicles were manned or not. The application of technologies to increase the scope, availability and use of 'big data' in road transport enforcement, and in evaluating policy and regulation has not attracted the same attention as vehicle automation but could provide genuine safety benefits by identifying problems in transport management at the company, industry or regulatory level that lead to on-road safety problems. This is an opportunity to improve road safety for heavy vehicles.

d) Heavy vehicle safety strategies implemented in other jurisdictions, both domestically and internationally.

One of the most striking differences in heavy vehicle safety strategies between Australia and other international jurisdictions is the working hours of service allowed under fatigue management regulations. Australia currently allows longer hours of work and requires the shortest continuous rest time compared to other OECD countries and regions to which we are usually compared. As shown in Table 2, compared to the EU, the US, Canada and New Zealand, total duty time allowed in Australia is higher and the continuous rest time required for a sleep opportunity is markedly lower. In fact, the Australian requirement of only requiring seven hours rest in 24 hours is too short to allow time for the recommended 7-8 hours of sleep as well as time for meals and other activities of daily living. Our regulations are inadequate to ensure fatigue management for heavy vehicle drivers. These regulations have remained largely the same for decades. Some small changes in 2008 have done little to improve the situation. Australia needs to review our fatigue risk management approaches for heavy vehicle drivers as soon as possible and at least bring them into alignment with those of other jurisdictions such as the EU.

Table 2: Comparison of working hours limits in Australia with selected similar countries

	US	EU	Canada	New Zealand	Australia
Driving time between long rests	11 hr	9 hr	13 hr	13 hr	12 hr (14hrs under BFM option)
Total duty time	60hrs/7 days 70hrs/8 days	56hrs/7 days 90 hr/14 days Mean 48hr/wk (in 17 wks)	70hr/7 days 120 hrs/14 days	70 hrs/7 days	72hr/7 days 144 hrs/ 14 days
Continuous rest time	10hr	11hr or 3+9=12hr	8hr	10hr	7hr

e) The road toll during the period commencing 1 December 2017 through to 31 January 2018.

NSW saw a notable increase in the road toll over the recent Christmas/New Year period. This produced a great deal of discussion in the media regarding the causes and whether this peak in road fatalities signified a worrying new trend or was a continuation of changes already occurring. In support of the latter alternative, road fatalities and crashes have been increasing markedly over the last few years. An increase between December, 2017 to the end of January, 2018 is consistent with this increasing pattern.

It might be argued that it could be worthwhile to do a specific analysis of the reasons for the increased road fatalities in the December to January period. A similar marked increase in road fatalities and fatal crashes occurred in NSW over a similar period in 2000-2001. We participated in a review of the causes of the increase conducted by a Road Safety Task Force instituted by the Minister for Roads. The review was very comprehensive and involved crash data analysis, mass media research reviews, an enforcement and deterrence study, an attitude survey, and observational studies of road use behaviour.

The analysis concluded that the higher crashes were part of an increasing trend in recent years. In general, the analysis indicated that the road user behaviours that presented highest risk were not different from previous years: speeding, drink driving, fatigue and non-wearing of seatbelts. The in-depth analysis also revealed some specific issues characteristic of the Christmas period. This involved more of the fatalities occurring on rural, high speed roads especially on curved sections. More of the crashes occurred in northern NSW and more involved speeding.

Overall, this was a very thorough attempt to examine a wide range of possible causes of the increased road toll. It is likely that a similar analysis of the most recent period of increased road crashes would also show that crashes occurred for the same reasons. This suggests that efforts might be better directed towards strategies to reduce known risk factors for crashes rather than trying to locate specific reasons for an increasing trend.

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