Submission

No 39

DRIVER AND ROAD USER DISTRACTION

Organisation: Transport and Road Safety Research

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Date Received: 18/05/2012

SUBMISSION TO THE JOINT STANDING COMMITTEE ON ROAD SAFETY (STAYSAFE) INQUIRY INTO DRIVER AND ROAD USER DISTRACTION

prepared and submitted
by

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Overview

This submission is made on behalf of Transport and Road Safety (TARS) Research, at the University of New South Wales, in response to a request from the Staysafe Committee. It is based on research conducted by the authors over the past few years, and on other relevant literature. The submission has two purposes: (a) to highlight important sources of literature that exist that have relevance to the activities of the Inquiry; and (b) to provide information and recommendations directly relevant to the Inquiry Terms of Reference.

Introduction

Driver distraction is a significant road safety problem.

In the United States, which collects the most accurate data on the role of driver distraction in crashes, it has been estimated, from Police-reported data, that between 18 and 22 % of all crashes involve driver distraction as a contributing factor (NHTSA, 2010). Findings from so-called "Naturalistic Driving Studies, in which vehicles are instrumented for several months with equipment (e.g., video cameras, accelerometers, GPS) that records continuously driver and vehicle behaviour, suggest that driver distraction (from non-driving-related activities) is a contributing factor in around 23% of crashes and near-crashes (Klauer et al., 2006). For truck drivers, it has been estimated that driver distraction (from non-driving related activities) is a contributing factor in 71 percent of crashes, and in 46 percent of near-crashes (Olson et al., 2009).

Moreover, there is evidence, also from the United States, that driver distraction and driver inattention are more important than some other factors known to be critical in crash causation.

Craft and Preslopsky (2012) conducted a relative risk analysis of data from two major studies of motor vehicle crash causes conducted in the USA between 2001 to 2007: the Large Truck Crash Causation Study (LTCCS; 2001-2003) and the National Motor Vehicle Crash Causation Survey (NMVCCS; 2005-2007). The latter included cars, small trucks, vans and sports utility vehicles. These studies involved 963 and 5,460 crashes, respectively. Driver distraction/inattention was coded for 20 percent of the large truck drivers and for 19 percent of the passenger vehicle drivers. Driver distraction/inattention was found to be the second most dangerous truck driver factor in large truck crashes (the first was travelling too fast for conditions), and the second most dangerous behaviour for passenger car drivers (the first was inadequate surveillance). Craft and Preslopsky concluded (p.31) that "Both the LTCCS and NMVCCS found distraction/inattention much more important than other factors thought to be critical in crash causation such as fatigue, illegal drugs and alcohol."

The last decade, and particularly the last 5 years, have seen a massive increase in interest in and research on driver distraction (Regan, Lee and Victor, 2012), including the publication of two seminal books on the topic (Regan, Lee and Young 2009; Rupp, 2011), preparation of another book on driver distraction and inattention in press (Regan, Lee and Victor, 2012), the conduct of two major international conferences on driver distraction and inattention (Regan and Victor 2009, 2011; the peer-reviewed papers from which are freely available for download), the convening in the United States, by the US Secretary of Transportation, Ray LaHood, of two national summits on distracted driving (Department of Transportation 2009, 2010; the paper and presentations from which are freely available for download), and the convening of a US-European expert "Focus Group" tasked with resolving some key issues relating to the definition and characterisation of driver distraction and inattention, and with identifying key research issues (Engström et al. 2010).

A search of eight major research databases, undertaken by the Governors Highway Safety Association for a recent review of distracted driving (GHSA, 2011), identified more than 350 scientific papers on driver distraction-related issues that were published between 2000 and 2010. In addition, there have emerged in the last 5 years several reviews of the literature on driver distraction (e.g., GHSA 2011; Kircher, Patten and Ahlstrom, 2011; Angell & Lee, 2011; TIRF, 2011; Robertson, 2011) and some seminal policy documents (eg NHTSA, 2010; WHO, 2011; TRB, 2011).

In Australia, the Parliament of Victoria Road Safety Committee published in 2006 the findings of its Inquiry into Driver Distraction (Parliament of Victoria, 2006), which provided the blueprint for the management of driver distraction in that state. The deliberations of that Committee were informed by a major submission prepared by the lead author of this submission (Regan, Young and Johnston, 2005), most recommendations of which are relevant to the deliberations of the current inquiry.

There is, in summary, a vast body of literature on driver distraction available to inform the present deliberations of the Staysafe Committee.

Addressing the Terms of Reference

a) The nature and extent of distraction as a contributor to crash casualties on NSW roads

Distraction can affect the safety of all types of road users, not just car drivers. This section looks at the evidence on the nature of distraction for car drivers, then for vulnerable road users.

Nature of distraction as a contributor to crashes: car drivers

(i) The mechanisms of driver distraction

To understand the nature of distraction as a contributor to crashes, it is necessary to understand its mechanisms. Much research has been done on driver distraction, without an understanding of what it means.

Driver distraction has been defined as "*the diversion of attention away from activities critical for safe driving toward a competing activity*" (Regan, Lee and Young, 2009; see below). This diversion can be self-initiated, or come about involuntarily, as when attention is caught by an attractive advertising billboard. Drivers do not always realise they are distracted: distraction periods without a surprising outcome often go unnoticed (Kircher, Patten and Ahlstrom, 2012).

Different sources of distraction exist, inside and outside the vehicle, which can divert attention away from activities critical for safe driving. These include objects, (e.g., a mobile phone), events (e.g. a crash scene), passengers, other road users, animals and stimuli internal to the driver's mind that trigger internal thoughts (Regan & Hallett, 2011).

Each potential source of distraction has certain *triggering modal properties* (Hallett, Regan & Bruyas, 2011) that may trigger a diversion of attention away from activities critical for safe driving: that is, whether it is *visual* (e.g. a billboard); *auditory* (e.g. an ambulance); *tactile* (e.g. a spider crawling on ones' arm); *olfactory* (e.g. car fumes); or *gustatory* (e.g. something awful just eaten that the driver wants to spit out). While a source of driver distraction can have one or more of these properties, research on the impact of driver distraction has focused almost entirely on sources of distraction that can be seen and heard.

The triggering modal properties of a source of driver distraction define, in turn, the *triggered response* to a source of distraction (Hallett, Regan & Bruyas, 2011). For driving, these triggered responses are *eyes off the road*, *ears off the road*, *mind off the road* (often referred to as "cognitive distraction"), and *hand(s) off vehicle controls* (e.g., steering wheel, gear stick). *Ears off the road* might occur when a driver is engrossed in a complex, emotional, telephone conversation: a driver may not attend to sounds around him that signal danger because attention is focused on the competing conversation. One or more of these triggered responses may be induced by driver engagement in a competing activity. An advertising billboard, for example, may take a drivers' eyes and mind off the road (if they think about what they have seen).

It is the interference with driving created by these triggered responses, alone or in combination, that degrades driving performance and increases crash risk. Although there are an infinite number of sources of distraction, the triggered responses that arise from a driver interacting with a source of distraction are limited in number, as discussed above.

Driving is a complex, multi-task, activity, and the *triggered responses* to a source of distraction have potential to interfere with one or more of the high level activities that comprise driving: route finding, route following, accident avoidance, velocity control, rule compliance and vehicle monitoring (Brown, 1986). It is beyond the scope of this submission to review the findings of studies that have examined the impact of these triggered responses on these driving activities, and the driving sub-tasks they comprise. These are summarised in Chapters 11 to 14 of the book by Regan, Lee and Young and in other documents (e.g., Kircher et al., 2011; Ranney, 2008; Caird and Dewar, 2006), and include missed traffic signals, prolonged reaction times, poorer lane keeping and other degradations in driving performance. There is some debate in the literature about whether these "degradations" in performance are indicative of loss of control or of compensation in response to distraction.

Generally, being distracted impacts negatively on driving performance, and increases crash risk. There is some evidence, however, that, for drivers that are sleepy, self-induced distraction (e.g. listening to the radio or talking on a mobile phone) may help drivers to stay awake (e.g. Oran-Gilad et al., 2008). Research on Australian long and short haul truck drivers shows that they use strategies such as listening to music or the radio, drinking and eating while driving as fatigue risk management strategies (e.g., Williamson, Feyer, Friswell & Sadural, 2000; Friswell & Williamson, 2008). Olsen et al. (2009), in a naturalistic driving study involving truck drivers, found that distracting activities that take the drivers' mind off the road (talking on a hands-free phone or on a CB radio) had a "protective" effect in reducing crash risk, presumably by keeping truck drivers awake.

Crashes and critical incidents occur when driver distraction "happens in the wrong place at the wrong time" (Kircher et al., 2011, p. 47) Thus, distraction disturbs driving performance, but it does not always result in a crash or critical incident.

Generally, taking the mind off the road (cognitive distraction), such as when conversing on a hands-free phone, increases reaction time, which can result in delayed or missed responses to safety-critical events. In addition, taking the mind off the road affects visual behavior, such that drivers look more straight ahead and less, or not at all, in the periphery. Several studies have shown that lane keeping actually improves when drivers are cognitively distracted. On the other hand, cognitive distraction has been shown to make it more difficult to remember and recognise objects that have been looked at during a distracting episode. It has been estimated that drivers using a mobile phone to talk "look at but fail to see" up to 50 percent of the information in their driving environment (NSC, 2010). Thus drivers who are cognitively distracted may be unaware of information that has been missed, and hence be unaware of their limitations when cognitively distracted (NSC, 2010).

Generally, looking away from the road leads to increased reaction time and decreased control of the vehicle, especially lateral control. (see Kircher et al., 2011 and Regan, Lee and Young, 2009 for reviews of the literature).

Thus, the impact of distraction on activities critical for safe driving (e.g. to yield at a traffic signal; to respond to a lead vehicle suddenly braking) depends on the extent to which the distracting activity takes the drivers' eye off the road, their mind off the road, their hand off the steering wheel, or one or more combinations of these triggered responses.

(ii) Factors that moderate the impact of distraction

The level of impact on driving that a source of distraction may give rise to depends on many factors. Young, Regan and Lee (2009) discuss these in Chapter 19 of their book:

- *Driver Characteristics* (e.g., age, gender, driving experience, driver state, degree of practice/familiarity with the distracting task, personality, etc) – for example, less experienced drivers, because they have only partially automated some driving skills, may have less attentional capacity available to manage competing activities.
- *Driving Task Demand* (e.g., traffic conditions, weather conditions, road condition/design, number and type of vehicle occupants, cockpit interface design, vehicle speed) – generally, the more heavily loaded is a driver, the less attentional capacity they will have available to manage competing activities.

- *Secondary Task Demand* (e.g., psychological compatibility of the distracting task with the driving task, complexity, ignorability, predictability, adjustability, interruptability and frequency and duration of engagement) – the less attention a secondary activity requires, the more likely it is that it can be time-shared with the primary driving task.
- *Self-Regulation Strategies* – the ability of the driver to adjust/regulate their driving behavior in anticipation of a distracting event, or in response to a distracting event, at the strategic, tactical and operation levels of control. e.g. turning off their mobile phone before a trip (strategic control); reducing conversation with a passenger when driving through an intersection (tactical control); and decreasing speed during a telephone conversation (operational control).

To date, the focus of research and countermeasure development has been almost entirely on "Secondary Task Demand" and, to a far lesser extent, on "Self-Regulation Strategies". Exploration through research of the "Driver characteristics" and "Driving Task Demand" factors that may potentially influence the impact of driver distraction – and, hence, which might be the target of appropriate countermeasures – have gone almost untouched.

(iii) Sources of distraction that pose the greatest risk to driver safety

To date, large-scale naturalistic driving studies conducted in the United States (e.g., Klauer et al., 2006; Olsen et al., 2009) provide the best available estimates of those sources of distraction which pose the greatest safety risk to car and truck drivers.

Hanowski et al. (2012) highlight an important finding from these studies: that competing activities associated with the highest odds ratios (i.e., highest increases in risk) also have the highest eyes-off-road durations. A detailed analysis of eye glance behaviour from the Olson et al (2009) study revealed that, for texting, the mean duration of eyes-off-road time was 4.6 s in a 6 s window. Conversely, competing activities that did not have high odds ratios did not have high eyes-off-road durations. The mean duration of eyes-off-road times for talking or listening on a hands-free phone, and for talking or listening on a CB radio were 1.6 seconds and 1.3 seconds, respectively. Hanowski et al (2012) go as far as saying that, at least for truck drivers, these latter two activities have a "protective" effect on driver safety. Regardless of what the driver was looking at, if their eyes were off the forward roadway for a total of 2 or more seconds in a 6 second period, then their crash risk doubled. Importantly, the 2 seconds could consist of multiple short glances to different things, not simply a single glance, meaning that multiple visual distractions can have a cumulative effect.

The Klauer et al (2006) and Olson et al (2009) studies reveal more specific information about those sources of distraction that appear to pose the greatest risk to driver safety.

In the study by Klauer et al (2006), involving instrumented *cars*, it was concluded that "reaching for a moving object" posed the most significant safety risk for drivers; drivers were 8.8 times more likely to be involved in a safety-critical event (SCE) while reaching for a moving object. Looking at external objects (i.e. external to the vehicle) increased significantly the risk of having a SCE, by 3.7 times, followed by reading (by 3.4 times), applying makeup (by 3.1 times) and dialing a hand-held phone (by 2.8 times). Interestingly, none of the following activities was associated with an increase in risk – inserting/retrieving CD, eating, reaching for a non-moving object, talking/listening to a hand-held device, and drinking from an open container. In this study, no texting was observed as it was not a common occurrence at the time of the study.

In the study undertaken by Olsen et al (2009), involving instrumented *trucks*, it was concluded that texting, using a mobile phone, posed the most significant safety risk to drivers. Drivers were 23.2 times more likely to be involved in a safety-critical event (SCE) while text messaging (although alarming, this figure should be treated with caution, as the number of texting events in the baseline and critical event windows used to analyse the data was very small). Use of a dispatching device increased the risk of having a SCE significantly, by 9.9 times, while writing, using a calculator, looking at a map, dialing a cell phone and reading increased risk significantly by 9.0, 8.2, 7.0, 5.9, and 4.0 times, respectively (Hanowski, et al., 2012).

The Olsen et al. (2009) study also yielded some interesting findings for mobile phone use. As Hanowski et al, (2012) point out, reaching for, and dialing, a mobile phone were determined to be high-risk activities (with odds ratios of around 6.0). However, for truck drivers, talking or listening on a hand-held phone did not increase the risk of being involved in a safety-critical event, a finding which is consistent with an earlier naturalistic driving study involving car drivers conducted by Klauer et al. (2006). For truck drivers in the Olsen et al. (2009) study, talking or listening on a *hands-free* phone was actually associated with a *decrease* in the risk of having a safety critical event (odds ratio = 0.4), as was talking or listening on a CB radio (odds ratio = 0.6). Similarly, looking outside at a “vehicle, animal, person, object” was also associated with a significant *decrease* in the risk of having a safety critical event (odds ratio = 0.5). Why this was so for truck drivers is unclear.

Evidence from controlled studies, such as in the laboratory or driving simulator, demonstrate that distracting activities that take the drivers’ mind off the road, such as talking on a hands-free or hand-held telephone, have a detrimental effect on various aspects driving performance. Clearly the differences between naturalistic driving studies and laboratory studies that allow control over the driving situation are a likely reason for these differences in findings. The results of these studies may also differ because driving is primarily a visual task; so in naturalistic driving studies, visual distraction is relatively easy to detect whereas cognitive distraction is not since it has not been possible in the naturalistic driving studies undertaken to date to know what a person was thinking about by observing them or their behavior. In the laboratory, it is possible to manipulate what people think about and so to measure the effects of cognitive distraction. The results may also differ as the criteria used to define safety-critical events in naturalistic driving studies are biased towards those events resulting from visual distraction, such as sudden changes in longitudinal acceleration, time-to-collision, vehicle swerve, and lane deviation; whereas in a state of cognitive distraction, drivers typically fail to react.

Currently, therefore, there is fairly good evidence that distractions that take eyes-off-the-road or hands off the steering wheel need to be avoided. The effect of cognitive distraction should not be dismissed, however. Further research is needed to understand more about its nature and effects on driving, especially in real traffic.

(iv) Commercial Roadside Signage

Driver distraction commonly arises in response to stimuli and activities inside the vehicle. However, events and stimuli outside the vehicle can also divert drivers’ attention away from the driving task and, potentially, away from safety-critical information.

For example, in a naturalistic driving study in the US, drivers' odds of having a crash or near-crash increased by 370% when they were looking at an external object rather than the forward roadway (Klauer et al, 2006). Indeed, regardless of what the driver was looking at, if their eyes were off the forward roadway for a total of 2 or more seconds in a 6 second period, then their crash risk doubled. Of particular concern among external distractors are commercial roadside signs and advertisements which are specifically designed to attract drivers' attention.

Roadside signs vary considerably in size and perceptual quality. They range from small kerbside signs on bus shelters or business premises, to large billboards over 4 metres square, and to signs that cloak multistorey buildings. Some signs are unlit, others are externally lit and others internally lit, producing considerable variation in brightness, contrast and visual conspicuity or salience. Signs also vary in their capacity to present moving images or to imply motion via special effects like flashing or fading.

There has been only limited good quality research investigating the effect that roadside advertising signs and their characteristics have on driving performance and safety.

TARS researchers have reviewed the available scientific literature on the safety implications of roadside advertising signs, most recently focussing on electronic signs (Friswell, Vecellio, Grzebieta, Hatfield, Mooren, Cleaver, & De Roos, 2011; Friswell, Vecellio, Grzebieta, Mooren, & Hatfield, 2010; Hatfield, 2005, 2008). These and other Australian and international reviews (e.g., Farbry, Wochinger, Shafer, Owens, & Nedzesky, 2001; Horberry, Regan, & Edquist, 2009; Wachtel, 2009; Wallace, 2003a) converge on a number of conclusions, including:

i) Advertising signs may pose a particular safety hazard when they are sited at locations where the demands on drivers' attention are already high. For example, high attentional demand might occur in areas where drivers need to continously monitor many or unpredictable elements of the driving environment such as the movements of multiple road users like pedestrians, crossing, merging or turning traffic, traffic controls like traffic lights and complex road geometry.

   Interestingly, there are now a small number of studies (e.g., Oron-Gilad, Ronen, & Shinar, 2008) that suggest some types of engaging distractions (like trivia questions) may benefit drivers in monotonous locations where the demands of driving are too low to maintain full alertness. It has been suggested but not demonstrated that commercial roadside signs in monotonous road locations may impart a similar benefit. Research is needed to test this suggestion.

ii) Laboratory research into the ways image properties affect attention has shown that features like size, brightness or salience, colour and apparent motion or change can guide attention (Becker & Horstmann, 2011; Wolfe & Horowitz, 2004) and that some features like sudden changes in the periphery of the visual field can draw an observer's attention involuntarily (Forster & Lavie, 2008; Theeuwes & Godijn, 2001). This means that, depending on the features of the advertising sign, drivers cannot necessarily self-regulate whether they look at signs only when the demands of the driving task are low.

iii) Signs that show moving images (like video) attract more and longer glances than signs that do not (e.g., Beijer, Smiley, & Eizenman, 2004) and are likely to be a more hazardous distractor than signs that do not involve motion.

iv) Sign placement within the visual field is likely to be important. Signs placed lower in the visual field at street level, within the driver's horizontal hazard scanning zone, may interfere with hazard scanning whereas signs higher in the visual field (3m above the ground) may not interfere in this way (Crundall, Van Loon, & Underwood, 2006). Further research is needed.

v) The contribution of advertising signs to visual clutter can impair drivers' ability to isolate and respond quickly to driving relevant information (including traffic signs), especially for older drivers (Edquist, Horberry, Hosking, & Johnston, 2011; Edquist & Johnston, 2008).

Systematic research on the impact of commercial roadside signs is needed to properly understand the risk they pose and the conditions that amplify or minimise that risk. In an ideal world, and in accordance with a Safe System philosophy and a Vision Zero ambition, public road safety would be afforded maximum priority and the placement of advertising signs where they can attract the attention of drivers should not be permitted.

It is understood that Austroads has commissioned a project ("Impact of roadside advertising on road safety") to develop guidance for road authorities about the safety implications of outdoor advertising and, in particular, the increasing use of digital display technology for outdoor advertising signs. It is also understood that the NSW Department of Planning and Infrastructure is reviewing currently SEPP 64 (Advertising and Signage). Of interest is the development of guidelines on electronic signs. The current status of these projects is unknown to the authors.

Nature of distraction as a contributor to crashes: vulnerable road users

Very few studies known to the authors have been undertaken to examine the impact of distraction on the behavior of vulnerable road users. Indeed, the authors are aware of only 4 published studies described below, all of them concerned with pedestrian distraction. Nevertheless, it could be expected that the psychological mechanisms of distraction for pedestrians and cyclists are the same as those for drivers, even though the sources of distraction, the routes that they travel when distracted, the timeframes over which distracting activity occurs, and the impacts that distraction has on performance and safety are different. Given that so few such studies exist, they will be given more detailed attention.

In a study by Bungum, Day & Henry (2005), 866 pedestrians were observed by trained data coders as they walked across a 105-foot wide street with a stop light and a zebra crossing. Distracted pedestrians were defined as those (p. 269) "wearing headphones, talking on a cell phone, eating, drinking, smoking or talking as they crossed the street." The pedestrians were coded as being "cautious" if they looking left and right, and entered the crosswalk only when the white "proceed" light was illuminated. The authors found that only 14% of the pedestrians observed looked left and right and entered the crosswalk while the white light was flashing (i.e. were cautious). Around 20% of walkers were judged to be distracted as they crossed the road. Regression analysis revealed that distraction was negatively, but only weakly, associated with displaying cautious pedestrian behaviors. The authors concluded that (p. 269) "because traffic lights were routinely ignored and lack of caution was predicted by distraction, we suggest that inexpensive education efforts target pedestrians near college campuses."

In an Australian study, Hatfield and Murphy (2007) reported the findings of an observational study of 270 females and 276 males to compare the safety of crossing behaviours for pedestrians who were using a mobile phone, versus those who were not. Female pedestrians who crossed the road while talking on a mobile phone crossed it more slowly. In addition, they were "less likely to look at traffic before starting to cross, to wait for traffic to stop, or to look at traffic while crossing, compared to matched controls." (p. 197). Male pedestrians who crossed the road while talking on a mobile phone crossed more slowly at unsignalised crossings. The authors concluded that talking on a mobile phone is associated with cognitive distraction that may undermine pedestrian safety, and recommend that "messages explicitly suggesting techniques for avoiding mobile-use while road crossing may benefit pedestrian safety." (p. 197)

In two studies, Nasar, Hecht and Wener (2008) studied pedestrians distracted by mobile phone use. In the first, 60 participants walked along a prescribed route, half of whom conversed on a mobile phone; the other half held the phone awaiting a potential call which never arrived. Pedestrians conversing recalled fewer objects that had been planted along the route than pedestrians who had not been conversing. In the second study, three observers studied the pedestrian behavior of mobile phone users, i-Pod users, and pedestrians with neither of these devices at three crosswalks. Mobile phone users crossed unsafely into oncoming traffic significantly more often than either of the other groups. The authors concluded that for pedestrians, as with drivers, "cognitive distraction from mobile phone use reduced situation awareness, increased unsafe behavior, putting pedestrians at greater risk for accidents, and crime victimization." (p. 69).

In a study by Stavrinos, Byington and Schwebel (2009), 77 children aged 10 to 11 years old completed simulated road crossings in a simulated pedestrian environment. Children crossed the virtual street 6 times while undistracted and 6 times while distracted by a cell phone conversation. It was found that childrens' safety was compromised when distracted by a cell phone conversation. "While distracted, children were less attentive to traffic; left less time between their crossing and the next arriving vehicle; experienced more collisions and close calls with oncoming traffic; and waited longer before beginning to cross the street. " (p. 179). Further analyses suggested that distraction on the cell phone might affect children's pedestrian safety no matter what their experience level as a pedestrian or phone user. The authors noted some evidence that younger, less attentive and more oppositional children may be slightly more susceptible to distraction while talking on the mobile phone than older, more attentive, and less oppositional children.

Although relatively few studies exist on this topic, the available evidence suggests that pedestrians, both older pedestrians and children, who talk on mobile phones, or listen to music while walking, experience cognitive distraction which has adverse affects on their safety on the road. Some of this research, however, suggests that pedestrians using mobile phones may compensate for the impact by modifying their behavior to some extent, for example, waiting longer to cross the road or walking more slowly. Clearly, we need further systematic research on distracted pedestrians.

Extent of distraction as a contributor to crashes

To be able to ascertain the true nature and extent of distraction as a contributing factor in crashes and critical events, in NSW, or in any other jurisdiction, it is first necessary to define distraction, and to distinguish it from other forms of driver inattention. Failure to do so can have several important consequences (Regan, Hallett & Gordon, 2011):

- it can lead to different schemes for classifying and coding crash data, leading in turn to different estimates of the role of driver distraction and driver inattention in crashes, near-crashes and incidents;

- it can make the interpretation and comparison of research findings across studies for a given form of inattention difficult, or impossible; and

- it has implications for the types of countermeasures considered, and for their likely effectiveness.

Gordon (2009), for example, analysed Police-reported crash data in New Zealand for the years 2002 to 2003. When driving-related distractions (e.g., trying to find a destination; compensating for the effects of sun glare, etc) were excluded from the analysis, distraction was estimated to be a contributing factor in 6% of all police-reported crashes. If driving-related sources of distraction were included, driver distraction was estimated to be a contributing factor in around 10% of police-reported crashes during the same period. Variation such as this also makes it difficult to compare accurately the relative role of driver distraction/inattention in crashes with that of other factors such as fatigue and alcohol.

One definition being used increasingly by the international research community is:

> *"the diversion of attention away from activities critical for safe driving toward a competing activity", (Regan, Lee and Young, p.34)"*

This definition, with very minor variation, has been adopted by a 6-member international US-European expert group on driver distraction (Engstrom et al., 2010).

The definition proposed by Regan, Lee and Young (2009) assumes that driver distraction can be driver-initiated (e.g., when deciding to send a text message), can occur involuntarily (e.g. when attending to an ambulance siren), can derive from inside (within the car cabin) or outside the vehicle, can include both driving (e.g., attending to a low fuel warning light) and non-driving-related activities (e.g., inserting a CD into a CD player) that compete for the driver's attention, and includes "internal" (i.e. within the mind) sources of distraction, such as daydreaming.

Noteworthy is that some researchers in the driver distraction community regard thinking about things and daydreaming as "inattention", which leads to a further issue.

There is much confusion in the road safety community about the distinction between "driver distraction" and "driver inattention". Regan, Hallett and Gordon (2011) have attempted to resolve this issue, and have defined driver inattention as "insufficient or no attention to activities critical for safe driving." (p. 1775). They argue that driver inattention is a consequence of driver distraction, but that driver distraction (which they refer to as "driver diverted attention") is just one of several forms of driver inattention, the other forms being what they call "driver restricted attention", "driver misprioritised attention", "driver neglected attention", and "driver cursory attention". The above-mentioned US-European international expert group on driver distraction (Engstrom et al., 2010) has drawn on the work by Regan, Hallett and Gordon (2011) in deriving a similar taxonomy of driver inattention.

At the present time, it is unlikely that any jurisdiction in the world has in place a system for accurately classifying and coding driver distraction-related data that derives from a commonly agreed definition of driver distraction and which distinguishes, taxonomically, between the different forms of driver inattention described above. This makes it difficult to know the true nature and extent of distraction as a contributor to crash casualties anywhere, let alone in the Australian state of NSW.

A proper scheme for classifying and coding distraction-related data is just one requirement for being able to quantify accurately the nature and extent of distraction as a contributor to crashes.

Regan, Young, Lee and Gordon and Lee (2009; and Gordon, 2009)) recommend 3 further mechanisms for improving processes for collecting and analysing driver distraction-related data.

The first is to improve the way in which Police-reported crash data are collected and analysed. This includes improving the design of reporting forms to include provision for the coding of distraction-related data, training Police investigators to collect distraction-related data, improving processes for the subsequent capture, review and coding of data by data coders, and using trained coders.

The second is to undertake specialist, in-depth crash studies, in which trained investigators and other specialists attend crash scenes and gather, using specially designed investigation protocols, more detailed data on the contributory role of distraction in crashes. However, as noted by Regan, Young, Lee and Gordon (2009), data yielded in this way, as for Police-reported crash data, rely heavily on retrospective self-reports from drivers and witnesses, which are prone to a wide range of biases, including among other things the reluctance by drivers to report engagement in distracting activities which are illegal.

The most informative approach for studies that attempt to understand the nature and extent of driver distraction as a contributor to crash casualties on NSW roads, is to install in vehicles data collection technology that records continuously for months or years, or for a few seconds before and after a crash (using video cameras and other sensors), what drivers do when they drive. So called “naturalistic driving studies” (NDS), such as those undertaken by the Virginia Tech Transportation Institute (VTTI; Klauer et al., 2006; Olsen et al., 2009) in the United States, exemplify this approach, and allow researchers to understand not only the activities that drivers engage in that distract them, and the extent to which they do so, but to quantify the *increase in risk* associated with driver engagement in those activities. To date, the vehicles instrumented in these studies have been mainly cars and trucks, although some recent studies have involved the instrumentation of motorcycles (in the EC-funded 2-BE-SAFE project; and in a VTTI-led study), and bicycles (by the SAFER institute at Chalmers University, in Sweden; Marco Dozza, personal communication, 15 May 2012; and by researchers and their affiliates at TARS – see below). Although crashes are rare events, the studies involving instrumented cars and trucks have yielded thousands of critical events in which driver distraction has been found to be a contributing factor, and have potential to improve understanding of how drivers self-regulate in anticipation of, and in response to, distraction – at least to those sources of distraction that can be observed and which can be linked to visible changes in driver and/or vehicle behaviour.

Transport and Road Safety (TARS) Research, at the University of NSW, has sought funding to undertake in 2013 such a large-scale naturalistic driving study in Australia. If funded, the study will be designed to collect, among other things, data on the role of driver distraction and inattention in crashes and critical events involving, in the first instance, cars.

Very little is known around the world about the nature and extent of distraction as a contributor to crash casualties for road users other than car and truck drivers – for public transport drivers, and for vulnerable road users. The issues involved in establishing the nature and extent of distraction as a contributor to crash casualties for these road users are similar to those for the drivers of cars and trucks, although the sources of distraction to which they are exposed, and the activities that are critical for safe walking, cycling or riding, may be different (e.g., Salmon et al., 2010; Hatfield et al., 2007).

The methods of the naturalistic driving study will also be useful in understanding the nature and extent of distraction as a contributor to crash casualties for *all road users* (i.e., not just the drivers of cars and trucks), and to quantify the increases in risk associated with the different distracting activities in which they engage. There is, for vulnerable road users, a need to undertake naturalistic motorcycling, cycling and walking studies; and, in the public transport domain, there is a need to undertake, for example, naturalistic bus driver studies. It is possible, for example, to fit miniature cameras and other sensors to the helmets and frames of bicycle riders, to observe their riding behaviours. To date, however, these studies are in their infancy and very few are being undertaken.

TARS researchers, at UNSW, are currently running a cyclist cohort study involving 2500 cyclists collecting a diary of their activities. Included in this study is a sample of riders videoing how they travel along various routes in Sydney. This work is currently being funded under an Australian Research Council Linkage grant. Collaborators to the grant are the Centre for Road Safety at Transport for NSW, Sydney South West Area Health Service, Bicycle NSW and Willoughby Council. The videoing of cyclists negotiating their way through traffic and on footpaths and cycle ways is being lead by Adjunct Associate Professor Andrew McIntosh with the assistance of Mr. Edgar Schilter. Seventeen participants have been using GPS and Cameras to record 2 to 4 hrs of footage over a week. Rides vary from 10 minuts to 1.5 hours. While the focus of this study is on cyclist behaviour in terms of route selection, travel duration, travel speed, crashes, near misses, etc., this study has the potential to observe how riders and pedestrians and vehicles around them are effected by distraction (Poulos et al., 2011).

b) Current rates and future trends in take up of electronic devices, both by road users and vehicle manufacturers

TARS has not undertaken research on current rates and future trends in the uptake of electronic devices, by road users and vehicle manufacturers, although this is an important activity in informing countermeasure development, and is recommended by TARS. Nevertheless, some general comments can be made.

There is a trend for portable electronic devices that enable people to communicate, be entertained, and access information to become, functionally, more integrated. The iPhone, for example, launched in 2007, brings together all of these functions into a single unit. The iPad is designed similarly. From a distraction perspective, this might be seen as a positive development in the sense that drivers may be interacting in vehicles with a fewer number of electronic devices to achieve their functional purposes. Further, with greater functional integration comes greater standardisation in the design of the human-machine interfaces across the functions with which drivers interact.

On the other hand, the number and variety of functions that are available on portable electronic devices, like the iPhone, and Android analogues, are increasing at a rapid rate. Third-party applications (apps) for the iPhone have increased from none in 2008 to over 500,000 in 2012 (Regan, Lee and Victor, 2012). This means that there are many more things a driver can do using an iPhone now than they could 5 years ago; and that many more drivers will be tempted to use them, especially young drivers who are known from previous research to be most likely to use mobile phones while driving. From a distraction perspective, the main focus to date on mobile phone interactions has been on talking and texting. Almost nothing is known about the effects of driving performance of driver interaction with the myriad other apps becoming accessible on Iphones and similar devices.

The iPhone, by virtue of its relatively user-friendly interface, is attractive to many people, young and old. This is a new phenomenon. It is not uncommon for people in their 50s and 60s to be seen comparing the apps that they have downloaded and stored on their iPhones. The corollary of this is that there is new potential for older generations of drivers to access those apps while driving which are attractive to them and easy to use. It is important to understand the extent to which all generations of drivers are interacting while driving with currently available smart phone applications.

There is a trend towards increased connectivity between portable devices, like iPhones, and vehicles. It is now common for new vehicles entering the Australian market to be Bluetooth enabled, allowing drivers to receive and make telephone calls using vehicle controls and displays without the need to look at or manipulate their mobile phones or other portable devices. In some vehicles, this is easy; in others, it is more difficult than using the phone itself, and may induce more distraction than direct use of the phone. It is important to evaluate the distraction potential of existing interface solutions and for vehicle designers to adhere to ergonomics design standards for integration of electronic devices to minimise distraction (e.g., NHTSA, 2012) – to minimise eyes off the road time, to minimise mind off the road time and effort, and to eliminate or minimise manual interactions that degrade vehicle control.

Portable electronic devices are increasingly able to host functions provided by original equipment manufacturers. These include advanced driver assistance systems (ADAS), like satellite navigation and intelligent speed adaptation, which are available on smart phones in Australia. In Europe, open architectures, that enable communication between smart phones and vehicle sensors, for example via Bluetooth, are being used to host on smart phones collision warning and avoidance systems. From a driver distraction perspective, it is important to ensure that the interfaces for these functions minimise distraction. Another angle to consider, however, is that, although mobile phones, and especially smart phones, have potential to distract, the safety benefits of the advanced driver assistance systems they can support, at relatively low cost, may outweigh any safety dis-benefits of driver distraction.

Advanced driver assistance systems, capable of saving lives, are becoming increasingly available on devices that can be retrofitted to production vehicles. An example is the Mobileye system, developed in Israel, that hosts several important ADAS functions. While these retrofitted systems have tremendous potential to reduce road trauma, and will likely be attractive to consumers who want protection but cannot afford a more expensive car, the question is whether their potential to distract has been considered during the design and development process. While vehicle manufacturers have generally gone to great lengths to design ADAS to minimise distraction, it is unclear to what extent this is the case for the developers of aftermarket products.

Hedlund, Simpson and Mayhew (2006), note that new products are developed, introduced and modified very rapidly, with a typical user replacing his or her mobile phone every 18 to 24 months.

In order to provide an estimate of how emerging technologies are likely to affect driver distraction, it is important to develop an inventory of the technologies that are available, and on the horizon – for OEM, aftermarket and portable devices.

Consideration should also be given to a systematic programme of formal evaluation of the safe usability of these new devices, both those inherent in new vehicles and add-ons. The safe usability could be implemented as part of the ANCAP system in which vehicles and devices are evaluated for the usability of their design and their effects on safe driver performance.

c) Regulatory means of enforcing harm minimisation caused by such devices

The Different Roles for Regulation

Regan, Young and Lee (2009; Chapter 30) point out that traffic law and its enforcement has potential to influence behavior associated with driver distraction at different levels of driver control of the vehicle.

Driving has been said to occur at three levels of control: at the strategic level (e.g., "what route will I take"); the tactical level (e.g., "is it safe to overtake the vehicle in front") and at the operational level (e.g., "I must brake or I'll hit the vehicle in front") (Michon, 1985). Regulation can have a role in influencing driver distraction at each of these levels.

At the *strategic* level, laws that *prohibit driver exposure* to certain sources of distraction (e.g., the mobile phone) or to functions that can be accessed using that source (e.g., texting) may be effective in changing societal judgment of what is acceptable risk. Laws might also be used to mandate that certain system functions deemed to be dangerously distracting are "locked out" of use e.g. by preventing a destination entry from being programmed into a satellite navigation system while the vehicle is in motion.

Traffic law and its enforcement can also be used to influence behavior at the *tactical* level of control. Here, for example, a law might be prescribed that prevents a road user from engaging in a distracting behavior (e.g. conversing on a mobile phone) while performing some tactical manouvre – for example, banning a pedestrian from using a mobile phone while crossing an uncontrolled intersection if there is data that shows that pedestrians are at increased risk of being harmed when traversing intersections in a distracted state. Janitzek et al. (2010) have made a similar point.

At the *operational* level, laws might be used to mandate the use of "workload managers" (see below) that, among other things, prevent a mobile phone from ringing when driver workload is high. Laws might also be used to mandate vehicle fitment of real-time distraction mitigation systems that warn drivers if the system judges them to be distracted. Laws might also be used to mandate adherence by vehicle manufacturers, aftermarket suppliers and portable electronic device manufactures to existing ergonomic design guidelines aimed at limiting distraction from electronic devices.

Effects of Bans on using Hand-Held Mobile Phones

To date, most laws that have been enacted in relation to electronic devices pertain to mobile phone use. Kircher, Patten & Ahlstrom (2011) have reviewed recent research findings on the impact of laws that ban use of hand-held mobile phones on (a) driver compliance with the law and (b) traffic safety.

In relation to compliance, Kircher, Patten and Ahlstrom (2011) conclude that such bans are ineffective, "because any reductions in mobile phone use generally dissipate within a year or so of the new legislation being introduced." (p. 39). They base this on findings from studies undertaken in the UK, Finland and Portugal. Interestingly, they cite evidence from Europe showing that drivers in highly regulated countries are just as likely to send text messages as drivers in countries with no legislation, …,"suggesting that the laws [have] little impact on actual behavior". (p. 41). They cite, however, data that suggest that commercial vehicle drivers are more likely to comply with bans on the use of mobile phones if the bans derive from company rules than if they are legislated.

In relation to traffic safety, Kircher et al (2011) conclude, based on a review of the available evidence, that laws that ban the use (for any purpose) of hand-held phones, or texting in particular, do not reduce crashes …Possibly because the bans that are in place are only requirements for hands-free equipment and not total bans." (p. 41)

There are some salient research findings that are relevant to consider in the framing of legislation relating to electronic devices:

- Existing bans on the use of hand-held phones are generally ineffective, after a year or so, in discouraging drivers from using a mobile phone when holding it, and in reducing crashes. (evidence reviewed in Kircher et al., 2011; Regan et al., 2009)

- Phone conversations lead to longer reaction times, regardless of whether the driver is talking hands-free or talking holding the phone. (evidence reviewed in Kircher et al, 2011; Regan et al., 2009).

- There is some evidence that drivers increase headway and reduce speed when talking on a hand-held but not a hands-free phone, possibly because holding the phone is a constant reminder to the driver that they are engaged in a secondary activity (evidence reviewed in Kircher et al, 2011).

- As noted, commercial vehicle drivers are more likely to comply with bans on the use of mobile phones if the bans derive from company rules than if they are legislated (evidence reviewed in Kircher et al., 2011).

- Epidemiological studies, which compare the prevalence of mobile phone use in crashes with their prevalence in baseline conditions (a comparable situation in which no crash occurs), have yielded odds ratios (a measure of change in risk of mobile phone use) of between 1 (no difference in risk compared to baseline) and 4 (4 times increase in risk relative to the baseline condition), for mobile phones used in hand-held and hands-free mode. (evidence reviewed in Kircher et al., 2012; Regan et al., 2009).

Adequacy of Existing Distraction Legislation in NSW

Drivers

Regan, Lee and Lee (2009) highlight some general issues that should considered in optimizing the effectiveness of distraction-related laws: the legislation needs to keep pace with the evolution of these technologies; exemptions, where these are provided, should be justified on road safety grounds; the effects of existing legislation must be evaluated, on a regular basis; emerging technological developments that might obviate the need for Police enforcement of distraction-related laws should be exploited (e.g., to automatically block phone reception if the phone is being used illegally); and penalties for violation of laws should be commensurate with those pertaining to other deviant behaviours, such as speeding and drink driving, which carry comparable increases in risk.

In NSW there are several regulatory provisions that prohibit the misuse of items or devices which cause driver distraction. These exist under the NSW Road Rules 2008. The NSW rules are based on the Australian Road Rules, which are a set of uniform national model laws that form the basis of standardized road rules across Australia. The current regulatory provisions relate primarily to the banning of the use of hand-held mobile phones while driving (NSW Road Rules 300 and 300-1), and to prohibit drivers from driving a vehicle in which a television receiver or visual display unit in the vehicle is visible to the driver from the normal driving position or is likely to distract another driver (NSW Road Rule 299). Research by Hatfield and Chamberlain (2008) provides some support for this Rule. They investigated the effects of audiovisual display units that are visible from another vehicle. Results indicated that such units are likely to distract drivers and impair their driving performance.

The Australian Road Rules adopted in NSW that relate to the management of driver distraction appear to be the same as those that were adopted and existed in Victoria in 2005, when the Victorian Parliamentary Road Safety Committee conducted its Inquiry into driver distraction. Only one minor change to Road Rule 300 (pertaining to the use of mobile phone when driving) is discernible since then. In Chapter 5 of the MUARC submission to that Inquiry (Regan, Young and Johnston, 2005), the authors commented on the suitability and enforceability of these laws. Most of the comments made in that submission remain relevant today, and we draw Chapter 5 of that document to the attention of the Staysafe Committee.

Other Road users

Currently, the authors are unaware of any laws in NSW that ban the use by other road users of electronic devices with potential to distract. Although there are very limited data on the effects of using electronic devices on walking behavior (noted earlier in this submission), it can be assumed that the psychological mechanisms of distraction will be similar for these road users, although the activities that divert their attention away from safe road use may be different, their ability to self-regulate in response to distraction will be different, and the adverse impacts of the distraction may be more severe given that they are vulnerable road users. These are important issues that remain to be researched and understood. Bans on the use of electronic devices by pedestrians and cyclists, at least in certain high-risk locations such as intersections, might be warranted. However, in the absence of data on the relative risks associated with pedestrian and rider engagement in distracting activities in different situations (which could be obtained by conducting naturalistic driving, walking and riding studies), there is currently no substantive evidence base on which to justify such laws.

At the time this submission was being prepared, it was announced in the media that, in the town of Fort Lee, New Jersey, Police officers have begun targeting "dangerous walkers" after a brief warning period ending in March 2012. According to one media report, more than 117 texting pedestrians have been ticketed in response to three pedestrian fatalities and 74 pedestrian crashes in 2011, apparently associated with distraction from mobile phones. (see http://www.theglobeandmail.com/life/the-hot-button/nj-town-issues-tickets-for-texting-while-walking/article2432570/)

d) Technological solutions to managing the harmful consequences of distraction.

From the perspective of Vision Zero, the ultimate target, in managing driver distraction as a road safety problem, should be a distraction-tolerant road system in which no one involved in a distraction-related crash is killed or seriously injured (Tingvall, 2009; in Regan, Lee and Young, 2009). As Tingvall points out, this approach requires technological solutions that support drivers at all stages of the crash causation sequence, including those that are capable of preventing distraction-related crashes.

At the earliest stage of the crash causation sequence, technologies can help distracted drivers to continue to *drive normally*. An automatic transmission vehicle, for example, will, for a young novice driver, and even for experienced drivers, free up attentional capacity that can be used to manage distracting activities that compete for attention. So called "workload managers", which already exist in some production vehicles in Europe, are designed to prevent drivers from engaging in distracting activities when the system judges that they are too heavily loaded to deal with the distraction (NHTSA, 2010). They use sensors and algorithms to make real-time estimates of driver workload and, based on these, prevent, for example, the phone from ringing and take a phone message if the driver is judged by the system to be in a high workload driving situation (e.g. driving through a busy intersection at night in the rain) (see Engstrom & Victor, 2009). The same systems can also lock out driver access to some vehicle controls.

Technologies can help distracted drivers to *regain control* if they are distracted and *deviate from normal driving*. If, for example, they are visually distracted, their attention can be diverted back to the roadway by real-time distraction warning systems or forward collision warnings systems. Distraction warning systems on the market use a course visual behavior metric (usually head direction on or off road) and measure the consequences of distraction, such as poor lane and headway keeping (Victor, 2011). According to Victor, precise, low-cost, mass-market in-vehicle eye trackers are still a few years away, and the most-needed development, in addition to these, is a "validated quantification of which inattentive behaviours best predict crash involvement" (p. 20). If, when visually distracted, drivers drift out of their lane, they can be alerted by a lane departure warning system and/or by road tactile edge markings. If, as a result of being distracted, they exceed the posted speed limit, intelligent speed adaption can warn them of this.

Technology can also support distracted drivers in "emerging situations" (e.g., if they drive off the road when distracted); by, for example, taking corrective action automatically if they are judged to be unable to prevent a crash (e.g., via lane keeping assist or electronic stability control or forward collision avoidance technologies).

Where a crash is unavoidable, both passive and active safety technologies can be activated to minimise crash impact and consequent harm to the distracted driver and other occupants.

The point to be made here is that technological solutions exist to support the driver at all stages of the crash causation sequence, many of which do not target distraction directly as the causal factor. These solutions will assist drivers whose performance becomes unsafe, no matter what the cause.

If one thinks even more laterally about the role of technology as a countermeasure in road safety, there are other ways in which it can be used to prevent and mitigate the effects of driver distraction. It can be used, for example, as a platform for delivering knowledge to learner drivers and for testing their knowledge of distraction-related issues. It can be used to provide young novice drivers with real-time, and post-drive, performance feedback during the learner period, and beyond, to make them aware of the effects of distraction on performance (e.g., Donmez, Boyle & Lee, 2009). It can be used to train them during the learner period to manage distraction and to test their ability to manage distraction prior to licensing.

Workload managers and real-time driver distraction warning systems have considerable advantages over other countermeasures in preventing and mitigating the effects of distraction related crashes. These are summed up by Regan, Lee and Young (2009, p. 627):

"First, these [systems] are potentially capable of detecting whether a driver is distracted regardless of the competing activity (driving- or non-driving related) and whether driver engagement in the competing activity is voluntary or involuntary, and regardless of whether the impetus for the competing activity derives from inside or outside the vehicle. Second, the system can be optimized so that it is adaptive to factors that moderate the effects of distraction (e.g., driving demand, competing task demand, driver state, age and experience; for example, by issuing more conservative warnings if the driver is inebriated). Third, they can be used to prime and activate the operation of other active and passive safety systems at different stages of the integrated safety chain to optimize driver safety during all stages of the crash sequence. Finally, through the provision of real-time feedback to drivers, they have potential to provide long-term benefits in calibrating drivers to the dangers of distraction so they can better manage distraction, even when they drive vehicles not equipped with such systems."

How drivers adapt, positively or negatively, to those technologies that have been developed specifically to target driver distraction is, to the knowledge of the authors, unknown. It is well known that drivers do not always adapt to new technologies in the manner intended by designers; ABS brakes are a case in point. Although there is underway presently in Europe a large-scale Field Operational Test (FOT) designed to understand driver adaptation to a wide range of advanced driver assistance systems (the EuroFOT project; http://www.eurofot-ip.eu/), there has not, to the knowledge of the authors, been an FOT undertaken that has evaluated the effectiveness of workload managers and real-time driver distraction warning systems. There is an urgent need for such a study.

While the focus of discussion here has been on technological solutions to managing the harmful consequences of distraction for car and truck drivers, there is great scope for considering technological solutions that might be effective in minimising the potentially harmful consequences of distraction for other road users, especially for pedestrians, for whom there is accumulating evidence of harm. Although there is much research and development work going on in Europe, North America and Japan, in the general field of cooperative intelligent transport systems, there has not been, to the knowledge of the authors, any work in this area targeted at distracted vulnerable road users. There is great potential for a research and development project in this area in NSW.

e) Other solutions to reduce information overload for road users

The number and types of technologies entering the vehicle cabin – vehicle-integrated, aftermarket and portable – that have potential to distract the driver is increasing at a rapid rate (Regan, Victor, Lee and Young, 2009). Distraction from driver interaction with technologies is estimated to account for around 15 to 20 percent of all distraction-related crashes (Gordon, 2009).

Regan, Victor, Lee and Young (2009) discuss a range of countermeasures that can be implemented to “design-out” driver distraction during the technology design phase, before vehicles and other technologies are manufactured, and thereafter.

Guidelines – a range of guidelines already exist to support the ergonomic design and evaluation of the human machine interface for technologies in the vehicle cabin, including aftermarket and portable devices (see Green, 2009 and NHTSA, 2012, for reviews)

Standards – these include design standards (providing precise specifications for vehicle or vehicle systems in terms of physical attributes, geometry etc), performance-based standards (prescribing the minimal level of performance that a system must meet when tested according to a prescribed test method) and process-oriented standards (which define the systems and procedures an organisation should establish during system development) (see Green, 2009, for a review of these).

Use of a human-centred design process – a user-centered design (UCD) process can be viewed as an overarching countermeasure for designing out distraction. An ISO standard exists for the UCD process (ISO 13407), but methods for the human-centred design and evaluation of in vehicle functions have not been defined to fit in with this more general process (Regan, Victor, Lee and Young, 2009).

Human-Machine-Interface (HMI) Integration – the number of in-vehicle systems and functions with which the driver interacts is increasing, and as a consequence, so too is the number and complexity of input/ouput devices and associated driver behaviours relating to them (Regan, Victor, Lee and Young, 2009). HMI integration (e.g. to solve problems associated with the presentation of multiple simultaneous warnings) has been the subject of several major research initiatives in Europe and the United States.

Safe Integration of Portable Devices – as noted, open architectures exist that allow portable devices, like mobile phones, portable navigation systems and music players to be integrated, to varying degrees, with the vehicle via Bluetooth. The “Ford Sync” is an example of a system for portable device integration. However, as noted, the assumption that integrated systems are necessarily better in minimising distraction than non-integrated devices is not always true, and requires further research.

Incentive schemes - under a voluntary regime, even the most ergonomically designed vehicles and technologies will be ineffective in limiting distraction if there is no demand for them from consumers. There exist various mechanisms for stimulating voluntary demand by consumers for vehicles and technologies that improve safety. Hedland et al (2006) suggest that bonus points should be made available to vehicle manufacturers (e.g. under programs like ANCAP) for electronic systems that have been assessed as meeting minimum requirements for limiting distraction.

Real-time distraction prevention – as mentioned above, “workload managers” have been developed to prevent distraction from occurring by ensuring that drivers do not receive information when they are highly loaded, by discouraging drivers from using functions when they are highly loaded, by locking out certain functions when drivers are highly loaded and altering the way information is presented to drivers when highly loaded to minimise distraction (e.g. auditorily rather than visually). As a corollary to this, mobile phone service providers, like Telstra, could take messages for the driver when they detect the phone is being driven (Regan, Victor, Lee and Young, 2009)

Real-time distraction mitigation – as mentioned earlier, systems have been developed for redirecting drivers’ attention back to the roadway when it is detected that they have been glancing away from the road for too long, or too often, or when cognitively distracted.

Driver-vehicle-environment (DVE) adaptive collision warning functions – these functions adapt warnings from other systems (e.g. forward collision warning) to certain states of the driver, vehicle or environment. For example, if a real-time distraction mitigation systems detects that the driver is distracted, this information can be used to alter the timing, intensity, duration complexity and even modality of a forward collision warning – to take account of the distracted state of the driver. There is currently little consensus about which functions are most useful, and the full benefits of these functions are not entirely clear (Victor, 2011).

f) Any related matters

Managing Driver Distraction: Recommendations for Countermeasure Development

Much can be done to manage driver distraction as a road safety issue, and there exist important resource documents that provide guidance on how to proceed in doing so (e.g., Regan, Lee and Young, 2009; Regan, Young and Johnston, 2005; Parliament of Victoria, 2006; NHTSA, 2010).

The remaining sections of this submission draw on these resource documents, and on material reviewed in this submission, to provide recommendations for preventing and mitigating the effects of driver and vulnerable road user distraction in NSW.

Data collection

Better data are needed to guide countermeasure development – to quantify road user exposure to different sources of distraction, to quantify the relative risks of exposure to different distracting activities, to track changes over time in exposure to risk from distraction, and to monitor over time the effectiveness of countermeasures:

- Develop a commonly accepted definition of driver distraction. The definition by Regan, Lee and Young (2009) is recommended as a suitable starting point.
- Develop adapted definitions of distraction for other road users eg "pedestrian distraction", "rider distraction".
- Use these definitions to refine existing schemes for coding road user distraction-related data from Police-reports, in-depth crash investigations and naturalistic driving studies.
- Optimise and standardize the way in which Police-reported distraction-related crash data for all road users are collected and analysed. Improve data quality and training for Police and crash investigators.
- Undertake regular exposure studies, using appropriate data collection protocols and techniques (e.g., self-report exposure surveys and roadside observational studies) to track annually changes at the population level in exposure to known sources of driver and other road user distraction.
- Undertake a series of *naturalistic* driving, motorcycling, bicycling and walking studies in NSW to collect data on the types of activities road users engage in which distract them, and to calculate the relative risks of exposure to different distracting activities. Naturalistic driving studies should include special populations, such as Police, emergency and public transport drivers, as these groups may be more susceptible to the effects of distraction due to relatively high driving demands and a greater number of operations-related technologies with potential to distract them.
- Commission research to create an inventory of new technologies that have potential to support data collection (e.g. the rate at which drivers interact with electronic devices with potential to distract).

Legislation and enforcement

- Research is needed to evaluate whether existing laws in NSW that target distraction-related activities are effective in discouraging the legal behaviours they target, and in reducing crash risk.

- Research is needed to determine whether existing exemptions provided under existing laws in NSW that target distraction-related activities are justified on road safety grounds.

- Research is needed to identify technologies that exist, or are being developed, to support Police enforcement of laws relating to driver distraction.

- Problems associated with existing laws, outlined in an earlier MUARC submission to the 2005 Victorian Parliamentary Inquiry into Driver Distraction, should be addressed.

Publicity

While drivers are generally aware of the risks associated with mobile phone use, perceived risk seems to be less important in regulating phone use while driving than perceived social norms, attitude, perception of control and the believed importance of the call (Kircher et al, 2012). Kircher et al review data on explanations for drivers' propensity to use mobile phones while driving. These these include time benefits; people believing they are more capable than others in doing so; because they are not aware of their decreased performance while distracted; and because they have not been in a phone-related crash. Kircher et al also review data showing that experienced drivers are better able to self-regulate driving behaviour to compensate for the effects of distraction.

- Publicity campaigns should focus on those distracting activities which have been shown, in naturalistic driving studies, to involve the highest increases in risk.
- Publicity campaigns should address factors that motivate drivers to engage in distracting activities.
- Publicity campaigns should support drivers in knowing where, when and how to self-regulate their driving behavior to compensate for distraction, especially for distracting activities that pose the greatest risk.
- Publicity campaigns should dispel public perceptions that using a hands-free phone is risk-free, or minimally dangerous.

Driver training and education

The available evidence, reviewed in Kircher (2012), Regan, Lee and Young (2009), and NHTSA (2010) suggests that young drivers engage relatively more frequently in distracting activities, that they are more vulnerable to its effects, and that they are more likely than experienced drivers to glance away from the forward roadway for more than 2 seconds. Furthermore, there is evidence that practice in the simultaneous performance of driving and using a mobile phone is not of itself sufficient to eliminate crash risk; rather, more experienced drivers have better strategies for self-regulating their driving behavior to compensate for the effects of distraction. This is likely also the case for sources of distraction other than the mobile phone.

- Chapter 31 of the book by Regan, Lee and Young (2009; pp 559-578) specifies a wide range of driver distraction management competencies that could be addressed in driver training and education programs, using as a unifying framework the European-derived Goals for Driver Education Matrix. It is recommended that these be used as a suitable starting point for the development and refinement of driver and road user distraction training and education programs in NSW.
- Driving instructors need to be made aware of driver distraction management competencies that should be addressed in driver training programs.
- There is a need to develop training and education programs for the management of distraction for road users other than drivers. However, at the present time, this is little knowledge on which to base development of these programs.

Company Policies

Regan, Young and Lee (2009) note that, in Australia, around a quarter of all vehicles involved in crashes are business vehicles and that nearly 50% of all Australian workplace fatalities occur on roads if the requirement to travel to and from work is included. As noted, there is evidence that that commercial vehicle drivers are more likely to comply with bans on the use of mobile phones if the bans derive from company rules than if they are legislated. Generally, fleet owners are in a powerful position to develop and implement policies that regulate exposure of their drivers to distraction in vehicles driven for work purposes. This is because they are able to influence driver behaviour at all levels of driver behaviour (Regan et al., 2009): at the strategic level (e.g., by limiting the availability to employees of distracting technologies and devices and reducing productivity pressures to use mobile phones on the job); at the tactical level (e.g., through on-the-job education and training in how to self-regulate driving behavior to compensate for the effects of distraction); and at the operational level (e.g., through the provision to drivers of vehicles equipped with technologies designed to minimise distraction). Regan et al., outline a range of options that employers have at their disposal for preventing and mitigating the adverse effects of driver distraction.

- All NSW government departments be directed by the NSW parliament to amend their vehicle fleet management policies to include strategies for minimising the risks deriving from driver distraction
- Guidance should be provided to NSW government departments to assist them in developing vehicle fleet management policies that address driver distraction. Suitable guidance is contained in Chapter 30 of the book by Regan, Lee and Young (2009; pp 547-550).
- Mechanisms should be put in place to ensure that vehicle fleet management policies to limit distraction developed by the NSW government filter through to, and influence, fleet safety management policies of private sector companies.

Employers also have a duty of care to employees who are distracted when walking or riding for work purposes. It is important, therefore, that company policies include distraction mitigation countermeasures for vulnerable road users; although, at this point in time, there is little research evidence on which to base the development of such policies.

Driver licensing

The driver licensing system provides a powerful mechanism for managing driver distraction. However, few jurisdictions have exploited its full potential as a driver distraction countermeasure. Regan, Young and Lee (2009; pp 550-551) provide the following general recommendations for doing so:

- Licensing handbooks for learner drivers, probationary drivers and supervising drivers, should include basic information: distractions inside and outside the vehicle that are most likely to increase their crash risk; their impact on driver performance and safety; factors that make young drivers more vulnerable to the effects of distraction; practical strategies for avoiding and coping with distractions; and advice on technology features and modes of interaction with technologies that minimise distraction.

- Knowledge tests should include items that test driver knowledge of these issues.

- Computer-based tests, like the Hazard Perception Tests, should be developed to test, prior to probationary licensing, a drivers' ability to manage distraction.

- Practical driving tests, undertaken in real vehicles, should be designed to assess driver awareness of distractions, and its effects on their performance, and their ability to safely compensate for the effects of driver distraction.

- Generally, Graduated Licensing Systems (GLS) should systematically, and chronologically, expose learner and probationary drivers to potentially distracting activities (e.g., finding radio stations, using hands-free phones, carrying passengers) based on their level of driving experience and demonstrated competence in managing distraction.

For vulnerable road users – pedestrians and cyclists – it is important that traffic safety educations in schools, and public information campaigns, warn road users of the dangers of engaging in distracting activities while interacting with the traffic management system.

Road and Traffic design

Data from crash studies, reviewed by Gordon (2009), suggest that around 30 percent of distraction-related crashes derive from driver engagement with sources of distraction outside the vehicle. Data from the 100-car naturalistic driving study (Klauer et al, 2006) suggest that, for car drivers, looking at external objects was the second most distracting activity observed from video footage (increasing crash risk by 3.7 times). For truck drivers, looking at external objects is associated with a lowered risk of a safety-critical event (odds ratio = 0.54) (Olsen et al., 2009). Why this is so is not clear.

- A systematic program of research is needed to identify which traffic management-related object, events and activities on or near road reserves distract drivers, how they affect driving performance, and the relative risks associated with driver engagement with those sources of distraction. The naturalistic driving study, augmented by use of eye tracking equipment, is an appropriate research method for this purpose.

- Road safety audits, routinely undertaken in Australia, should include criteria for the identification and assessment of roadway-related activities, objects and events that could distract drivers.

- Guidelines and standards (design, performance-based and process oriented) are needed to support the ergonomic design and evaluation of the human machine interface for the design of the traffic management system to limit the effects of driver distraction.

- Systematic research is needed on the impact of commercial roadside signs is needed to properly understand the risk they pose and the conditions that amplify or minimise that risk. The naturalistic driving study, using eye tracking equipment, is an appropriate research method for this purpose.

- Guidelines should be developed which regulate the design, location, size and content of all road commercial roadside signs in order to minimise driver distraction.

- Standards should be developed which prescribe the maximum levels of distraction that commercial roadside signs must meet when tested, and prescribed methods for assessing the distraction potential of commercial roadside signs.

- Mechanisms should be put in place to put the onus on the developers of commercial road signs to design signs using the above guidelines and to prove, using the above standards, that their signs are safe to deploy.

- All commercial roadside signs that are to be erected should be accompanied by an assessment protocol for evaluating their impact on road safety.

Vehicle and Technology design

- Ensure that HMI design guidelines and standards are effectively disseminated, known and used by responsible stakeholders – vehicle manufacturers and suppliers of aftermarket products and portable devices - initially by reviewing the extent to which stakeholders that sell their products in Australia are adhering to specially-developed ergonomics guidelines already developed for limiting the effects of driver distraction (eg NHTSA, 2012).

- Support local industry to develop objective, safety-relevant, and efficient test procedures for OEM and aftermarket electronic devices that can assess the distraction potential of the devices before they allowed in a vehicle to be sold in Australia.

- Promote self-commitment by vehicle manufacturers and suppliers of aftermarket products and portable devices to a user-centred design process that supports HMI Integration and limits the adverse effects of driver distraction

- Commission research to create an inventory of new technologies available, and over the horizon, which have potential to distract drivers – OEM, aftermarket and portable technologies – and to evaluate their potential for distraction.

- Commission research to evaluate the effectiveness in improving safety of real-time distraction prevention and mitigation systems, and DVE adaptive collision warning functions, using naturalistic driving studies and field operational tests. Such studies are critical, given differences across countries and cultures in driver acceptance of these technologies, and in driving styles.

- Require the Australian New Car Assessment Program (ANCAP) to provide vehicle manufacturers with bonus points for electronic systems and interfaces that are known to be effective in limiting distraction, as a way of stimulating voluntary demand by consumers for vehicles and technologies that improve safety.

- Commission research to assess mobile phone interfaces – to identify the relative prevalence of use within the NSW car fleet of the various mobile phone interfaces (e.g., hand-held with manual dialing/reception; hands-free with manual dialing/reception; integrated with voice control via an OEM interface) and to evaluate the relative impact on driving performance and crash risk of these when used by drivers.

- Commission research to assess the effectiveness of cell phone filters and other technical options for restricting phone while driving, their technical capabilities and limitations, and driver acceptance of them.

- Commission in NSW a field operational test (FOT) to evaluate the effectiveness of workload managers and real-time driver distraction warning systems in mitigating the harmful effects of distraction for the drivers of light and heavy vehicles.

- Commission in NSW a systematic research, development and evaluation project to derive technological solutions that might be effective in minimising the potentially harmful consequences of distraction for road users other than car and truck drivers, and especially for pedestrians and bicycle riders.

General Research Needs

Continuing research is needed to help direct policy and action on distraction in the longer term:

- We need to know more about the effects of different types of distraction, especially cognitive distraction, and how they affect driving performance and safety.
- We need to know more about how other factors such as age, driving experience and driver state *moderate* the effects of distraction.
- We need to look at the nature and effects of distraction for road users other than drivers.
- We need a better understanding of how road users self-regulate in response to distraction.
- Research is needed on current rates and future trends in the uptake of electronic devices, by road users and vehicle manufacturers

- Research is need to understand the critical reasons behind differences in findings on the impact of distraction that derive from experimental and real-world studies.

Concluding Comment

An insightful comment, made by NHTSA (2010) in the preface to their Driver Distraction Plan, is relevant to highlight as a final conclusion to this submission:

"…to be effective, countermeasure programs must have built into them mechanisms to identify and control for risks that, left unchecked, would limit the program's success, such as driver acceptance and/or low adoption rate of technologies. Technology-based solutions may be difficult to implement due to high costs, marketplace resistance, and unproven effectiveness. Effectiveness may be reduced by driver efforts to circumvent unpopular countermeasures. In addition, benefits may be compromised if drivers overestimate the protection afforded by technologies and adopt unsafe behaviours, such as increased phone use, that are counterproductive to safety. Behavioural approaches, such as laws restricting cell phone use or educational programs, must overcome the resistance of drivers who may not fully appreciate the risks associated with common and "electronic" distraction".

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