Accident Analysis and Prevention xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Sharing the responsibility for driver distraction across road transport systems: A systems approach to the management of distracted driving

Kristie L. Young[a,*], Paul M. Salmon[b]

[a] Monash University Accident Research Centre (MUARC), Monash Injury Research Institute, Monash University, Victoria, Australia
[b] University of the Sunshine Coast Accident Research (USCAR), University of the Sunshine Coast, Queensland, Australia

ARTICLE INFO

Article history:
Received 14 August 2013
Received in revised form 10 February 2014
Accepted 31 March 2014
Available online xxx

Keywords:
Distracted driving
Systems approach
Road safety
Risk management framework

ABSTRACT

Distracted driving is acknowledged universally as a large and growing road safety problem. Compounding the problem is that distracted driving is a complex, multifaceted issue influenced by a multitude of factors, organisations and individuals. As such, management of the problem is not straightforward. Numerous countermeasures have been developed and implemented across the globe. The vast majority of these measures have derived from the traditional reductionist, driver-centric approach to distraction and have failed to fully reflect the complex mix of actors and components that give rise to drivers becoming distracted. An alternative approach that is gaining momentum in road safety is the systems approach, which considers all components of the system and their interactions as an integrated whole. In this paper, we review the current knowledge base on driver distraction and argue that the systems approach is not currently being realised in practice. Adopting a more holistic, systems approach to distracted driving will not only improve existing knowledge and interventions from the traditional approach, but will enhance our understanding and management of distraction by considering the complex relationships and interactions of the multiple actors and the myriad sources, enablers and interventions that make up the distracted driving system. It is only by recognising and understanding how all of the system components work together to enable distraction to occur, that we can start to work on solutions to help mitigate the occurrence and consequences of distracted driving.

1. Introduction

Distracted driving is acknowledged as a large and growing threat to road safety (WHO, 2011). While it is difficult to quantify the role of distraction in road crashes given the lack of systematic reporting, there is a growing body of data indicating that is an important contributor to both fatal and injury crashes. In Australia, nearly two-thirds of serious crashes resulting in hospital admission involved driver inattention, including driver distraction (Beanland et al., 2013). Figures from New Zealand indicate that distraction contributed to 10% of fatal crashes from 2004 to 2008 (Ministry of Transport, 2010). In the United States, distraction was a factor in 16% of fatal crashes in 2008 (NHTSA, 2009), while the 100-car study found that distraction contributed to 23% of crashes and near crashes (Klauer et al., 2006). Moreover, these numbers are predicted to increase over the next decade as the number and complexity of technologies brought into vehicles continues to rise.

Although driving is a complex task, it is not uncommon for drivers to engage in various non-driving activities. For example, in the United States, Spain, New Zealand and Australia around 60% of drivers report using a mobile phone (Gras et al., 2007; McEvoy et al., 2006; Stutts et al., 2003; Sullman and Baas, 2004; Young and Lenné, 2010), while approximately 95% of drivers listening to the radio, CDs or cassettes (Laberge-Nadeau et al., 2003; Young and Lenné, 2010). Despite this apparent willingness to engage, drivers have a finite set of cognitive and motor resources and are therefore limited in their ability to divide attention efficiently between competing tasks (Kahneman, 1973; Wickens, 2002). As a consequence, driving performance can begin to degrade if drivers do not devote sufficient attention to the driving task because they are engaged in another task. This phenomenon is referred to as driver distraction, or "a diversion of attention away from activities critical for safe driving towards a competing activity" Lee et al. (2009, p. 34). A synthesis of distraction research reveals that engaging in distracting activities negatively effects driver performance and behaviour in a range

* Corresponding author at: Monash University Accident Research Centre, Monash University, Clayton, Victoria 3800, Australia. Tel.: +61 3 9905 1258; fax: +61 3 9905 4363.
E-mail addresses: Kristie.young@monash.edu (K.L. Young), psalmon@usc.edu.au (P.M. Salmon).

http://dx.doi.org/10.1016/j.aap.2014.03.017
0001-4575/

of ways, including reduced longitudinal (Rakauskas et al., 2004; Strayer and Drews, 2004) and lateral control (Engstrom et al., 2005; Reed and Green, 1999); changed visual search patterns (Recarte and Nunes, 2003; Strayer et al., 2004); reduced situation awareness (Kass et al., 2007); and impaired hazard detection and response (Burns et al., 2002; Lee et al., 2001).

Distracted driving is a complex, multifaceted phenomenon and, as such, management of the issue is not straightforward. Distracted driving continues to be a global road safety concern despite significant investment in research and the management of the problem. The continued contribution of distraction to road crashes and the high prevalence of driver involvement in distracting activities suggest that current distraction countermeasures are only partially effective in addressing the distraction issue. Although recent road safety strategies, such as the Australian National Road Safety Strategy 2011–2020 argue for a more systemic approach to road safety issues, traditionally management of distracted driving has focussed on individual components of the issue in isolation (e.g. drivers, mobile phones) without properly considering the relationships and interactions between the components that make up the system in which distracted drivers operate. That is, the current approach to distraction countermeasures has been largely reductionist or component-based, typically focussing on the driver and altering their behaviour. Prevailing countermeasures reflect this stance with legislation and enforcement common countermeasures. Take, for example, the widespread use of mobile phone legislation banning drivers' use of hand-held phones (amongst other phone activities) while driving. This approach to distraction management not only focuses on driver behaviour as the source of distraction (as opposed to, say, the phone designers), it often fails to consider the wider system factors (e.g., enforcement, public awareness) needed to support the legislation and ensure its effectiveness. For instance, research in the United States examining the effectiveness of driver hand-held phone bans have found substantial reductions in mobile phone use immediately after the introduction of bans, but has also found that the sustention of compliance appears to be closely related to the intensity of enforcement of the ban (McCartt et al., 2010). Such findings indicate that, for distraction legislation to be effective, it must be coupled with strict and vigorous enforcement over a sustained period.

More recently, there have been growing calls for a systems approach to road safety, arguing that the focus on addressing individual components of the road safety system in isolation is inadequate (e.g., Larsson et al., 2010; Salmon et al., 2012b). Rather, the systems approach advocates that all of the components that make up the road system as well as the relationships and interactions between them should be considered as an integrated whole. Although prevalent and well described in other areas such as aviation (e.g. Dekker, 2011), a systems approach has not yet been adopted in attempts to manage driver distraction, and it is not clear what a 'systems approach' to distraction should entail in terms of a research agenda and countermeasures.

Like road safety more broadly, this paper contends that there is a need to take a more holistic, systems approach to the management of distracted driving. The aim of the paper is to initiate this through examination of the problem of distracted driving from a systems theory perspective in order to determine how road transport systems contribute to distraction, to examine the current approach to managing distraction, and to outline how a systems approach will support more appropriate, holistic solutions. The paper does this by using a popular systems model to describe the sources of distraction and the factors that enable these sources to be present in the road system. Next, the traditional component-oriented approach to distracted driving is then presented and issues with this approach are discussed. Finally, the need for a systems approach to distracted driving is discussed and how such an approach might offer better, more holistic solutions to the distraction problem is identified. First, however, the systems approach is described in more detail.

2. The systems approach: an alternative approach to the distracted driver problem

The systems approach contends that "a system is more than the sum of its elements" (Rasmussen, 1997, p. 184) and focusses on emergent properties resulting from the interaction of these elements The approach thus argues that interventions should be based on an understanding of how the different elements or components of a system interact with one another to create emergent properties. That is, it is the interactions between components that are of interest, not the behaviour of individual components themselves. Central to the systems approach is the concept that safety and accident causation are emergent properties of complex socio-technical systems, arising from interaction between components at each level ranging from government through to individual people or pieces of equipment (Rasmussen, 1997). Thus, to fully understand a complex problem in a manner that supports effective safety interventions, the system must be examined as an interactive whole, not as individual parts (Salmon et al., 2012b). The road transport system is a complex, dynamic system and, as such, road safety is viewed as emerging from the interaction of the numerous components that make up the system. Like safety, distracted driving is also an emergent property of the road transport system: it is created through the interaction of different components within the system. At a simplistic level this is not ground breaking, since distraction emerges when drivers interact with other components such as in-vehicle technologies. Taking a wider systems view, however, becomes more interesting. What are the interacting components across the road transport system that creates an environment in which distraction can happen? While this perspective includes drivers and in-vehicle technologies, it also includes other upstream factors such as road rules, training, legislation, vehicle design and so on. That is, multiple regulatory, organisational and technological components of the road system (e.g., road rules, mobile phone design, driver phone use and hazardous roadway event) interact with each other to produce a situation in which distraction is created, or emerges. Given this, it is only by examining distraction from a wider systems approach, where the sources and enablers of distraction at various levels are identified, that appropriate solutions to the problem can be identified.

Previously, there have been calls for distraction to be addressed from a systems-based perspective (e.g., Tingvall et al., 2009). However, these calls have typically been made in reference to the *safe systems* philosophy, such as Vision Zero. While there are similarities, it is important to note that the road safety *safe systems* approach is not the same as the *Systems* approach. The safe systems philosophy contends that a range of different actors share responsibility for safety within the road system; however, it is still essentially a component-driven approach, with a focus on driver behaviour and how the system can be designed to support safe driving behaviour and tolerate unsafe behaviour. With the systems approach, in contrast, factors beyond the immediate driving environment and how these interact to influence driver behaviour and safety are considered (Salmon et al., 2012b).

There are many safety models underpinned by systems thinking (e.g., Leveson, 2004; Rasmussen, 1997; Reason, 1990) along with accident analysis frameworks, such as Leveson's (2004) Systems-Theoretic Accident Model and Process (STAMP) and Rasmussen's (1997) Risk Management Framework (RMF) and Accimap; however, these models and methods have had only limited applications in the road transport domain. Rasmussen's RMF is particularly useful as it can be applied across different complex domains and can

Please cite this article in press as: Young, K.L., Salmon, P.M., Sharing the responsibility for driver distraction across road transport systems: A systems approach to the management of distracted driving. Accid. Anal. Prev. (2014), http://dx.doi.org/10.1016/j.aap.2014.03.017