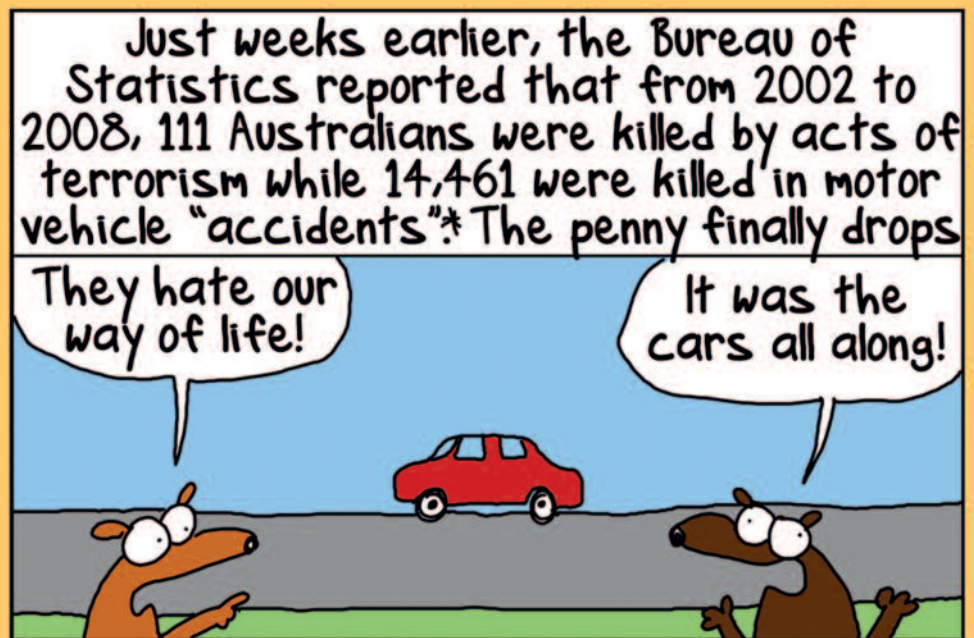




# Journal of the Australasian College of Road Safety

Formerly RoadWise — Australia's First Road Safety Journal



## In this issue

### Special feature:

Occupational health and safety related to road safety

### Contributed articles

- Work-related road safety management systems
- Driver fatigue: More than tuckered truckers
- Blue Care road safety program
- Helping the helpers: The role of EMSPA in paramedic practice
- Motor transport and traffic safety in Australian agriculture: A review
- Heavy vehicle safety: A comprehensive approach
- Improving worker safety through better visibility

### Peer reviewed papers

- Taking an OHS-led approach to work-related road safety: Research, policy and practice
- The influence of safety ownership on occupational road safety outcomes
- Forecasting negative effects of monotony and sensation seeking on performance during a vigilance task

### Contributed articles

- Holistic road safety report released
- National Alliance communiqué: Safe driving with a disability
- Western Australia's Safe System Working Group
- ARRB Group at 50
- Journey Beyond Road Trauma online community

### Peer reviewed papers

- Data and graphing errors in the Voukelatos and Rissel paper
- A prospective study on pedestrian injuries in an urban Australian population



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# CALL FOR PAPERS

## 2011 NATIONAL CONFERENCE

a safe system  
*making it happen!*



Australasian College of  
Road Safety Inc.

Melbourne Convention Exhibition Centre | 1st and 2nd September 2011

The 2011 Australasian College of Road Safety national conference will be held in Melbourne on the **1st and 2nd September 2011**. The one and a half day program will include at least one international keynote speaker, presentations on work in progress and also a conference declaration. A social dinner will be held on the first night of the conference.

The organising committee is pleased to announce that the call for abstracts is now open, with submissions closing on 15 February 2011. The organisers are looking for papers which showcase road safety programs and their impact in helping to create a safe system. Abstracts are sought within one or more of the following categories that characterise the safe system — safe speeds, safe road use, safe vehicles and safe roads and roadsides. For more information on abstract guidelines, please visit [www.acrs.org.au/activitiesevents/](http://www.acrs.org.au/activitiesevents/)

For those who do not wish to present at the conference make sure you put this date in your diary to attend. The conference aims to take road safety to the next level of knowledge and implementation and to assist in the translation of research into action. The size of the conference allows for more direct interaction with presenters and is an important opportunity to network with senior practitioners and those with policy responsibilities.

The conference declaration will provide impetus for ACRS to work with partners and members in Australia in the implementation of the Australian National Road Safety Strategy 2011-2020 in the Decade of Action on Road Safety. Join with us in this exciting program in making it all happen!

### Our supporters:



### Diary dates

Abstracts by 15 February, 2011

Notification of acceptance by 18 March, 2011

Manuscripts must be submitted by 26 May, 2011

Reviewers' comments to authors by 15 June, 2011

Final papers must be submitted by 30 June, 2011

Abstract guidelines and template at:

[www.acrs.org.au/activitiesevents/](http://www.acrs.org.au/activitiesevents/)

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happen!*



ACRS Executive Officer, Linda Cooke, and Managing Editor of the *ACRS Journal*, Nancy Lane, staffing the ACRS booth at the September road safety conference in Canberra

## Road safety conference wrap-up

Thank you to all the ACRS members who met with ACRS staff Linda Cooke and Nancy Lane (pictured) and volunteer Sandra Wheeler at the Australasian Road Safety Research, Policing and Education Conference, held 31 August to 3 September in Canberra. It was great to be able to put faces to members with whom we had previously only corresponded by email or spoken with by phone. Thanks also to the ACT-NRMA Road Safety Trust, which supplied the very popular road safety posters. They were snapped up for use in schools, offices, travelling exhibitions and elsewhere.

We are pleased to announce that Graeme Moffatt is the winner of the free ACRS membership for 2011. His name was drawn from among all those who successfully answered the question, 'What does ACRS stand for?'

## Strategic partnership with Safety Institute

It is timely to announce in this issue of the *ACRS Journal* featuring occupational health and safety that, after exchange of information

and a visit by the ACRS President to the Safety Institute of Australia Inc (SIA) in Melbourne, ACRS is considering entering into a strategic partnership agreement with SIA. SIA was formed in 1949 and is a not-for-profit, independent, apolitical professional association with over 4000 members within Australia and in other countries.

The SIA believes that the distinctive advice of qualified and experienced health and safety practitioners is a prerequisite to the specification of the health and safety responsibilities of all levels of government (federal, state, territory and local), employers (across all industry sectors) and community organisations. ACRS is seeking to establish a collaborative relationship with the SIA on preventative health, safety and environment, and will consider accepting SIA's invitation to become the SIA's Strategic Partner 'Road Safety'. ACRS believes that this move will increase the profile of road safety within the promotion of health and safety awareness and will bring practical benefits to members of both organisations.

*Linda Cooke, Executive Officer*

## STOP PRESS

The College understands that a draft of the National Road Safety Strategy 2011 - 2016 will be launched on 1 December with consultation until early February 2011.

ACRS will advise its members of the draft document when it becomes available, and Chapters may organise special meetings to seek feedback.

# Graduate Certificate/ Graduate Diploma in Road Safety

Do you want to enhance your knowledge and skills in road safety? If yes, you may consider enrolling in a Graduate Certificate or Graduate Diploma in Road Safety.

The program is run by the Centre for Accident Research and Road Safety - Queensland (CARRS-Q), a joint initiative of the Motor Accident Insurance Commission and Queensland University of Technology (QUT). The courses are offered in internal mode at QUT's Kelvin Grove campus and external mode through our well established distance education program.

**Mode:** Internal or via distance education  
**Venue:** QUT Kelvin Grove campus, Brisbane  
**When:** Semester 1, 2011

Applications will close January 2011. Both domestic and international students can enrol in either the internal or distance education mode.

### More information

For more information or an application kit, phone (07) 3138 4592, email [roadsafetycourses@qut.edu.au](mailto:roadsafetycourses@qut.edu.au) or visit [www.carrsq.qut.edu.au/education](http://www.carrsq.qut.edu.au/education)

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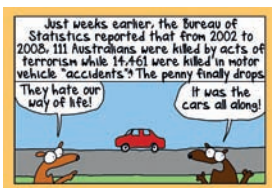


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## Disclaimer

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## Cover photo

We are grateful to First Dog on the Moon (Andrew Marlton), who has given permission to the ACRS to reprint the first panel of his cartoon from the 2 March 2010 issue of Crickey. Crickey is an online resource at <http://www.crickey.com.au>, providing independent news, blogs and commentary on politics, media, business, the environment and culture. Marlton has also illustrated the children's book *The Wombat and the Grand Pooljam*, written by Jackie French.

## Editorial policy

The aim of the journal is to provide a medium for expression of views and debate on a wide range of issues within the traffic safety community, and the College encourages interested persons and organisations to submit articles, photographs or letters for publication. The journal provides the opportunity for researchers to have their work submitted for peer review, in order to improve the quality of their research papers. However, peer review cannot guarantee the validity of research nor assure scientific quality. The publisher reserves the right to reject submissions or, with approval of the author, to edit articles. No payment is offered for articles submitted.

Material in this journal may be cited with acknowledgement of the full reference, including the author, article title and the year and volume of the journal. For permission to reprint articles in full, please contact the Managing Editor.

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The *Journal of the Australasian College of Road Safety* publishes articles  
on all facets of the study of traffic safety. Articles are accepted from a  
variety of disciplines, such as health and medicine, road and  
automotive engineering, education, law, behavioural sciences,  
communication, history, management, and urban and traffic  
planning. Interdisciplinary approaches are particularly welcome.  
Authors' guidelines may be downloaded from the College website at  
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Articles may be up to 5000 words in length and should be  
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should state whether or not peer review is requested. Articles should  
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Messages can be left on voice mail when the office is unattended.

## From the President



Dear College Members,

The College is continuing to offer to assist with the national process of discussion and implementation of a new National Road Safety Strategy for the next decade. We believe that involvement of the community with the facilitation which the College, its Fellows and Members can provide in

the introduction of the strategy will be vital for it to be effective. We have met with senior government officials and have written to the Prime Minister, premiers, senior ministers and Opposition shadow ministers, recommending that the strategy must result in a reduction of a least 50% of the current level of deaths and injuries from road crashes. This is consistent with the target set by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) for the UN Decade of Action for Road Safety.

We have asked that the strategy is ambitious, that it drives an action plan to prevent deaths and injuries, and that it cements Australia as a leader in road safety performance. We noted that 40 years ago, Australia embarked on a very successful reform program to arrest the then rising death and injury rates from road crashes. Some 90,000 lives have been saved and hundreds of thousands of injuries avoided as a result.

A group of the ACRS Executive met with the National Road Safety Council, and after a constructive discussion, we have offered to assist the Council in a range of partnership activities. We believe these activities would benefit both organisations, and the results should lead to reductions in road crash deaths and injuries.

We recognise the importance of the leadership role you entrust to the Executive. We have agreed to develop a partnership with the Safety Institute of Australia and are re-establishing links with other like-minded organisations such as the Australian Local Government Association. Road safety must be integrated into safety or risk management generally. At a recent management seminar I attended on Leadership and Safety, I was reminded that the most likely place for death and injury at work is in a vehicle. That was a sobering reminder of the work ahead for us all.

While on the subject of leadership, I would remind you that at the recent Australasian Road Safety Research, Policing and Education Conference, we were able to publicly congratulate Professor Barry Watson on his award of the ACRS Fellowship. A detailed article on Barry is included in this journal.

We will be approaching the National Health and Medical Research Council (NHMRC) and the Australian Research Council (ARC) to seek amendments to current guidelines/codes to recognise the seriousness of road safety as a health/injury prevention issue within our community and to seek the alignment of successful road safety research with road safety strategic objectives. We believe this will increase the opportunities for distribution of more funds for specific road safety research.

With increasing levels of activity our resources are stretched, but we remain committed to improving our services to all members. You will have received a renewal notice, and I would urge you to promptly renew so we can continue together.

*Lauchlan McIntosh AM FACRS  
President*

---

## Thank you to retiring editor, Colin Grigg



*by Brian Connor*

Colin Grigg has decided to step down as Contributed Articles Editor for the *ACRS Journal*, and I have been asked, on behalf of the ACRS, to thank him and pay tribute to his many contributions. Indeed, Colin's direct involvement in road safety at community and national levels has spanned more than 30 years.

He was responsible for organising eight biennial national traffic education conferences, and his efforts were foundational in ensuring the formation of the Australian College of Road Safety as a result of discussions at the first two of these conferences in 1986 and 1988. He edited the proceedings of these meetings, which were held in various parts of Australia – initially at the University of New England in Armidale, New South Wales.

He was on the National Executive of the College from 1988, as foundation Treasurer from 1988 until 1992 and Publicity Officer from 1992 to 1995. He was responsible for the development of the College's business plans and he convened a meeting in 1999 that saw the establishment of the New England Chapter of the College as its first rural Chapter. He retired from the Executive in May 2005.

Colin was very heavily involved with the establishment of the New South Wales Traffic Education Centre in Armidale, as Board Secretary from 1981 to 1993, Vice-Chairman from 1984 to 1988 and Chairman from 1988 to 1989. He was Secretary of the Traffic Education Centre Reserve Trust from 1982 to 1989.

He was responsible for coordinating the first university courses in road safety at the University of New England in 1993. He published the first Australian textbook on road safety studies, entitled *Safe and mobile: Introductory studies in traffic safety* (J. Clark, editor. Armidale: EMU Press, 1999). This book was used for training road safety practitioners elsewhere in Australia.

The publication entitled *A community model for traffic safety – The Armidale experience* was written by Colin in 1987. This seminal work was commissioned by the Federal Office of Road Safety for use in their community education package, which was distributed nationally. He has been responsible for numerous publications and articles in relation to road safety over many years.

Colin undertook the preparation, editing and publication of the quarterly road safety journal, *RoadWise*, for the Australian College of Road Safety from 1988 to 2004. This is the only continuing journal of its type in Australia. Colin has continued his association with the College journal in his role as Contributed Articles Editor until his recent decision to retire from this position.

Colin's contribution to road safety was recognised internationally by the presentation to him in 1993 of the World Safety Organisation's Education Award. He became a Fellow of the Australasian College of Road Safety in 2001.

More recently, he has been involved with his wife, Dr Jennifer Clark, in their interest in roadside memorials and with the organisation of the first international symposium on that subject held in 2004 at the University of New England. Colin maintains a concern for the development of a national memorial to commemorate the lives of all those who have died on our roads.

It is difficult to quantify such a long-term contribution to a major public health problem as that made by Colin Grigg. There are few people in Australia with his length and breadth of contribution to community road safety and traffic education. In the words of another eminent road safety authority, 'No-one has done more to promote the interests and goals of the College', and I would add my belief in the significance of Colin's legacy in the development of road safety professionalism. This has been of great benefit to us all.

---

## Welcome to new editor, Andrew Scarce

Andrew Scarce is replacing Colin Grigg in providing current news and reviews for the journal. His role as Road Safety Literature Editor starts with this issue, and we welcome him to the team.

Andrew is a workplace driver safety specialist based in Bendigo in central Victoria and is the sole operator of Road Class ([www.roadclass.com.au](http://www.roadclass.com.au)). Andrew started Road Class about four years ago, and he has a growing list of private and government clients.

Andrew's training content pays particular attention to the dangers of rural roads and staff who drive long distances, so it is very fitting that his first journal issue is on the theme of occupational health and safety related to road safety. Andrew has worked with some of Victoria's top trainers and travels widely.

Prior to starting Road Class, Andrew worked for about 17 years in the print media in regional Victoria. His former roles included journalist, subeditor and stand-in editor.

---

## RRSP profile – Senior Engineer Suman Joshi



*Following the introduction of this feature in the May 2009 journal, we are continuing to profile in each issue an ACRS member who is on the ACRS Register of Road Safety Professionals. To be on the Register, applicants must satisfy stringent criteria. They must have relevant academic qualifications, have worked for at least five years at a senior*

*level in their particular field of road safety, and be acknowledged as an expert by their peers. For details, visit [www.acrs.org.au/professionalregister](http://www.acrs.org.au/professionalregister).*

After completing his bachelor's degree in civil engineering from Kathmandu Engineering College in Nepal in 2002, Suman Joshi started his career with a private contractor as a project engineer and continued to work there through 2006. He was

responsible for the construction supervision, project management and delivery of infrastructure works, as well as individual houses, during his tenure with CE Construction Pty Ltd in Nepal.

At the very end of 2006 he migrated to Australia, and for about eight months he worked for another private contractor in Toowoomba where he got the chance to work as a civil engineer cum estimator. His primary work involved preparing, submitting and bidding for tenders, as well as procurement planning, and finally checking the bills of quantities submitted by subcontractors.

Then, his eagerness to explore core Australia and its outback life took him all the way to the North West Region of Queensland. He started working as a civil engineer in the Department of Transport and Main Roads (DTMR) Cloncurry, and this is where he got an opportunity to participate in the safety side of



road projects. He has been involved in many road safety audits, crash investigations, and funding proposals for the region to increase and maintain the safety conditions of the state and national highways. Suman truly enjoyed his time and gained a lot of experience from his seniors during almost three years in this remote outback – and he survived the ruthless, unforgiving heat!

Recently, Suman was promoted and moved to the DTMR Gold Coast office as a senior engineer. He is currently working in the program development and delivery section. In early 2010, he completed his Master's degree in Pavement Technology via distance education from La Trobe University, Victoria. He is registered as a Chartered Professional Engineer with Engineers Australia (CPEng) and as a Registered Professional Engineer of Queensland (RPEQ) with the Board of Professional Engineers of Queensland. Moreover, he is currently registered as a Road Safety Auditor for DTMR and is a member of the Australian Institute of Project Management.

*We asked Suman the following questions:*

#### **How long have you been a member of the ACRS?**

I am a fairly new member of the ACRS. I joined in the last quarter of 2008, but since then, have enjoyed the benefits of becoming a member. Being RRSP, I feel more responsible and proactively look for safety issues, whether during the concept, design or implementation phase of a project.

#### **What do you value most about your membership?**

I have always enjoyed reading and learning new things from the ACRS journals. The journals enable me not only to keep myself updated with the latest safety-related technological developments, but they have also helped me to increase and enhance my level of knowledge in this field. Moreover, they have provided me an opportunity to know more about Australian safety standards and regulations.

#### **What is your particular expertise in road safety?**

I have had the opportunity to work in various aspects of road safety. I did safety audits of various roads in various stages – namely, preliminary design, detail design, existing road safety audits and pre-opening stage audits within the Queensland North West Region. I also worked as a crash investigating officer for the DTMR Cloncurry, carrying out more than half a dozen investigations and preparing reports on behalf of DTMR to ensure the safety standards of the road at the crash site.

With the shortage of resources and funding, it was always a challenging task to maintain and provide high safety standards on the roads in these remote locations. Hence, I decided to work towards analysing, preparing and submitting projects for funding from Black Spot and Safer Roads Sooner (SRS) programs for state-controlled and national highways within the region.

#### **What is a typical working day for you?**

Currently I am working as a Program Manager cum Co-ordinator for Program Development and Delivery – Preservation Team. My role is to deal with different internal and external stakeholders and sort out various issues within the team for various types of projects. As Program Manager, I prepare, analyse and update the status of the projects, and then prioritise and develop the delivery strategies to get the maximum benefit out of the projects. In addition to that, I am working as Project Manager for a handful of projects, and I focus more on integrating the scope, time, costs and risks within these projects.

I am utilising my safety knowledge and experience to help the graduates develop a detailed scope of works for all SRS and Black Spot projects for the Southeast region. As a Project Manager, I never miss an opportunity to provide feedback on the safety-related issues within the projects, and I am always willing to contribute to improve the safety standards of our roads.

## Letters to the editor

### **Response to Voukelatos and Rissel paper**

A letter was received from Tim Churches, Medical Epidemiologist, concerning errors in the Voukelatos and Rissel paper in the August issue of the journal. His response was peer reviewed and appears on page 62.

### **Bicycle helmet legislation**

The article on bicycle helmet legislation (*Journal of the ACRS, August 2010*) raises some interesting questions about the value of bicycle helmets.

It is intuitive that if the head is protected there should be less injury, so it is strange there should be argument against the use of helmets. We need to be very careful when analysing data, as the anecdotal experience of numerous colleagues who have

fallen while cycling, shattering the helmet, is that they felt they had avoided major injury. These experiences go unreported and therein lies the problem – an immeasurable but highly significant gap in the data.

Similarly, the paper is reliant on the reporting of arm injuries – if treated outside the hospital system these will not appear. We are therefore starting to argue something which we have not truly measured. We need to look at this more carefully and a large survey of cyclists with impact injuries would seem to be the way forward.

*Associate Professor Daryl Wall AM, FRACS, Chair;  
Trauma Committee, Royal Australasian College of Surgeons*

*Associate Professor Robert Atkinson FRACS, Member;  
Trauma Committee, Royal Australasian College of Surgeons*

## Long-term perspective on bicycle safety

I received the August *ACRS Journal* this week with its emphasis on bicycle safety, and wanted to thank you for it and congratulate you on its contents. You have done a mighty job. For interest, I have decided to make a few comments from my experience in working in the area of bicycle safety for 35 years.

My perspective is that we have made relatively little progress in bicycle safety over the years, and your contributors make this point repeatedly. In my opinion, we need greater coordination of effort, and you make this point in the second last paragraph of your Guest Editorial.

Unfortunately, in Australia, we suffer from the ‘territorial imperative’ and ‘constitutional drift’, both of which work against any definitive action across the nation and between disciplines. Thus, the ‘systems’ approach has yet to be implemented and, specifically, the 4 E’s strategy, which originated in Geelong in the mid-1970s and has since expanded to 6 or 7 E’s, has really disappeared and features nowhere in the latest journal articles. And in Queensland, there are opposing views about cycling safety (page 61).

I note the constant plea for better data collection. This has been a hallmark of our activities in road safety for decades. In Armidale in the 1980s, we attempted to overcome this problem with collection of data for all bicycle injuries for three years or so, which was the first such community study. We had nearly one severe injury per week, and the greatest proportion was in young adults (note the comments about Victorian bicycle crash injuries on page 20).

There is the regular mention of promotion of bicycle education, and this discussion has been continuing ever since I brought the first Bike Ed Kit (illegally at that time) into New South Wales. There are conflicting opinions about the value or otherwise of education. This discussion could take up a whole essay – but in our state, the RTA does not believe in bicycle education while at the same time reintroducing it to schools. There has been no uptake of this offer in our area. The research as to the effectiveness of this sort of education has yet to be done.

I note the mentoring program being introduced in Canberra (pages 14-15). We successfully trialled this approach in the 1980s in Armidale using older children in primary schools. In the state of Washington (USA), in what was termed the Stop Auto Fatalities Through Youth Efforts (SAFTYE) program, the poor-achieving students were selected to run such courses. Our work was all part of the development of the New South Wales Traffic Education Centre in Armidale, which was opened in 1991 by the Premier and then gradually closed by the government with the subsequent loss of an enormous amount of intellectual capital in relation to traffic safety.

The helmet-wearing issue occurred in several articles with an interesting comment in the second paragraph of the abstract on page 50. The problem is that we have to be careful

equating our traffic conditions with Copenhagen or the Netherlands. Until we have a fully integrated system of traffic safety, I see no alternative to making the wearing of bicycle helmets compulsory. As a former clinician, I have dealt with the devastating effects of head injuries and the ripple effect on families and friends. Thus, I believe that the prevention of even one such tragedy is worth it.

The NSW Bike Plan, reviewed on pages 15-16, tends to be a Sydney-centric document and again lacks cohesion. As I have already noted, the RTA is at war with itself over the value of road safety education. The issue of cycle lanes is an important one and I am glad to see some research in this area (note page 33). It is an important matter for us, as we have been forbidden by the RTA to have them in Armidale, and we are still at loggerheads about bicycle markings on our roads. Interestingly, at the launch of the Sydney Bike Plan in Martin Place in 2006, there was a public admission that they were 10 years behind Melbourne.

The article entitled ‘Cycling injuries in Australia: Road safety’s blind spot?’ (pages 37-43) is particularly good, especially as it deals with issues of equity and international comparison.

Conspicuity is an important issue in bicycle safety and I liked the idea of reflectors noted in the abstract on page 56. Interestingly, in our first College National Road Safety Awards, a finalist was a school in southern rural Australia where the children had a reflective piece of Velcro across the back of their school shoulder packs.

On page 49, the incredibly significant point is made about children exercising less. This is a national problem and we have found similar concerns in Armidale where, in my 1998 survey, I found that no school was prepared to accept that the bicycle was a legitimate form of transport for children – with the obvious corollary that bicycle use amongst children was falling.

The ‘safety in numbers’ proposition was mentioned in a couple of articles. Let’s hope that your good work results in an increase in numbers of cyclists, which will eventually result in improved safety on our roads, and by implication, a more sustainable world.

In terms of implementation of bicycle strategies, my belief is that we should be tackling this at local government level, rather than through the present top-down approach. It could be done quite easily with financial and enforcement incentives.

I hope that your seminar, ‘Toward best-practice cycling infrastructure’, went well. Thanks again for a magnificent job on behalf of Australia’s cyclists.

Kind regards,

*Brian Connor*  
41 Judith Street, Armidale, NSW

## Travelling to the conditions

Why does the government provide such a wide range of educational facilities for government, sport, academics, industry, defence, science, etc? Is it not to give people a chance at ability and excellence in their chosen fields? When it is considered that road use is probably the most dangerous activity in which most people participate, why do governments appear to use any possible excuse to avoid providing similar education in this field?

The fundamental principle of safe road use is to use the road according to all the conditions that prevail at any given moment, and to do so with consideration for others. This is not theory; it is simple, practical commonsense. For any road safety policy to be fair, just and reasonable, it should treat individuals on this basis. Policies to date do not. That part of government road safety policy subject to the most focus is undoubtedly speed limits and government speed limit policy (GSLP).

GSLP is promoted as reducing crash fatalities. This being the case, where is the direct link between the penalty given to an individual for speeding and that person's crash history? GSLP

appears to pay no regard to the crash history of the individual and therefore appears to have no direct link to the penalising of individuals who actually cause harm. Why? GSLP penalises speeding offenders with exactly the same penalty regardless of whether the individual's crash history is clean or dirty. Why? As long as there continues to be a disconnect between having, or not having, a history of causing harm and the offence of speeding, GSLP will appear to many as unjust and dishonest treatment of ordinary people. Why is this acceptable?

Government speed limit policy appears to provide minimal education, sells a licence that reflects a minimal standard of ability, provides offences and penalties with little or no direct link to any crash history of the individual that can nonetheless result in loss of licence, uses offences to deflect scrutiny and criticism from poor road surface standards, and provides no incentive or carrot for developing a harm-free history of safe road use. Travel to the conditions and stay safe.

*Stuart Mason, Road-skills Advocate*

*16 Hillside Road, Peak Crossing, Queensland 4306. (07) 5467 2273*

# Literature Review

## Victoria's graduated licensing for motorcyclists

*Reviewed by Andrew Scarce*

VicRoads has sought public comment on *Victoria's graduated licensing for motorcyclists – A discussion paper 2010*. The paper outlines some significant changes to licensing requirements for novice riders, who are over-represented in crash statistics.

The paper (page 7) quotes a report for the Australian Institute for Health and Wellbeing, which says that 'the rate of serious injury per 100,000 registered vehicles for motorcyclists nationally is 10 times that for car occupants' [1]. Common crash-contributing causes for learner and novice riders are failure to respond to hazards, ineffective braking and bad road positioning.

An increase in motor scooters has made matters worse. In 2007, motor scooters accounted for about 6.4 per cent of registered motorcycles in Victoria, yet they comprised about 15 per cent of all killed or seriously-injured motorcyclists. The discussion paper says one anomaly of the current licensing system allows riders as young as 19 years and 3 months to ride any size motorcycle. 'Such motorcycles are capable of speeds well in excess of 200km/h and can accelerate from 0-100km/h in under four seconds,' the report says (page 21).

VicRoads is proposing a similar framework to its GLS for cars, but with some specific modifications tailored for riders. The proposed changes include:

- **Learner permit:** A more comprehensive and rigorous assessment of practical skills (range-based)

- **Learner:** Standardised mandatory pre-learner training and minimum hours of on-road supervised driving
- **Three years on intermediate licence** (with car licence)
- **Intermediate licence:** Standardised mandatory pre-licence training. Must wear an L plate or something similar
- **Full licence:** More comprehensive assessment of practical skills, including an on-road component, and a motorcycle hazard perception test

Numerous restrictions and sanctions are also being mooted. While in the learner phase, riders will be asked to wear a high-visibility vest and motorcycle protective clothing while riding. They will also be restricted to an automatic transmission if the practical test for a full licence is passed on an automatic motorcycle/scooter.

Public consultation on the discussion paper finished on 29 October. Copies of the paper are available from VicRoads, 60 Denmark Street, Kew Victoria 3101, or phone Chris Brennan at 03 9854 2753.

## Reference

1. Cited in Berry JG, Harrison JE. Serious injury due to land transport accidents, Australian 2005-06, Injury research and statistics number 42. Cat. no. INJCAT 113. Adelaide: Australian Institute for Health and Wellbeing, 2008.

# Quarterly News

## Presentation of College Fellowship to Professor Barry Watson



Australasian College of Road Safety President, Mr Lauchlan McIntosh AM, presented the College Fellowship plaque to Professor Barry Watson (on left) at the Road Safety Research, Policing and Education Conference in Canberra on 2 September 2010. The citation follows:

‘Each year the Australasian College of Road Safety honours an outstanding contributor to the cause of road safety by electing that person as a Fellow of the College. The honour is reserved for those who have worked at a senior level in road safety over a number of years and have also contributed substantially in support of the College’s mission to reduce road trauma. I am very pleased today to present the 2009 Fellowship to Professor Barry Watson.

‘Barry is probably well known to many of you here today. He is one of those quiet, unassuming but high achieving people who is regarded by his peers as a genuine all round nice guy. He is recognised as being willing to spend his valuable time to listen, assist and help where needed. Time is often a challenge for Barry since he became Director of the Centre for Accident Research and Road Safety at Queensland University of Technology in Brisbane, but he always makes time for others. This is one of his many attributes.

‘In terms of his contribution to road safety, Barry has 25 years experience in, and outstanding contribution to, the fields of research, teaching, mentoring, promotion and policy guidance. He was the first behavioural scientist appointed to the NRMA, the first lecturer in Road Safety at QUT and the first to deliver tertiary-level road safety training at QUT, covering both postgraduate and undergraduate course level. Barry’s knowledge

and expertise across a broad range of illegal and risky road user behaviours is widely acknowledged and used nationally and internationally.

‘As a voluntary organisation, ACRS relies heavily on the goodwill of committed members who are passionate about road safety. Barry has been a member of the College since its inception in 1989, and his input to the national executive discussions since 2003 and his contributions to the Queensland Chapter in various roles has been much appreciated.

‘In some senses ACRS punches above its weight, and that is due to the efforts of committed persons such as Barry and other members of our executive. We are all pleased to have this public opportunity to acknowledge Barry’s enthusiasm, professionalism and longstanding dedication and service to road safety. Congratulations, Barry!’

Barry joins a list of Fellows elected annually since 1992. The full list of those honoured as Fellows is available at <http://www.acrs.org.au/collegefellowships/acrsfellowlist.html>. Nominations for the 2010 Fellowship closed 30 September.

The College patron, Her Excellency Ms Quentin Bryce AC, Governor-General of the Commonwealth of Australia, was unable to attend, but conveyed her warmest best wishes to Professor Watson, along with the following message:

‘Those of you, who like our Fellow, work away diligently in your efforts to reduce our road deaths and injury, receive little public acknowledgement. It is important to maintain your vigour and enthusiasm in applying your research and practical knowledge to the benefit of our community in your efforts to ensure all road users can travel safely. On behalf of our community, I thank you for what you do, and all the very best for the future.’

## Chapters

### Australian Capital Territory and Region

The Australasian Road Safety Research, Policing and Education Conference was held at the National Convention Centre in Canberra 31 August - 3 September 2010. This enabled a

number of Chapter members to attend and be involved in a wide range of meetings organised by the ACRS Executive. As noted by the President, the College met with the National Road Safety Council, and as part of a wide-ranging discussion, the issue of road safety communication was raised. As a follow-up to that meeting, a copy of Dr Stephen Jiggin’s report on his 2008 Winston Churchill Memorial Trust Fellowship was provided to

the Council. The study examined how the news media report road crashes and the potential impact these reports have on public perceptions of road trauma. The report, which is available on the NRMA-ACT Road Safety Trust website at <http://www.roadsafetytrust.org.au/c/rtt?a=da&did=1004593>, argues that the role of the media is inimical to good road safety outcomes and a better understanding by the community of the issues involved.

The need to engage with the community on stronger road safety efforts was also identified as a key issue in the *Vision Zero ACT road safety strategy 2011-2020 discussion paper*, prepared as part of the consultation process for the next ACT road safety strategy. The document was released for public consultation, which ended on 30 September. A copy is available at [http://www.tams.act.gov.au/\\_data/assets/pdf\\_file/0012/199578/ACT\\_Road\\_Safety\\_Discussion\\_Paper-August\\_2010.pdf](http://www.tams.act.gov.au/_data/assets/pdf_file/0012/199578/ACT_Road_Safety_Discussion_Paper-August_2010.pdf).

The ACT Department of Territory and Municipal Services is now working through the comments arising from the consultation process, the ACRS ACT Chapter having provided input via the Road Safety Roundtable organised by the Chief Minister. The discussion paper proposes increased focus in the following areas to support a move towards the Vision Zero philosophy and a more robust application of Safe System principles:

- Engaging with the community on stronger road safety efforts
- Emphasising speed management as a critical component of the Safe System approach, with targeted awareness campaigns supported by strong enforcement and targeted engineering measures
- Implementing Safe System infrastructure – which could include local area traffic management measures, revised speed zoning, median barriers on undivided roads and calming treatments at intersections
- Strengthening efforts to encourage best practice in adopting vehicle safety technology
- Developing an educational approach for all road users – with increased investment in strategic awareness campaigns and lifelong learning measures – in an attempt to change the ACT road safety culture
- Supporting this broad educational approach with effective and sustained general enforcement measures
- Implementing stringent controls to remove high-end offenders from the road system – for example, in relation to speeding and drink driving
- Continuing efforts to obtain strong alignment with key road safety stakeholders on the overall approach to road safety in the ACT
- Strengthening synergies between road safety and sustainability/environmental issues
- Implementing best practice data and evaluation processes.

Chapter Secretary Eric Chalmers has been attending the World Injury Conference in London. The conference examined a range of issues related to his area of interest – child safety and the

contribution to injuries and morbidity from road crashes. The issues raised at the conference will be fed into the proposed Child Safety seminar series being planned by the College. The first of the seminars is planned for Canberra in February next year.

*Steve Jiggins, ACT and Region Chapter President and Representative on the ACRS Executive Committee*

## New South Wales

The Sydney Chapter ran a successful half-day workshop in September on ‘Toward best-practice cycling infrastructure’ at the Parliament of NSW Theatre. Approximately 80 people attended. The seminar was chaired by Dr Julie Hatfield from the Injury Risk Management Research Centre (IRMRC) at UNSW. State-of-the-art research relating to which types of infrastructure offer the safest cycling environment was presented, and recommendations for best-practice cycling infrastructure and cycling were discussed. Rider and driver behaviour were also discussed.

Speakers for the event were Dr Jan Garrard from Deakin University, Associate Professor Stephen Greaves from Sydney University and Ms Marilyn Johnson from Monash University’s Accident Research Centre. An outcome from the seminar was a unanimous agreement that major cities, in particular Sydney, still needed considerable injection of funds and strong political support for dedicated cycling infrastructure if Australians are to realise the desire of advancing cycling as a serious alternative transport mode.

As the Chapter’s last event for the year, a half-day workshop focussing on ‘Pedestrian safety in our cities’ is scheduled for 10 December, 1 to 5 pm. The workshop will be held in the Level 6 Seminar Room at The George Institute, 341 George Street, Sydney. The list of expert speakers includes Dr Soufiane Boufous from The George Institute, Dr Peter Cairney from ARRB, Tim Hughes from the New Zealand Transport Agency, Haggai Bocman from the RTA, Michael Paine from Vehicle Design and Research, Terry Lee-Williams from the City of Sydney and Peter Croft from ARRB/Austrroads.

Members of the College made submissions to the NSW Parliamentary StaySafe Committee inquiry on Vulnerable Road Users. Professor Grzebieta, Dr Julie Hatfield and Ms Liz de Rome provided evidence on behalf of their institutions, the IRMRC at UNSW and The George Institute at Sydney University, with support from the ACRS Sydney Chapter. Evidence was provided concerning motorcycle fatalities, ‘motorcycle into barrier’ crashes, motorcyclist ‘safety’ clothing, cycling fatalities and injuries, cyclist safety and cycling infrastructure. Reports and testimony concerning the submissions are available on the NSW Parliament’s StaySafe website.

Finally, as Chairman of the Sydney Chapter, I would like to thank our committee members – Lori Mooren (Secretary), Teresa Senserrick (Treasurer), Liz de Rome (immediate past Chairwoman), Peter Croft, Harry Camkin, David McTiernan, Tom Gibson, Jack Haley and Julie Hatfield – for their tireless

efforts and commitment in helping run the Chapter. I would also like to thank all speakers and those members (and non-members) who have attended our seminars and helped make them successful and have passed on the valuable knowledge to the greater community. Assistance (and patience) from the ACRS Head Office's Linda Cooke, Jacki Percival and Nancy Lane over the past year is also greatly appreciated. The Sydney Chapter wishes you a very safe journey and Merry Christmas and Happy New Year.

*Professor Raphael Grzebieta,  
NSW Chapter Chairman and Representative  
on the ACRS Executive Committee*

## Queensland

The Queensland Chapter held its September quarterly seminar and Chapter meeting on 7 September 2010. The seminar, 'Piecing the puzzle together: Data linkages in road safety', was presented by Ms Angela Watson, PhD candidate, CARRS-Q.

The final 2010 Queensland Chapter meeting and seminar are scheduled for Tuesday, 7 December 2010, and will incorporate a tour of the driving simulator based at CARRS-Q.

*Dr Kerry Armstrong,  
Queensland Chapter Chair and Representative  
on the ACRS Executive Committee*

## Victoria

A Chapter seminar on bicycle safety was held on 3 November. Speakers included Jan Garrard, Senior Lecturer at Deakin University; Marilyn Johnson, PhD candidate at Monash University Accident Research Centre; and Juliet Reid, Project Manager at VicRoads.

Conference preparations are under way with the conference venue, dates and duration decided. Please refer to the call for papers in this issue of the journal, as well as the ACRS website, for further details. Professor Tom Dingus from Virginia Tech in the United States is likely to be a keynote presenter. Professor Dingus has been instrumental in the conduct of the 100-car naturalistic driving study that tracked the driving behaviours of a sample of drivers over an extended period to identify risky behaviours and events.

*David Healy,  
ACRS Co-Vice President and Victorian Chapter Representative  
on the ACRS Executive Committee*

## New Zealand

September has been a busy month with a number of significant milestones being achieved towards implementing the first actions outlined in the government's *Safer journeys 2020 road safety strategy*. Cabinet has given the green light to progress a change to New Zealand's give way rule and to introduce better motorcycle licensing and training systems. Currently in New Zealand, if you are turning left, you have to give way to right-turning traffic coming towards you. Changing the give way rule

would reverse the current situation so that the left-turning vehicle has right of way.

New transport legislation to improve the safety of young drivers and crack down on drink drivers was passed unanimously through its first reading in Parliament. The bill includes raising the minimum licensing age in New Zealand from 15 to 16 and allowing courts the option to require repeat or serious drink drive offenders to use alcohol interlocks. As well as raising the driving age, New Zealand is seeking to redesign the restricted license test to require a greater level of driver competence and to encourage 120 hours of supervised driving practice.

New Zealand's Trafanz Conference was held in September with a strong focus on the Safe System approach. The line-up of international speakers was very impressive, with Tony Bliss, Eric Howard, Soames Job and Javier Sanchez-Ferragut Andreu. The KiwiRAP star ratings model, launched in June this year, was awarded the Trafanz Road Safety Leadership Award.

The Chapter is looking to hold a seminar on motorcycle safety early in 2011. A date and venue are yet to be set.

*Fabian Marsh,  
New Zealand Chapter Chair and Chapter Representative  
on the ACRS Executive Committee*

## Western Australia

The WA Chapter of the ACRS supported a seminar organized by the ARRB Group for Main Roads WA (MRWA) on the Safe System approach to road safety. Titled 'Engineering towards zero: Practical road safety solutions', this one-day seminar was designed to expose MRWA and local government staff to the principles of the Safe System approach to road safety and to present project examples that exemplify Safe System principles. The presenters were Dr Soames Job (Director, Centre for Road Safety, RTA NSW), Neil Edgar (Principal Manager, Safer Roads Strategy, TMR Queensland), James Holgate (Director, Safer Roads, VicRoads) and Angela Conway (Manager, Land Transport Safety Policy, DIER Tasmania).

*Dr Paul Roberts,  
Western Australian Chapter Representative on the  
ACRS Executive Committee*

## Former ACRS Associate Fellow honoured

Former ACRS Associate Fellow Sarkis Petrossian is a triple award winner. On 2 August he was awarded the Engineers Australia Medal for service to the profession and traffic engineering. On 20 August at the launch of the State Road Safety Report for WA prepared by three eminent World Bank Traffic Consultants from the UK, New Zealand and Victoria, he was presented an Outstanding High Commendation 'in recognition of active involvement over many years and contribution in improving road safety'. On 1 October the Injury Control Council of WA conferred on him the title of Community Safety Champion.

# Special Feature

## Occupational health and safety related to road safety

*Future issues of the journal will have themes as follows:*

- February 2011 – Road safety in the Asian region
- May 2011 – Heavy vehicle safety (a special issue with guest editor Lori Mooren)

*Members are invited to contribute articles related to these themes or on road safety more generally. Contact the Managing Editor (journaleditor@acrs.org.au) with respect to deadlines for receipt of articles.*

### OHS news

*by Andrew Scarce, Road Safety Literature Editor, JACRS*

#### Road safety for mine workers

A road safety workshop aimed at young drivers working in mines around Cobar, NSW, was held on October 22. The workshop included safe driving topics such as driving to local conditions and the perils of long distance driving, giving young drivers a better understanding of road safety.

Sponsored by the NSW Mine Safety Advisory Council (MSAC), the workshop was conducted by the NSW Roads and Traffic Authority. MSAC chairman Norman Jennings said the council had working closely with industry to help manage fatigue, with a successful workshop in Cobar earlier this year.

'Fatigue is an issue at the workplace and on the road. Through this program, the MSAC is promoting workplace health and safety principle to safe driving on the roads,' Mr Jennings said.

(Source: *Get Machinery* news item at [http://www.getmachinery.com.au/index.php?option=com\\_content&view=article&id=1226:-road-safety-program-for-cobar-mining-apprentices&catid=1:latest-news&Itemid=18](http://www.getmachinery.com.au/index.php?option=com_content&view=article&id=1226:-road-safety-program-for-cobar-mining-apprentices&catid=1:latest-news&Itemid=18))

#### Firefighters fighting youth road trauma

South Australia is expanding its Road Awareness and Accident Program so that more than 90 per cent of secondary students can access it every year. The SA Government has tipped in \$740,000 to expand the project over the next four years.

Developed by the Metropolitan Fire Service, the driver training program targets novice and pre-licensed drivers, delivering a hard-hitting, realistic insight into road crash trauma. Firefighters will visit metropolitan and regional schools to conduct a multimedia interactive presentation that explores the causes and consequences of crashes.

The program enables students to gain an understanding of road trauma through the eyes of the firefighters, who undertake road crash rescues. It includes a practical demonstration of rescue techniques.

(Source: Press release by SA Road Safety Minister Jack Snelling issued 22 September 2010, <http://www.mfs.sa.gov.au/site/home.jsp>)

# OHS contributed articles

## Work-related road safety management systems

By Lori Mooren, Senior Research Fellow, and Professor Raphael Grzebieta, Injury Risk Management Research Centre, University of New South Wales

### Abstract

Increasingly organisations are applying risk management, occupational safety and road safety principles in an effort to reduce the incidence of work-related road crashes and injuries. This paper discusses some of the developments, models and tools that, while at present not all having a strong evidence base, show potential for an active role for employers to advance road safety within their organisations.

### Keywords

Work-related driving safety, Occupational safety, Safety management system

### Introduction

Opportunities to encourage the corporate sector to actively pursue road safety objectives within their own organisations can pay large dividends in reducing road injury overall. Around 60% of all new vehicles are registered as corporate fleet vehicles [1]. Moreover, work-related driving is a large part of the road risk exposure, and work-related driving carries more risk than non-work-related driving [2].

Increasingly, employers are making some attempts to reduce work-related driving crashes – whether this is to reduce costs or to meet duty of care responsibilities, or because they have carried across their safety ethos to work-related driving. Apart from one notable study conducted in Sweden in 1996 [3], there has been very little evaluative quantitative research into effective work-related driving measures [2], although some case study research is providing promising results. For example, the British company Wolseley has implemented a range of fleet safety measures and has reduced their road incident rates dramatically [4].

Drawing from risk management and occupational safety models and practices, some organisations have adopted what appear to be quite effective policies and practices in managing work-related driving risk. Some examples of these cases can be found at Driving for Better Business (<http://www.drivingforbetterbusiness.com>), a program undertaken on behalf of RoadSafe in the UK. But more research is needed to define exactly what works and how.

What is known is that some industry sectors have comparatively low road injury incident rates compared with others [5], even when controlling for exposure. And some companies have been able to reduce crash rates over time with active safety programs.

### Risk factors

Through cross-disciplinary research [6] and benchmarking processes [7], more can be learned about what can be done. Combining the collective knowledge of road safety risk factors and occupational safety knowledge, it is possible to conceptualise occupational risks associated with driving tasks and devise safety management systems that address these risks.

Reason [8] and others have argued that the reason for any incident is that the system in which humans behave is not error-proof. In other words, the starting point, as it is with the Safe System approach, is recognition that humans are vulnerable and fallible. Injury prevention – and indeed, accident/crash prevention – requires successive layers of defence against adverse events happening due to a human mistake.

The idea is that if holes in a set of management safety measures are in alignment, this enables an error to manifest into an accident. In other words, the ‘accident trajectory’ travels through holes or inadequacies of safety management barriers and will either be thwarted or get through the barriers to result in an adverse event.

### Root cause analyses

Looking at the work-related driving crash problem in this way encourages a root cause analysis to examine where the crash and injury defence system is weak. There are a number of methods to conduct a root cause analysis, to trace back from a crash event to discover each failure to prevent injury in the process chain. Sklet described 14 types of root cause analysis processes [9]. The objective of these kinds of investigation is to reveal weaknesses in the safety management system, thus enabling the investigator to identify system rectifications for more enduring safety defences.

A simple approach was developed by Toyota [11]. It says that conducting an investigation into an adverse event by asking five questions, each subsequent to the next one, drills down to



the systemic roots of the problem. An example of this is provided in Figure 1 where the investigator asks: 1) why did the injury occur? – because of a crash, 2) why did the vehicle crash? – because the driver was distracted, 3) why was the driver distracted? – because he was fatigued, 4) why was the driver fatigued? – because he worked a 16-hour shift, 5) why did the driver work a 16-hour shift? – because there was no back-up when another worker didn't show for work.

Figure 1 shows how individual factors result in a chain of individual and systemic factors. Stopping at any one of the preceding questions will not result in determining the root cause or weakness in the safety management system or practices.

Effects	Caused by	Factors
1. Injury	>	Collision
2. Collision	>	Distraction
3. Distraction	>	Fatigue
4. Fatigue	>	Long shift
5. Long shift	>	No back-up

Figure 1. Continuum of causal factors from individual errors to system gaps

Stuckey has examined the problem of occupational light vehicle safety. She has developed a conceptual model of the problem that moves beyond identifying discrete risk factors to one that places the locus of the injury problem with the individual, but recognises that there are spheres of influence that condition the ability of the individual driver to avoid a crash or injury [11].

### The 12-element fleet safety model

A 12-element fleet safety model, which is based on a combination of risk management, occupational safety and road safety principles and practices, was devised by the author with assistance from Phil Sochon (now Deputy Chief of the Australasian Railway Association, Inc.) and Bruce Searles (Director, Benchmarking Partnerships). This model is shown in Figure 2.

This model suggests that work-related driving safety is a continual process of setting safety management foundations, applying work and vehicle safety management practices, analysing crashes and incidents, and reactively and pro-actively managing risk. At the hub of the fleet safety 'wheel' is management leadership and commitment that aims to foster a safety culture within organisations.

A description of the elements is provided below:

- 1. Policy and procedures.** Clear statement of priority on safety combined with defined behavioural expectations
- 2. Recruitment.** Select staff with low risk driving tendencies
- 3. Induction.** Ensure that employees understand the priority placed on safe driving
- 4. Safe work planning.** Ensure that work tasks do not compromise safe driving
- 5. Fleet selection/maintenance.** Make sure that vehicles are safe for occupants and other road users
- 6. Crash reporting.** A system to ensure reporting of timely accurate crash incidents



Figure 2. Twelve-element fleet safety management – Mooren Model'

## Special Feature

7. **Data analysis.** Rigorous interpretation of crash reports identifying risk areas
8. **Risk resolution.** Follow up incidents to alleviate identified risks
9. **Incentives and sanctions.** Rewards or recognition for safe practices and safety results, and sufficient penalties to deter unsafe practices
10. **Driver education.** Make staff aware of crash risks and how to avoid them
11. **Leadership.** Senior managers demonstrate an active and practical commitment to safety
12. **Communication.** Regular communication within the organisation about fleet safety issues

While this model is based on theoretical principles drawn from various safety disciplines, not all elements have been empirically proven to reduce work-related crashes. Further studies should aim to identify management characteristics that, in combination, will be a reliable corporate fleet safety tool.

However, the 12-element system has been used as a template by organisations in examining possible gaps in their corporate road safety management, and in finding ways to fill these gaps. For example, this system was used to review a dangerous goods transport company, first by conducting a questionnaire survey on the perceived importance and performance of the company against these 12 criteria, then investigating the specific gaps in safety management practices [12]. After two years, the operations manager of the company was interviewed and incident data was reviewed. While the company had implemented many of the recommendations from the initial review, the safety performance outcomes had not changed substantially (although the incident rates were small on both occasions).

This suggests that more research is needed to examine empirically the effectiveness in safety management practices. Currently, there is a project underway to develop a safety management system for heavy vehicle transport operations through a research process.<sup>2</sup> In the first phase of the study, safety management and other organisational characteristics of good- and poor-performing companies will be analysed. From this, a safety management system will be constructed. Then the system will be implemented in a selection of poor safety-performing companies, and the safety outcomes will be measured and evaluated. This project will, for the first time, demonstrate the outcomes of implementing a holistic set of safety management elements.

## Acknowledgements

The author gratefully acknowledges the helpful guidance and editorial comments on this paper provided by Professor Raphael Grzebieta, Chair of Road Safety, Injury Risk Management Research Centre at the University of New South Wales.

## Notes

<sup>1</sup>Copies of this model are available on Wikipedia at <http://en.wikipedia.org/wiki/Special:Search?search=Mooren+model&go=Go>

<sup>2</sup>This research is being conducted by the Injury Risk Management Research Centre and the School of Aviation at the University of New South Wales with funding from the Australian Research Council Grant No. LP100100283, supported also by the New South Wales Roads and Traffic Authority, Motor Accidents Authority, Zurich, Transport Certification Australia and the National Transport Commission.

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# Driver fatigue: More than tuckered truckers

by David Segrott CPMSIA RSP (Aust), ANZIIF (Allied), MAICD, AFRMIA, Director, Australian Health and Safety Services

For a significant number of years, considerable concern has been expressed at the issue of driver fatigue, particularly among the long distance road haul industry. Whilst traditionally the main focus has been on drivers and operators, developments since 2000 have more broadly considered and ultimately led to the concept of a 'chain of command' approach. This has in turn led a number of jurisdictions to introduce, as a supplement to already existing road traffic controls, formal legislative and regulatory processes that require the development and implementation of fatigue management plans.

Naturally, there has to be a starting point for the application of these controls. With the focus of the legislation and regulation so far being primarily on the heavy vehicle industry, in NSW, this has been set at a commencement point of applying to journeys carrying freight for more than 500km and to all vehicles with a Gross Vehicle Mass (GVM) of more than 4.5 tonnes.

## What about other commercial road users?

Whilst the new fatigue management framework for heavy vehicle users has resulted in improvements in fatigue management and will continue to have this impact so long as complacency and lack of funded enforcement do not set in, what about other commercial road users who fall outside the above framework? There are a wide range of employment-related situations where people who are not specifically employed as 'professional drivers', but for whom driving is a significant element of the related activities of their work, fall outside these guidelines.

Persons conducting a business or undertaking (the new terminology in the harmonised Work Health and Safety framework) have an explicit obligation to protect the health, safety and wellbeing of workers (the expanded definition replacing employees in the harmonised Work Health and Safety framework) under their relative state OHS/work safety legislation. However, I see many companies that have not yet even identified fatigue as a potential, let alone specific, work safety issue that applies to their business.

## Examples of others who may be affected by fatigue

The following are some examples of fatigue-related issues that could arise for businesses not in heavy transport where, if there was a specific accident able to be proven as a result of fatigue, could face specific prosecution by their relevant work safety regulator.

### **Example A: A country-based community service organisation, covering a large area, that provides counselling and support services for youth and aged persons.**

The base for this organisation may be in one or more locations, and staff may be required to drive up to 200km in any one day. On top of this driving, they may call in and see up to six to eight clients and provide services such as one-on-one counselling or, in some cases, physical personal care services such as bathing, feeding, domestic cleaning, etc.

Whilst the 200km drive in itself would not be considered likely to result in fatigue, in combination with the other activities it may well be, particularly if the client work is stressful or physically demanding and is followed by a relatively long journey back to home base.

Couple this with particular issues related to time of year (in winter it can be dark by 4.30pm) and wildlife (kangaroos and wombats come out from just before dusk onwards), and this could easily be an issue that needs to be managed not just from a fatigue management basis but from the basis of worker health and safety.

### **Example B: A small Canberra-based Commonwealth agency that is preparing for a Senate inquiry.**

During the lead-up to the Senate inquiry, most senior managers have been working long hours, preparing information and material to submit to and present before the inquiry. Many of the staff members concerned are starting as early as 6am and working until 11pm, and this goes on for about three weeks. At the end of the day, the staff members who have been working 17-hour days get into their cars (some are packaged cars through salary sacrifice) and drive home, with some journeys of up to half an hour.

Whilst this may appear somewhat unremarkable, the agency is not aware that the fatigue-related effect on the staff of working these hours means that at the time of their journey home, it is estimated that they are as affected as if they had been drinking to above the 0.05 blood alcohol limit.

The issue that follows is twofold. If one of the persons is involved in an accident on the way home, whilst there may not be a workers' compensation issue (the Commonwealth withdrew journey coverage in 2005), there is, firstly, the issue of potential prosecution for failing to provide a safe system of work and, secondly, the issue of potentially losing a key member of staff and the associated corporate knowledge. This is on top of the potential that the accident may involve another vehicle and result in serious injury or death to an innocent road user.

## Work safety responsibilities

Whilst both of the examples outlined above may appear to be somewhat implausible, they are nonetheless completely possible and should be identified as part of the risk exposure that the business or activity faces and must manage as part of doing business. Many employers struggle with the concept of risk management where the risks go beyond the standard slips, trips and falls, but have a clear responsibility to identify, assess and control such risks.

Persons who are in control of any business or undertaking must take a broad view of the risks associated with work and, in relation to those risks involving potential fatigue during the use of a vehicle, must look beyond just the long journey to the combination of the work done during the day and the journey itself. It is only when these aspects are managed together that successful fatigue management for journeys involving the use of vehicles will be treated to the same level of scrutiny and management as the framework applied to heavy vehicles.

## Summary

According to the NSW Road Traffic Authority (RTA), for the 12 months ended July 2010, 19.5% of all fatal accidents that occurred in NSW were able to be proven to have had fatigue as a major if not the primary element. Whilst strict fatigue management will have some impact on improving this element for the heavy vehicle industry, only action on the part of the general community and by persons in control of businesses will have an impact on the rest of the road users.

Driver fatigue is an issue for more than just the heavy vehicle industry and long distance truck drivers. It is an issue for every business, every time someone has to get into a vehicle and drive somewhere to do work. Every business has an obligation to identify, assess and control the risks associated with vehicle use, not just when they think about it, but all the time.

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# Blue Care road safety program

*by Mark Stephens, Fleet Manager, Blue Care*

This paper outlines how Blue Care moved fleet safety from an era where there was minimum focus on crash frequency or driver risk analysis and no training, to today, where fleet safety is a core function of the Fleet Management Unit. This case study reviews the processes Blue Care undertook to reduce crash rates which included (a) comprehensive risk analysis, (b) driver education, (c) thoughtful vehicle selection and (d) the development of industry partnerships to achieve the desired outcomes.

## Who is Blue Care?

Blue Care is one of Australia's largest not-for-profit aged care providers with a diverse range of community and residential care services that engage with most special needs groups, specialised community social and health agencies, and the acute health care sector. Blue Care services cover large geographic regions in metropolitan, regional and remote areas of Queensland and northern New South Wales.

Blue Care's Residential Aged Care Services operate 4240 residential aged care beds and provide over 1.5 million days of care per annum. Blue Care also delivers in excess of 3 million occasions of service annually for community clients in their homes or in our community centres.

## Fleet snapshot – History of growth

Since 1953, Blue Care has been delivering community nursing services. During the early days, community nurses used public transport to travel to clients' homes. Since those early beginnings, the Blue Care fleet has grown to over 1500 vehicles

that travel over 32 million kilometres per annum. This includes staff using their own vehicles. Prior to 2005, vehicles were managed at a local level using a spreadsheet or simple database. From 2005, all vehicle management was centralised on an outsourced fleet management database with the physical management split between a contracted fleet management company and the Blue Care fleet unit of four full-time staff.

Since the amalgamation of fleet from a locally managed model to a centrally managed model, the number of vehicles has grown from 1300 to over 1500 in 2010. This number will continue to grow as the demand for more community services increases. The current fleet consists of 950 pool passenger cars, 350 salary vehicles, and 200 bus people movers, light commercials and trucks.

## The motivation - Vehicle crash and infringement history

Until 2008, Blue Care did not provide a coordinated staff education program in road safety or have a risk analysis process in place to identify poor driving and potential driver or vehicle risks. From the day Blue Care commenced operations until 2005, there were very few data that could have been used to analyse and determine where risks existed in order to put in place risk mitigation interventions. What data was available indicated a high number of at-fault crashes. The move to smaller cars between 2005 and 2006 went some way to reducing the number of crashes, especially reversing crashes (see Figure 1).

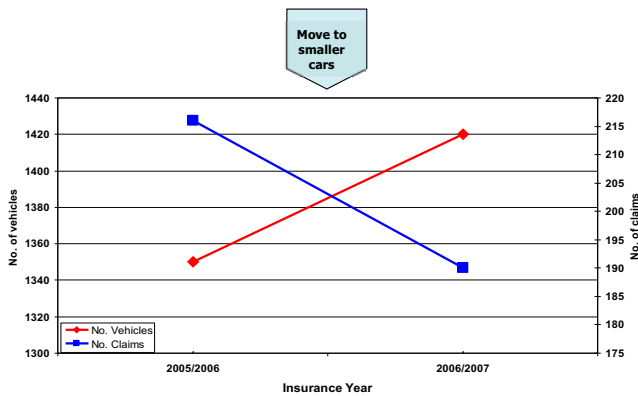


Figure 1. At-fault claims in relation to vehicle numbers

A number of significant issues have highlighted the importance of fleet vehicle and road safety as an imperative for modern-day fleets. Driven by legislated changes in Europe, Australia has recognized that ‘duty of care’ compliance encompasses all aspects of working life and should include every aspect of fleet operations from the purchase and operation of fleet vehicles to staff training in their ‘duty of care’ to other road users and pedestrians.

Additional financial motivators to develop and implement a fleet road safety campaign include:

- the high cost of a road accident, which can be greater than 20 times that of the actual physical damage to the vehicle
- escalating insurance premiums, as insurers recognize the higher risk of insuring fleet vehicles
- the potential negative impact on organisational reputation if road safety programs are not implemented.

## Partnerships and the development of the driver safety campaign

A road and vehicle safety program was designed and delivered in consultation with internal stakeholders and peak bodies. This ensured that acceptance by staff and the embedding in organisational culture from the top level of management to the drivers at the coalface. It became obvious that the acceptability of the program and compliance with the program would be more likely if key external partners were associated with the program. To add credibility to the program, external collaborators were selected because they were icons that Blue Care drivers recognised and respected for their contributions to driver safety more broadly.

Both the Centre for Accident Research and Road Safety Queensland (CARRS-Q) and the RACQ have had long relationships with Blue Care and were obvious partners for designing, developing and implementing the program. CARRS-Q’s involvement started as a research program with Australian Research Council funding in 2006. This research program contributed to the first interventions, with CARRS-Q providing technical assistance in the development of slogans

and the review of resources during the development phase of the program.

The RACQ has for many years provided road side assistance to Blue Care. Currently, Blue Care uses a number of the RACQ services to develop and review road safety and the operation of fleet vehicles. The RACQ road safety education unit has been pivotal in providing the technical support to develop internal education resources and in delivering the education sessions. Since 2008, over 3000 Blue Care staff and volunteers have attended the two-hour driver safety awareness sessions, with over 150 hours of driver safety sessions being delivered across Blue Care’s metropolitan and regional centres.

The development of the resources to support the education program and to provide continuing reminders to existing and new staff was essential and was the first task completed before the rollout of the regional training program. With the assistance of RACQ and CARRS-Q, the Blue Care marketing team’s graphic designers developed a range of posters aimed at protecting drivers and also reminding them of their responsibilities to their families and the public.

These posters were designed from the driver view of the road, reinforcing that, as drivers, people are depending on them (Figure 2). Other communication and dissemination strategies included stickers and driver safety handbooks and brochures. To ensure that all Blue Care staff, volunteers and their families receive the road safety message, over 20,000 copies of the road safety manual were printed and distributed. Copies were made available for visitors to pick up in Blue Care centres.



Figure 2. Road safety poster developed in-house

## Delivery of driver safety awareness training

As a not-for-profit organization, funding of the fleet safety program was always going to be a challenge. It was important that training sessions and printing of resources would have no impact on individual cost centres. Finding external funding for the program also ensured buy-in and the goodwill necessary to ensure acceptance of this initiative by managers who would engage maximum staff participation in training opportunities.

## Special Feature

The sources of funding to implement the program included:

- rebates from CTP insurance that committed 100% to driver training
- a grant from the Community Benefit Fund (CBF) for regional and remote driver training
- additional costs borne by the fleet management cost centre.

The timing and delivery of the program across a large geographical area was a key challenge. There was also a funder requirement from the CBF that the program had to be delivered within a specified timeframe. Road trips were undertaken across Blue Care's care delivery clusters with Blue Care fleet staff accompanying the RACQ trainers. This allowed local Blue Care staff to meet Blue Care fleet staff to discuss issues openly, with the added benefit of reinforcing the road safety message to participants. This approach resulted in excellent up-take of the program.

## Outcomes

Evidence from data shows a significant drop in 'at fault' accidents and infringements over the last 12 months. Figure 3 depicts reductions that have been achieved against the number of vehicles in the Blue Care fleet since 2005. The following points highlight the success of the program to date:

- no increase in Blue Care's insurance premium for the 2010-11 insurance year, as compared with most fleets where there was at least a 10% increase
- a projected 30% decrease of at-fault accidents between 2008 and 2011
- a 35% reduction in 'fail to give way' accidents
- a current infringement rate at an average of one per month for every 150 cars on the road compared with a range of 1 to 95 in 2008. This has occurred in the context of increases in the number of fixed and mobile photo units during the last three years
- the building of a solid foundation that will ensure a culture of road and vehicle safety within Blue Care

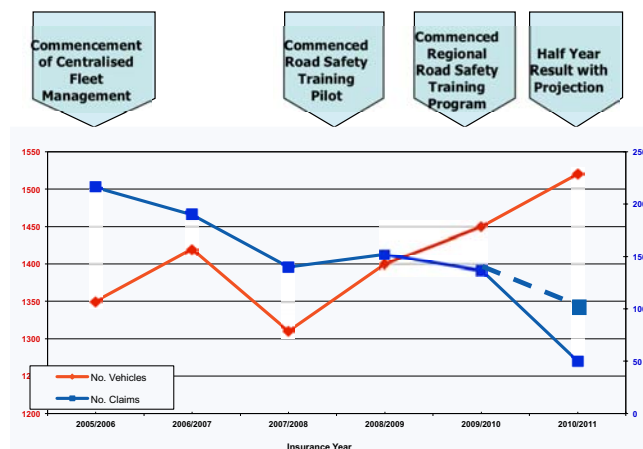


Figure 3. Incidence of at-fault crashes in relation to fleet growth

## Where to from here?

Blue Care is currently developing a number of new programs and resources to enhance the existing programs and fill any future gaps. These include the following:

- A bus driver program specifically for bus drivers transporting the elderly. This program is being developed in partnership with the RACQ and Mount Cotton Driver Training Centre. Once developed, this program will be able to be delivered to any organisation.
- A range of DVDs used to orientate drivers to specific vehicle groups, which cover topics such as safety checks and safe driving techniques.
- A driver assessment program that provides options for managers when employing staff. These programs will be aimed at inexperienced drivers, international drivers or drivers identified as 'at risk'.
- New resources to build on the current road safety messages, including a web-based skills and assessment program and new posters with messages targeting specific areas such as the use of mobile phones in vehicles and respect for other road users.

## Implications for future practice

Blue Care believes that a level of best practice in fleet safety has been achieved. However, the question of how to extend this initiative needs further consideration. This could also inform other organisations with large numbers and varieties of vehicles to have the confidence to provide best practice initiatives in fleet safety and to also address their duty of care.

To achieve these outcomes, all fleets need to address the following:

- providing drivers with all the current knowledge in road and vehicle safety, as well any traffic regulation changes.
- multimedia educational strategies that include print materials and structured training sessions
- comprehensive data collection on all facets of vehicle operation that will enable the analysis and identification of 'at risk' drivers and/or centres of operation
- use of data analysis to determine the effectiveness of interventions to improve vehicle operations and driver safety, e.g., training, HR intervention
- use of GPRS technology as an additional means of providing data to improve vehicle and driver optimisation and safety
- procurement policies for the selection of safe and sustainable vehicles that will lead to reductions in vehicle incidents, carbon emissions and improvements in vehicle operating costs
- organisational policies and procedures for the operation of vehicles that provide clear direction on the operation of vehicles.

## Conclusion

Blue Care is committed to furthering the development of initiatives that add value to current strategies. The future direction in road safety will be exciting and challenging as Blue Care looks to enhancing the use of data, introducing new technologies and developing new training methods to further

reduce the incidence of road crashes. The lessons learned in the delivery of this road safety program may inform similar organisations. Through continued engagement and input of internal and external stakeholders, Blue Care will continue to take a leadership role in the delivery of road safety.

# Helping the helpers: The role of EMSPA in paramedic practice

by Ben Goodwin, State Liaison Officer, Emergency Medical Service Protection Association (Queensland)

Danger is the first step in the analysis of a critical situation. Paramedics have this entrenched in them from the first day of their education with the acronym 'Dr. ABC' applied in the systematic assessment of almost all patients. The theoretical knowledge and awareness of potential hazards is an essential element in the training and day-to-day practice of a paramedic. It stands to reason, though, that while paramedics are immersed in such a dynamic work environment, recognising dangers and then taking steps to avoid harm can be an art as much as a science.

There are multiple policies and procedures in place in an attempt to keep paramedics safe; however, new dangers arise and inevitably injuries occur. The Emergency Medical Service Protection Association (EMSPA) is an organisation that was founded by front-line paramedics for the support of ambulance service personnel. EMSPA is constantly engaged in communication with paramedics across Australia, assisting them with legal and workplace issues. As a non-politically aligned, democratic association, we are solely focused on giving essential support to members and improving work conditions for all emergency medical service personnel.

EMSPA currently represents over 1600 paramedics and, as an organisation driven from the ground up, is constantly seeking ways to improve the health and safety of ambulance service personnel. One of the most visible and also most dangerous aspects of a paramedic's profession is the rapid response to an emergency situation. While most patients will be inside a dwelling, the dynamics of this line of work is exemplified by the attendance at a road traffic accident.

The health and safety of paramedics attending a road traffic accident is a multi-faceted issue. The EMSPA liaison network has given support to paramedics for many incidents that have unfortunately not gone according to plan. These situations typically arise due to the number of uncertainties that are inevitable when working in the field. EMSPA has received feedback from concerned or affected members about issues that have occurred while they are involved in the following activities:

- Driving with lights and sirens on through traffic
- Dealing with potentially irate patients or bystanders

- Attending an accident with other vehicles driving quickly past or causing another accident from slowing down and showing too much interest
- Manually handling patients and equipment
- Using sharps and pharmacological agents in an uncontrolled or dangerous environment.

The situations mentioned above have all been raised by EMSPA members but are by no means the only issues confronting paramedics. The scope of the concerns raised, however, does provide some insight into the diverse nature of hazards for ambulance service personnel.

Psychological issues affect many paramedics, and there are support organisations within many of the services throughout Australia. Every call-out is different, and the multitude of possibilities that necessarily runs through the minds of paramedics in an attempt to consider possible injuries, other resources or services that may be required and the most appropriate medical facility for casualties must be dealt with before arriving at the scene of the accident.

Fatalities and serious injuries have enormous impact on all people present, and debriefing is performed informally between colleagues and, if needed, formally by support networks developed by employers. EMSPA members are directed to the independent counselling service provided for free by the association for any psychological complaints. If they just want someone to talk to, they can contact their EMSPA Regional Liaison Officer, as there is often no one better placed to offer support than a fellow paramedic.

The altruistic nature of the ambulance profession implies that the well-being of front-line staff is not always their highest priority, and this is most clearly evident in an actual emergency situation, such as a road traffic crash (RTC), where lives are at stake. Different services throughout Australia have different driver training regimes for new paramedics. While some states have intensive five-day courses followed by on-road supervised driving and mentoring, other states have a briefer introduction to 'code 1' or 'hot response' driving. Most states have legislative provisions that provide drivers of emergency vehicles with

exemptions under the road rules to enable rapid response without undue repercussions; however, paramedics can be charged with dangerous or negligent driving. The law explains that during the emergency response, it is a paramedic's duty to operate the vehicle with reasonable care, and to be exempt from the law, it must also be reasonable that the relevant road rule should not apply.

It is undoubtedly difficult to prepare a person to drive under lights and sirens while on the way to a potentially life-threatening injury or illness but it is always a paramedic's first priority to arrive safely at the scene in the quickest possible time. If, unfortunately, an accident does occur, EMSPA members are advised to comply with their employer's requirements and also to contact their EMSPA Regional Liaison Officer for support, advice and possible legal representation.

Manual handling is an important issue raised by many EMSPA members when treating and transporting patients. At the scene

of an RTC, this occurs when moving and/or lifting a patient out of a vehicle onto a stretcher and also, on occasion, when lifting the patient from the ground onto a stretcher. Once the patient is on the stretcher, the loading of a stretcher into the vehicle is another manual handling area that potentially causes injury.

Any injuries sustained by a paramedic should be recorded according to the employer's policy, and an EMSPA liaison officer should also be contacted. When a liaison officer is contacted, EMSPA is able to give the support required and monitor trends in workplace incidents, as well as provide vital legal support during the WorkCover process where required.

This monitoring has, in the past, resulted in EMSPA contacting ambulance service management about workplace health and safety issues. EMSPA has petitioned and lobbied ambulance service management to have recurring 'near misses' or potential hazards examined with the goal of changing paramedic practice for the better.

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## Motor transport and traffic safety in Australian agriculture: A review

by L Fragar and T Lower, Australian Centre for Agricultural Health and Safety, University of Sydney, Moree

### Abstract

In rural communities, motor transport features as a leading cause of on-farm fatalities. The most common agents of injury are quad bikes, farm utilities and two-wheeled motorcycles. This paper describes the current status of knowledge and action in safety associated with on-farm motor vehicle transport, and provides recommendations to reduce this injury burden.

While farm transport has benefited from improvements in design features associated with on-road vehicles, there are specific design approaches that will further enhance safety – for example, minimising the potential for crush injuries from quad bike rollovers. Additionally, as farmers and farm managers are responsible for health and safety in farm work settings, ensuring maintenance of farm roads and laneways, and enforcing compliance with rules relating to speed, passengers and helmet use, will all be important. The road safety industry can play an important role in assisting the small and generally family-based farming businesses to adopt these approaches.

### Keywords

Farm vehicle, Farm injury, Farm safety

### Introduction

Motor vehicle safety research and initiatives have focused largely on reducing the human and societal toll associated with vehicle use on public roads and highways. The high rate of road traffic deaths of rural relative to urban populations has been well

recognised and explored both internationally (for example, [1]) and in Australia [2-4]. In relation to off-road motor transport safety, the focus of attention has been drawn to driveway deaths of children [5-7], and to deaths and serious injury associated with quad bike deaths of children and adults in a range of settings [8].

The problem of traumatic deaths and serious injury on farms due to a variety of different agents of injury is well recognised internationally and in Australia [9]. However, initiatives to improve safety associated with motor vehicle use in agriculture has been limited to improving quad bike safety on farms and, in North America, to risks associated with driving slow-moving farm 'vehicles' on roads [10, 11]. Little attention has been given to the whole issue of on-farm traffic and the interaction between the wide range of motor vehicles and mobile plant.

Most vehicles that are used to transport people and goods on farms are also used on public roads, quad bikes being the key exception. Similarly, items of mobile plant used in agricultural production are sometimes driven on roads between farms. From a user perspective then, both on- and off-farm (or on- and off-road) safety should not be ignored in any serious attempts to improve safety, whether opportunities be in terms of improvement in vehicle characteristics, in operating environments or in human behaviour.

This paper aims to describe the current status of knowledge and action in safety associated with on-farm ground transport vehicles on Australian farms, and recommends action that should be initiated to reduce the burden of injury.



Published papers and reports were identified using Web of Science™ and Medline™ search engines, and Google Scholar™, and keyword combinations of ‘injury’, ‘off-road’, ‘farm’, ‘motor vehicle’ and ‘traffic’. The literature is somewhat confusing in light of mixed inclusions of vehicles in different classifications of external cause of injury.

On one hand, tractors are specifically included within the classification of Transport Accidents with other vehicles in the External Causes of Morbidity and Mortality in the International Classification of Disease ICD-10-AM [12], rather than within the section on contact with machinery. Hence tractors and some items of mobile plant are included as vehicles in broad transport accident groupings showing cause of death or injury. This is reflected in much of the North American literature relating to slow-moving agricultural mobile plant (tractors and harvesters) on public roads.

On the other hand, occupational health and safety classifications (Type of Occurrence Classification System - TOOCS2.1, May 2002) include tractors within a separate section of ‘mobile plant’. This is a more logical placement, as tractors are not primarily designed for driving on roads, nor for pulling or transporting loads or people; rather, they are designed to power mounted or trailed equipment (for example, cultivators, seeders or sprayers) by way of either hydraulic or rotating drive shafts. The National Farm Injury Optimal Dataset has placed tractors within the category of ‘mobile plant’ [13], and this review has treated tractors as mobile plant and not motor vehicles.

## Motor transport injury on Australian farms

The most comprehensive overview of motor vehicle injury and death on Australian farms is found in the chart-book report *Vehicle injury associated with Australian agriculture – The facts 2008* [14]. Motor vehicles made up 34.6 per cent of all injury deaths on farms for the period 2001 to 2004. Table 1 indicates the motor vehicle types that were involved in those deaths, with quad bikes (four-wheeled motorcycles, previously termed all-terrain vehicles or ATVs), farm utilities (pick-ups) and two-wheeled motorcycles comprising the most significant vehicles.

Table 1. On-farm deaths by agent of injury, Australia 2001-2004

Agent of injury death	Number of deaths	Per cent of deaths
Farm vehicle	133	34.6
Truck	9	2.3
Utility	22	5.7
Car	11	2.9
Motorcycle 2-wheel	17	4.4
Motorcycle 4-wheel	51	13.3
Aircraft	11	2.9
Gyrocopter	1	0.3
Helicopter	3	0.8
Farm vehicle other NEC	7	1.8
Unknown	1	0.3
Mobile farm machinery/plant	101	26.3
Farm structure	63	16.4
Animal	26	6.8
Working environment	31	8.1
Fixed plant/equipment	8	2.1
Workshop equipment and materials	10	2.6
Other agents	12	3.1
<b>Total</b>	<b>384</b>	<b>100.0</b>

Source: Morton C, Fragar LJ, Pollock K. [14].

## Quad bike safety

Quad bikes are associated with a large number of deaths and serious injury worldwide, with global focus on deaths and serious injury to children [15, 16], adults and older people [17-19]. The propensity of the vehicle to roll over and crush the rider (and passenger) has been well documented.

Quad bikes are used on farms for a wide range of production activities, including checking water, crops, etc.; mustering stock; spraying weeds; and carrying small loads. Since the late 1990s, the leading agent of vehicle injury death on Australian farms has been quad bikes. Table 2 provides a breakdown of the age of victims related to how the injury occurred that resulted

Table 2. Deaths associated with 4-wheeled motorcycles on farms – Age of victim and mechanism of injury death, 2001-2004, Australia

Mechanism of injury	Age group of victim					Total
	0-9	10-14	15-29	30-54	55+	
<b>Passenger</b>						
ATV rolled and pinned victim	2	1				3
Fell off		1				1
Loss of control of ATV and crushed, or other						
<b>Rider</b>						
ATV rolled and pinned victim	2		1	5	15	23
Thrown from ATV after incident		2	4	2	2	10
Loss of control of ATV, crushed or other			1		2	3
Collision with other vehicle					2	2
Loading ATV onto utility				1		1
Knocked by bull, ATV rolled					1	1
Unknown	1				3	3
<b>Total</b>	<b>5</b>	<b>4</b>	<b>6</b>	<b>8</b>	<b>25</b>	<b>51</b>

Source: Morton C, Fragar LJ, Pollock K. [14].

## Special Feature

in death. In 27 cases the injury was caused by the quad bike rolling and crushing the victim.

Table 3 shows the activity being undertaken by the victims of on-farm quad bike injury deaths for 2001 to 2004. While for most cases the activity was unknown, mustering stock, spraying weeds and checking were the more common activities being undertaken at time of injury event.

**Table 3. On-farm activity being undertaken at time of quad bike injury death 2001-2004**

Activity	Number of deaths
Shooting/hunting	2
Checking	5
Mustering	7
Work other	6
Spraying	5
Leisure	1
Unknown	25
<b>Total</b>	<b>51</b>

In a summary of all quad bike deaths in Australia, it was noted that the body parts injured and associated with death were most commonly head (28% of cases) and cervical spine and thorax (9%) [20].

#### Interventions to reduce quad bike deaths on Australian farms

Farmsafe Australia, the peak association of organisations that share an objective of improving safety on Australian farms, established an all-terrain vehicle safety reference group and developed its national strategy to improve quad bike safety in 2004 [21]. In implementing the strategy, a number of television promotions were undertaken and a guideline for farmers and operators was produced [22]. These guidelines have been incorporated into farm safety management resources made available to farmers and managers on the Farmsafe Australia website ([www.farmsafe.org.au](http://www.farmsafe.org.au)). Principles for quad bike safety for farmers include:

- Selection of the safe machine to do the job. The quad bike may not be the right machine
- Wearing of a helmet to prevent head injury
- Ensuring that all riders are properly trained to operate and control a quad bike
- Keeping quad bikes well maintained
- Attention to ensure that quad bikes are not overloaded
- No operators under 16 years of age
- No passengers.

More recently, the Heads of Workplace Safety Authorities has assembled the Trans-Tasman Industry Solutions Program Working Party Quad Bikes (Agricultural Industry), which is addressing the issue of quad bike safety on farms in Australia and New Zealand. This group is working to establish solutions

across the whole 'hierarchy of control', with a clear focus on the difficult problem of prevention of rollover and crush injuries. Options for improved design and protection of operators, safety training and use of personal protective equipment (particularly helmets) are being examined. This group has a strong record of achieving positive change for improved standards for some agricultural machines (for example, grain auger guarding).

#### Farm utilities, trucks and cars

Farm utilities (colloquially termed 'utes' in Australia, Figure 1) are typically more open-style vehicles than the North American 'pick up' utility vehicle. They are in constant use by farmers and workers both on-farm and on public roads for getting around the farm and for transporting small- and medium-sized farm items – for example, tools, fencing gear and feed.



**Figure 1. Typical Australian farm utility vehicle or 'ute'**

Fatalities associated with farm utilities were from all ages. Table 4 indicates the activities being undertaken at the time of injury event and how the injury occurred. Of concern are the six deaths where people were riding unrestrained on the tray-back of utilities, while engaged in shooting or hunting activity.

There are a wide range of heavier trucks used to transport goods on and off farms. All 9 victims of injury death associated with trucks were adults aged over 30 years of age engaged in work. Three of the 9 deaths were associated with hydraulics failure during truck maintenance or repair activity. One death was associated with collision of the truck with another vehicle on farm.

The 11 deaths associated with sedan cars on farms included 2 children under 14 years of age where the child was unrestrained either in a towed vehicle or on the exterior of the car, and 9 adults over 30 years old where the injury event involved loss of control, cars hitting objects and/or rolling over (6 cases). There were 3 cases where the person was out of the car and was run over or crushed by the car.

#### Interventions to improve ground transport safety on farms

There has not been an Australia-wide approach to specifically address safety of utilities, trucks and cars on farms, although

Table 4. Deaths associated with utilities on farms – activity being undertaken and mechanism of injury death (where known), 2001-2004, Australia

Mechanism of injury	Activity being undertaken							
	Shooting/ hunting	Checking	Vehicle maintenance	Mustering	Work other	Spraying	Watering	Unknown
<b>Passenger</b>								
On back of ute	6							
Sitting on driver's lap/fell out		2						
Other				1				
<b>Bystander</b>								
Run over by utility					2			
<b>Driver</b>								
Got out, run over/crushed		2					1	1
Swerved/lost control						1		2
<b>Mechanic/operator</b>								
Welding explosion			1					
Changing tyre/jack failed			1					
<b>Total</b>	<b>6</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>3</b>

Source: Morton C, Fragar LJ, Pollock K. [14].

traffic safety is included within safety checklists, industry-specific guidelines and safety induction guides provided through Farmsafe Australia (see above).

In New South Wales, the NRMA and Farmsafe New South Wales joined forces to produce the leaflet, 'Don't wait till you're at the front gate to put your seat belt on. Seat belts save lives on farms too!' This leaflet has been circulated at farm field day promotions and at all relevant events by both organisations.

### Motorcycle safety

Two-wheeled motorcycles continue to be used for mustering stock and getting about many farms. Table 5 shows the age group of the 17 riders of two-wheeled motor cycles who died between 2001 and 2004 on Australian farms. Two cases were associated with use of the motorcycle for mustering, and in 10 cases the motorcycle was most likely being used in leisure activities. The greatest number of deaths associated with two-wheeled motorcycles occurred in young adults and all cases were males.

Table 5. Age distribution of victims of two-wheeled motorcycle injury deaths on farms, 2001-2004, Australia.

Age group	Number of deaths
0-9	1
0-14	2
15-29	10
30-54	3
55+	1
<b>Total</b>	<b>17</b>

### Helmet wearing to increase motorcycle safety

The key message being promoted to reduce deaths and serious injury associated with two-wheeled motorcycles has been the importance of wearing helmets. Moves have been made by Farmsafe Australia and farmer organisations to develop a single Australian and New Zealand standard for a farm helmet that would be used to protect the head and neck when riding two-wheeled motorcycles, quad bikes and horses. There are many farms where all three forms of transport are used, and such a helmet needs to be comfortable for use throughout the working day and provide ventilation for work in hot conditions.

Data was presented to the Committee of Standards Australia that demonstrated the need and usefulness of such an approach. While a draft standard was produced by the working committee, the standard failed to be adopted by Standards Australia at a higher committee level.

### On-farm traffic and mobile plant

Many farms in the broad-acre cropping sector experience heavy on-farm traffic of trucks, utilities, and mobile harvesters and other plant, especially at harvest time. Similarly, traffic around packing sheds can be heavy in fruit and vegetable enterprises. These industries have included guidelines to assist producers in managing traffic safety in their safety guidelines, again available through the Farmsafe Australia website.

### Trends

While there have been some general reductions in numbers of ground transport deaths over time (specifically deaths associated with trucks, cars and two-wheeled motorcycles), there has been a dramatic increase in deaths associated with quad bikes and a small increase in deaths associated with farm utilities between the periods 1989-1992 and 2001-2004 (Table 6).

## Special Feature

Table 6. Type of ground transport vehicle causing death on Australian farms in two study periods

Ground transport type	Number deaths 1989-1992	Number deaths 2001-2004
Truck	23	9
Utility	20	22
Car	32	12
Motorcycle 2-wheel	24	16
Motorcycle 4-wheel	4	51

Source: Fragar L, Pollock K, Morton C. [9]

## Discussion

Internationally, with the exception of New Zealand and Australian work addressing quad bike safety, there has been no strategic focus on the problem of ground transport injury and deaths on farms. This review has only considered deaths, but serious injury associated with transport is also a major problem, clearly described by reference to hospital admissions and workers' compensation claims [14]. Clearly the work of the Trans-Tasman Industry Solutions Program Working Party Quad Bikes should be supported strongly. However, broad strategies are also appropriate.

Farm transport safety has benefitted from the improvements in safety design features of vehicles used on public roads – cars, utilities and trucks. However, many of these potential benefits are not being realised in the farm setting (for example, seat belts), as responsibility for safety on farms rests with farmers and farm managers under occupational health and safety regulatory arrangements. There is little or no compliance activity to ensure people are restrained in seat belts, or to ensure roads, laneways and traffic ways are maintained to a safe standard.

It is proposed that the agriculture sector, through its Farmsafe Australia members, enter into partnership with relevant Australian road safety agencies to systematically examine the known factors associated with transport safety on Australian farms and to develop evidence-based solutions that will provide farmers, managers, operators and other stakeholders with improved systems and guidelines to enhance safety. These will include:

- Vehicle design safety – furthering the work on quad bikes, and including farm utilities
- Maintenance of farm roads and laneways to a safe standard for the likely traffic use with relevant speed limits/restriction
- Assistance in establishing and enforcing compliance with farm rules that include
  - restraint for drivers and passengers inside the vehicle
  - helmet use
  - on-farm traffic control
- Design of a suitable helmet for use on two-wheeled motorcycles, quad bikes and horses
- Safety in maintenance of farm transport.

Many of these solutions are in use in other workplaces. However, isolated farming businesses need assistance to learn from other industries and disciplines, and the road safety industry can help make a difference.

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# Heavy vehicle safety: A comprehensive approach

by Keith Simmons, General Manager Safer Vehicles, RTA

A news article published in the *Sydney Morning Herald* on 11 July 2010 commented on the increased rate of speeding among heavy vehicles in NSW and the fatal impact this has on the road toll. The article quoted from a report published by the Roads and Traffic Authority of NSW (RTA) detailing that as many as 37.7% of heavy vehicles exceeded the speed limit in 100km/h zones. This was reported as a significant increase from an estimated 28% of heavy vehicles 10 years ago, according to an RTA survey at that time.

Since this is a major road safety concern, what are the RTA and other agencies doing about it?

Heavy vehicles are defined as those weighing 4.5 tonnes or more and include rigid trucks, articulated vehicles and buses. In 2009, there were around 114,000 heavy vehicles registered in NSW. In addition, thousands more heavy vehicles that are registered outside NSW travel on NSW roads. Some estimates suggest as much as 80% of the national freight task moves within or through NSW.

Heavy vehicles represent about 2.5% of all vehicles registered in NSW, but along with those from interstate, were involved in nearly 6% of all crashes. Sadly, this translates to around 14% of all fatal crashes where at least one person is killed. However, this has decreased from around 22% of fatal crashes in 2003.

## RTA response

The RTA has identified three main contributory factors for crashes involving heavy vehicles. Speed is the major cause, followed by fatigue and vehicle roadworthiness. In 2007-08 nearly 50,000 fines with a value of around \$17.7 million were issued against heavy vehicles and their drivers in NSW. This includes various offences such as speeding, unlicensed driving, failure to wear seat belts and other offences.

A comprehensive suite of responses, using a multi-agency approach, is required to address these and other road safety issues, for an industry that has a deeply entrenched set of cultural values, has operated at the limits of competitiveness during the Global Financial Crisis, is subject to pressure from others outside their direct line of responsibility and has a range of characters who consider themselves 'hard men and women' who can keep going when the going gets tough. All this, while driving on roads with ever increasing numbers of other vehicles, driven by people who act impatiently and are often oblivious to a heavy vehicle's turning circle, swept path or braking distance requirements.

To improve road safety and to limit the damage to roads and bridges, the RTA undertakes a broad range of responsibilities in the areas of regulation, detection and enforcement associated with heavy vehicles.

In his response to the NSW Auditor General's report of May 2009, *Improving road safety – Heavy vehicles*, the RTA's Chief Executive Michael Bushby wrote, 'The challenge of regulating heavy vehicles requires a mix of technology, regulation and enforcement initiatives to provide the economic, environmental and safety outcomes the community expects. While on-road enforcement is a critical compliance and enforcement tool in regulating heavy vehicles, it has to be complemented by other compliance assurance tools to meet the challenge of increasing freight tasks in NSW and increasing complexities in the road freight and logistic sector.

'An integrated and more sophisticated heavy vehicle compliance and enforcement framework is required in addition to conventional on-road enforcement. This framework now includes chain of responsibility legislation, accreditation and incentive based schemes, industry consultation and education, a professional RTA inspectorate, and better use of technology such as the Intelligent Access Program. The framework facilitates appropriate and timely regulatory responses to areas of non-compliance that pose high risks to road safety and road wear. The highest deterrent value is achieved by appropriate enforcement. For example, chain of responsibility investigations and prosecutions have produced significant improvement in the compliance of vehicle loading.'

## Enforcing compliance

On the ground, these over-arching statements translate into actions that are and will continue to improve road safety in NSW. In 2009 the RTA commenced introduction of a point-to-point camera system that detects heavy vehicle speeding over a known route, in order to manage and deter speed-related behaviours. At present there are two point-to-point systems operational, from Harwood to New Italy on the Pacific Highway and from Meadow Flat to Raglan on the Great Western Highway. The RTA will deliver a further 19 point-to-point systems by the end of 2011, with six of these already partially constructed. The point-to-point scheme commenced operation on 1 April 2010 and included a period of warnings prior to sanctions being imposed.

Heavy vehicle speeding is also enforced by the network of 172 fixed speed cameras in 141 locations throughout NSW. Fixed speed cameras in NSW are supplemented by on-road heavy vehicle speed enforcement operations by the NSW police force, and the deployment of mobile speed cameras and the use of point-to-point speed enforcement technology will identify and breach speeding heavy vehicle drivers.

Since 1991, Australian Design Rule 65 has required all heavy vehicles with a GCM over 12 tonnes to be fitted with an effective speed limiting device, to restrict their maximum driving speed to 100km/h. In NSW, the Road Transport Legislation (Speed Limiters) Amendment Act 2005 exists to support enforcement for the speed limiting of heavy vehicles.

## Special Feature

Under these laws, the responsible person for a vehicle commits a speed limiter offence when a heavy vehicle that is required by law to be speed limited travels at a speed in excess of 115 km/h. Apart from the speeding offence incurred by the driver of the vehicle, the speed limiter is deemed to be functioning incorrectly and the vehicle operator is heavily penalised. This law applies to all vehicles, not just those registered in NSW.

The Safe-T-Cam program operated by the RTA in NSW is an initiative designed to reduce the risk associated with heavy vehicle driver fatigue, in order to prevent heavy vehicle crashes. By monitoring the time taken to travel between two known locations, the system can detect vehicles or drivers that may be exceeding safe limits on driving (work) hours or possibly falsifying log book entries. Safe-T-Cam also detects unregistered heavy vehicles that operate on NSW roads.

The RTA is introducing improved camera triggering systems that will be deployed from next year. This involves the installation of Transportable Infra-Red Traffic Loggers (TIRTLS) at 22 Safe-T-Cam locations. The TIRTLS enhance the Safe-T-Cam performance to overcome behaviours such as shepherding, where vehicles travel close together in an attempt to avoid camera detection.

### Monitoring

The RTA operates seven heavy vehicle checking stations, sited strategically along major freight routes in the state. Heavy vehicle checking stations are an important tool to monitor and enforce vehicle condition, loading and driver fatigue en-route. Four of the stations have automated screening lanes, where a Safe-T-Cam camera will read the number plate and check earlier Safe-T-Cam sightings and registration records, while other sensors check the vehicle's weight and height. These data, combined with driver and vehicle offence histories, are used to determine if a vehicle should be directed into the checking station.

In addition to fixed heavy vehicle checking stations, the RTA deploys their 280 heavy vehicle regulation inspectors across 170 roadside inspection sites, where heavy vehicles can be safely stopped and checked. Inspectors are rostered and deployed using a risk-based approach to target locations and vehicles based on

traffic flow, crash history, results of previous actions and seasonal changes in movements. This is on top of the annual roadworthiness inspection program, which ensures vehicles are maintained properly; where vehicle identification irregularities are identified, these are referred directly to the NSW police force.

In addition to all of the above, the RTA is increasing its team of chain of responsibility investigators, to be able to more effectively investigate parties in the supply chain that force drivers to take risks by setting unrealistic deadlines and ensure they are held accountable. The RTA is working with the NSW Road Freight Advisory Council to help the trucking industry develop a 5 Star Trucking Scheme, that would recognise and reward effort for those owners and operators who are achieving industry best practice for safety. The RTA is undertaking a pilot of electronic work diaries with other states to further improve heavy vehicle driver fatigue management and speed compliance.

Regular multi-agency activities include working with WorkCover NSW to visit truck stops and heavy vehicle rest locations, to educate drivers about fatigue management reforms and health and safety initiatives that relate directly to them. The RTA provides additional funding to the NSW police force to increase the visible police presence on the road and undertake enhanced enforcement above normal operating requirements.

The RTA is undertaking a campaign of targeted advertising, using radio and print media, and localised campaigns incorporating roadside advertising, variable message signs and bridge banners, to address safety issues like speeding, wearing of seatbelts, fatigue and drug use. All of these increase the profile of road safety in the heavy vehicle industry.

As Mr Bushby noted in his closing comments to his letter to the NSW Auditor General, 'In comparison to other states in Australia, NSW has the largest road transport enforcement workforce, the greatest number of checking stations, a Safe-T-Cam network across the state, and the highest level of investment and usage of technology in heavy vehicle compliance and enforcement. The RTA will continue to develop an integrated approach to heavy vehicle compliance and enforcement.'

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## Improving worker safety through better visibility

*by Agota Berces, Traffic Safety Systems Division, 3M Australia*

Road trauma represents a significant cost on society, and governments are developing various measures and safety programs to reduce the number of fatal accidents and serious injuries. The recent Safe Work Australia report [1] shows that in the 2006 to 2007 period, 453 people lost their lives in work-related injuries, with 295 dying of injuries sustained in the course of work activities. Of these 295 workplace fatalities, around 35% (103) people died in road-related trauma, which was a 32% increase on the previous reporting period.

The casualties from road trauma represent 13% of the national road toll, and the estimated costs in relation to workplace accidents comprise \$1.5 billion annually. This amount, however, might not include medical expenses, rehabilitation, lost productivity, costs of investigation and vehicle damage, and write-off expenses, among other items. This figure represents a huge burden on our society, which is why cooperating stakeholders are open to investigating innovative technologies that can help reduce and prevent workplace death and injuries.

When discussing roadside safety from the occupational health point of view of roadside workers, several research studies have been carried out recommending the extensive use of personal safety garments combined with fluorescent colours and retroreflective materials. These have resulted in numerous regulations and measures implemented to protect the safety of workers and drivers.

As an example, a recent study by researchers at Queensland University of Technology (QUT) highlights the most effective configuration of retroreflective markers on road workers' protective gear, drawing the conclusion that the adoption of reflective markers in a biomotion configuration has the potential to be an affordable and convenient way to provide a sizeable safety benefit. Adding biomotion markings to standard vests can enhance the night-time conspicuity of roadway workers by capitalizing on perceptual capabilities that have already been well documented [2]. The benefits of using high visibility clothing providing both daytime and night-time visibility are indisputable.

Although better visibility of personnel working along roadsides has always been focused on intensively, not so many studies are available about the visibility of roadside objects and vehicles, which can also contribute indirectly not only to the safety of workers, but also to the safety of other road users. This paper aims to provide an overview of how high visibility markings of roadside objects and vehicles have helped to prevent accidents by introducing best practices from various industries, including mining, emergency response services and freight forwarders.

### Roadwork zones – roadside vehicle safety

Between 1989 and 1992, 32 workers were killed while carrying out their jobs in road construction or maintenance. Safety is of high concern at roadwork zones, with workers being exposed to traffic movements and changing road conditions. It has been confirmed that roadwork zones show higher accident rates than non-work sections due to the change in the road environment and the distractions that may occur owing to construction activities.

As roadwork zones are set up relatively frequently due to the many projects improving or maintaining existing networks, not only are work site personnel endangered, but accidents may involve other road users, drivers, cyclists and pedestrians as well. A research project called ARROWS, funded by the European Union between 1996 and 1998, resulted in a practical handbook for roadwork zone safety to help traffic professionals, such as highway authorities, designers and contractors, create a safe road work design and operation.

Results of accident studies show that more than half the accidents on work zone areas of motorways are rear-end collisions (e.g., 60% in the UK, 63% in Germany). Those accidents, as well as sideswipe crashes, are found to occur mainly in the daytime, with higher traffic volumes. Another

relatively common work zone accident type is collision with a fixed object, more commonly occurring at night-time and associated with inappropriate vehicle speeds. Finally, of special importance for road work zones are accidents involving collisions with road workers.

Generally, accident rates tend to be higher for work zones of shorter duration and for work zones utilizing full (rather than partial) contraflow [3]. Complementing the use of high visibility protective garments, it is also important to apply fluorescent and retroreflective markings to roadside vehicles to alert drivers and roadworkers to all vehicles on site in order to help prevent collisions with parked or moving objects.

### Increasing vehicle visibility in the mining industry

Mines are networks of complex processing areas where the environment is monochrome with generally poor ambient lighting. Visibility is often limited and vehicles can be either large (such as haul trucks or earthmoving equipment) or relatively small (light vehicles and four-wheel drives). The terrain, combined with the absence of visual cues such as buildings and trees, means that vehicles are at a greater risk of collision and injury, particularly at poorly marked junctions. It is also essential for all road users on the mine site to be able to identify and recognise larger and smaller vehicles. All these indicate that there are many issues to be addressed to ensure workers' safety when navigating the road network within the mine site.

After having experienced a substantial number of near miss incidents, one of the Australian mining companies has started to investigate incidents related to poor visibility of their heavy vehicles by recording data about incidents resulting from people not being able to detect each other's machines. They initiated a visibility project run from 2005 and began to apply day- and night-time visibility markings on their vehicles. As an outcome of this project, there has been a dramatic decrease in incidents reporting visibility as an issue. Figure 1 illustrates the change in the number of reported near miss incidents.

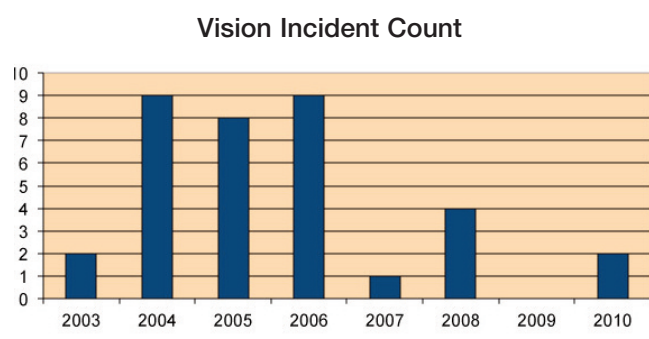


Figure 1. Number of near-miss incidents reported to be related to poor visibility

## Special Feature

Utilizing high-visibility markings combined with fluorescent colourants, especially fluorescent yellow-green, provides superior conspicuity during daytime, at dusk and dawn, and at night. Such markings can deliver exceptional luminance through multiple viewing positions. A key point to mention is that the optimum reflectivity and visibility is delivered not only at a long distance, but also at wide angles. The type and the size of the marked-up vehicle is easy to detect, and large number panels allow operators to be identified easily during shifts, as shown in Figure 2.

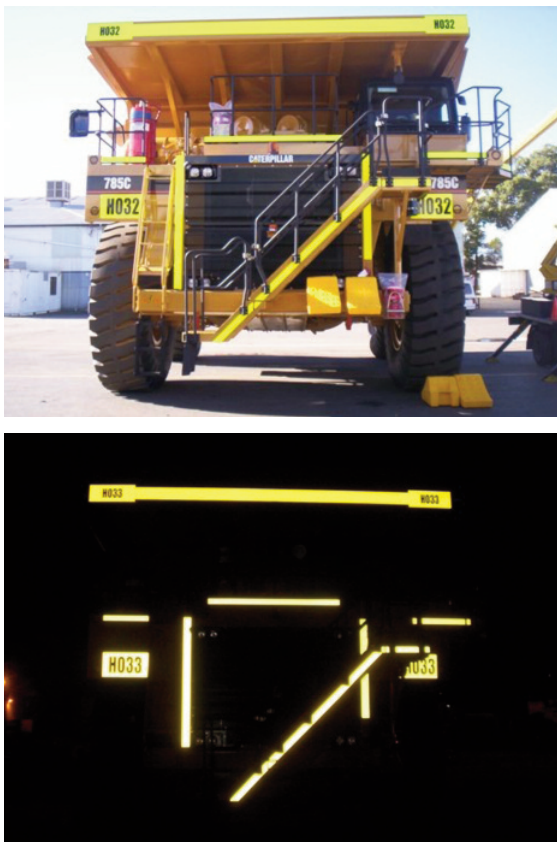


Figure 2. Haul truck day and night

### Faster response through increased visibility in emergency services

Emergency response services are considered a dangerous operation. Response vehicles may drive at higher speeds, cross into oncoming traffic and enter controlled intersections requiring greater visual and audible detection for other motorists. Visibility and conspicuity are two very important factors to ensure emergency vehicle safety while on the roads or parked along roadways. Reducing the risk exposure of emergency services personnel servicing the public is a key focus area and some facts demonstrate how important it is to address this issue.

Studies conducted in the United States and elsewhere suggest that increasing emergency vehicle visibility and conspicuity

holds promise for enhancing first responders' safety when exposed to traffic, both inside and outside their response vehicles (e.g., patrol cars, motorcycles, fire apparatus and ambulances) [4].

The importance of addressing vehicle characteristics and human factors to help positively affect the safety of emergency workers operating along the nation's roadways is starkly established by first responders' morbidity and mortality experience. Over the past decade, numerous law enforcement officers, firefighters and emergency medical services workers were injured or killed in roadside crashes throughout the United States [4].

It is clear that properly applied and maintained high visibility markings, including the use of fluorescent materials, can effectively increase the early detection of ambulance vehicles. An example of best practice addressing visibility can be attributed to St John Ambulance in Western Australia. During the past years, St John Ambulance Service introduced a new livery onto their vehicles that fulfil a twofold objective: safety and corporate identity (Figure 3).



Figure 3. St John Ambulance vehicles, Perth WA (Photo used with permission of St John Ambulance)

### Avoiding accidents through increased truck visibility

Transport experts agree in stating that the mobility of people and goods affects our growth and well-being, making it one of the major socio-economic challenges of the 21st century [5]. Road transport is a complex system with implications based on several factors, including road safety, energy consumption and the environment. The transport and storage industry has the highest fatality rate of any industry in Australia. During 2006-07, one-fifth of all workplace deaths (59) were made up of a single occupation – truck driving [1] – from a total of 103 people dying as a result of road accidents. These numbers do not include accidents where death or serious injury occurred to a non-working individual, e.g., collision with a truck.

Numerous reports are available about the effectiveness of visibility markings aimed at reducing rear and lateral collisions. Visual perception is limited at night, which results in relevant



information not being received and more attention being required of the motorist. In this situation, trucks, which normally move relatively slowly, represent a potentially dangerous obstacle, especially since the fatality rates for drivers of passenger cars involved in accidents with them are very high on account of the high mass of the trucks.

About 40% of road accidents take place at night, dawn or dusk, in spite of the fact that not more than a third of the traffic is on the roads (compared to daytime driving). It can be concluded that driving at night is at least twice as dangerous as during the day [5].

The German Technical University of Darmstadt conducted an examination of night-time and daytime accidents between a test group comprising 1000 vehicles equipped with contour markings and a control group of 1000 vehicles without such measures. After two years of the installations, the conclusion was drawn that 95% of night-time collisions could have been avoided if trucks in the control group had had retroreflective visibility markings [5]. Figure 4 shows the difference in visibility at dusk between trucks with and without retroreflective contour markings.

Another study commissioned by the European Union and undertaken by the German TÜV Rheinland Group in 2004 [6] outlines the situation in the individual member states of the European Union. The study investigated the effects of the mandatory introduction of conspicuity markings for heavy vehicles by creating a detailed cost-benefit analysis for decision makers.

In the past, governments tried to minimize the negative impacts of heavy vehicle accidents by introducing national legislation, but as new technologies and borderless trade evolved, there was a crucial need to harmonize the international requirements, which led to a new European Directive in 2008. The European-wide study by TÜV Rheinland also contributed to the reasons why the European Union has decided to implement mandatory conspicuity markings for heavy goods vehicles and trailers in all member states. This is an excellent example of how the adoption of high performance retroreflective sheeting for usage in vehicle marking has resulted in another safety improvement for many road users.

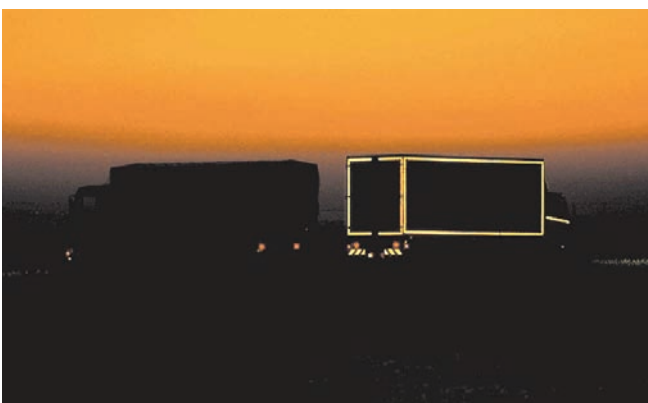


Figure 4. Unmarked and marked trucks at night

## Summary

Australia has set a target to reduce the annual road fatality rate per 100,000 population by 40% between 1999 and 2010. The National Road Safety Strategy (NRSS) shows that by 2010 we can save 700 lives every year by improving safety of the roads (332 lives), improving the safety of vehicles (175 lives), improving driver behaviour (158 lives) and adopting smarter safety technology (35 lives) [7].

High visibility markings used not only on safety clothing, but also on roadside, emergency and heavy vehicles, can effectively contribute to achieving these targets and saving the lives of those who are working on our roads. The use of these markings is relatively low cost and is a practical solution to improving the visibility of these vehicles to all road users.

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# OHS peer reviewed papers

## Taking an OHS-led approach to work-related road safety: Research, policy and practice

by Dr Will Murray, *Interactive Driving Systems, Loughborough University and CARRS-Q* (Correspondence to [willmurray@roadrisk.net](mailto:willmurray@roadrisk.net))

### Abstract

This paper reviews the extent to which the vehicle is classed as part of the workplace in Australia in occupational health and safety (OHS) research, policy and practice. It focuses on published research from Australia and overseas. It concludes that although the vehicle can be seen as part of the workplace, it is rarely managed or enforced in this way. Despite this, it is argued that the extent of the work-related road safety risks means that adopting an OHS-led approach can bring many potential benefits to work-related road safety.

### Keywords

Work-related road safety, Occupational health and safety, Fleet safety

### Introduction

The Australasian Fleet Managers Association *Safer motoring guide* [1] stated that any organisation-supplied vehicle is considered a workplace for occupational health and safety (OHS) purposes and as such is subject to all health and safety legislation. This means that, so far as is reasonably practicable, organisations are required to ensure the health and safety of all employees while at work and not to impact negatively on the general public.

Despite this, in our day-to-day research and practice on work-related road safety, we are frequently asked questions along the following lines: Are our vehicles classed as part of the workplace under occupational health and safety regulations? Should our health and safety team focus on managing road risks as part of their day-to-day priorities? What regulations and enforcement are we likely to face? Should we treat all our people – including commercial and car drivers – the same or differently? Thus, this paper provides some international comparisons of the extent to which the vehicle is perceived as part of the workplace under OHS regulations and aims to:

- review OHS and worker road safety policy responses in Australia and in selected jurisdictions around the world
- understand the potential to apply OHS-led approaches to work-related road safety
- identify some lessons and next steps for research, policy and practice.

### Review of the current situation in Australia

According to Driscoll et al. [2], motor vehicle-related deaths accounted for 31% of all work-related deaths in Australia, increasing significantly if commuting is included [3, 4]. Queensland-specific data showed that approximately a quarter of road fatalities involve people at work, and upwards of 50% of occupational fatalities involve vehicles [4]. Many of these involve heavy trucks, which are relatively heavily regulated in Australia through road transport, fatigue management and chain of responsibility requirements, initiated in part due to such initiatives as the Quinlan enquiry in New South Wales [4].

At the policy level, light vehicles, including cars and smaller commercial vehicles, remain relatively unregulated, with Stuckey et al. [5] suggesting that as many as 40% of Australian work vehicle crash-related fatalities are not identified by OHS nor workers compensation surveillance systems, as they are operated by small organisations or sole traders. Due to the scale of the worker and road safety risks identified, a great deal of research, guidance and good practice has originated in Australia, described and in some cases critiqued by Staysafe [6], Haworth et al. [3], Murray et al. [4], Stuckey et al. [7,8], Pratt et al. [9], Pope [10], AfMA [1] and Murray et al. [11].

At the Staysafe36 conference hosted in Sydney [6], several speakers discussed the potential of OHS as a framework for improving work-related road safety policy and practice in Australia. Following on from this, Haworth et al. [3] reviewed the OHS legal perspective in relation to fleet in some detail, concluding that under Australian OHS legislation, vehicles can be considered to be workplaces on public roads. Their research identified that there is a requirement to ensure that vehicles and the ways in which they are used provide, so far as practicable, a working environment that is safe and without risks to health.

Haworth et al. [3] concluded, however, that work-related road safety is often neglected in practice, as it is not clearly seen as the responsibility of fleet management or OHS groups within organisations. They used the OHS legislation in Victoria to show the considerable opportunity for promotion of best practice injury prevention measures, suggesting, however, a lack of attention to specifically targeting vehicle and driver safety in the occupational setting.

They also identified that at that time, no investigations of employers in relation to the operation of car fleets had ever been undertaken by WorkCover Victoria [3]. Typically for road

crashes, WorkCover only becomes involved if notified by the police or coroner, which occasionally happens with truck crashes but had never happened with fleet car crashes [3]. Based on more recent work undertaken by Murray et al. [11], this is typical of many other jurisdictions around the world, where truck safety is heavily regulated, but light vehicle safety less so.

Further developing the findings of Haworth et al. [3], Murray et al. [4] described a wide range of OHS-led initiatives in Australia, where each state and territory has a principal OHS Act, setting out requirements for ensuring that workplaces are safe and healthy. They identified that employers, employees and contractors have a duty to do everything 'reasonably practicable' to protect the health and safety of people in the workplace. Vehicles are considered as part of the workplace in all jurisdictions around Australia, and people who drive in the course of their employment form the majority of drivers on the road on any given work day and a disproportionate number of vehicle-related workers compensation claims are made.

In this context, organisations operating vehicles have a 'duty of care' to provide a safe and healthy workplace, with minimal risk to health – covering risk factors such as safe vehicles, information, work instructions and training. The employee must co-operate with the employer to meet health, safety and welfare requirements. They concluded, however, that in practice, vehicle safety rarely appears to be managed as an OHS issue and has not been strongly enforced at the policy level. They also identified that relevant surveillance data is often unavailable or fragmented between the agencies for compulsory third party insurance, road safety and OHS.

Despite this, Murray et al. [4] identified several good practice case studies that have adopted an OHS-led approach to work-related road safety in Australia, and summarised all the existing research and practice into an OHS risk assessment-led model for reviewing and improving work-related road safety in organisations. The Roche Australia case [12] provides a good peer reviewed example of the potential of such a risk assessment approach, the full evolution and application of which was described by Murray et al. [11].

Stuckey and LaMontagne [7] reviewed insurance data on the extent of the work-related driving risk in light vehicles such as cars and vans. They focused on policy, legislation, work patterns (including the growth of contingent workers using private vehicles that fall outside of the current workers compensation), motor accident insurance and public health surveillance systems.

They concluded that at the policy level, OHS legislation varies between states and territories in Australia, leading to poor OHS surveillance data on the full extent of the problem. They recommended changes to OHS regulations across Australian jurisdictions to better address light vehicle safety. Particularly, there is an increased likelihood of related OHS regulatory or policy failure in multi-employer supply chains, where OHS legislation focusing on employees in large enterprises, fragmented OHS reporting and poor access to workers compensation are particular problems.

Stuckey and LaMontagne [7] went on to suggest that in OHS law, workplaces, including vehicles, are recognized under statutory 'general duties of care', regardless of employment arrangements or locations. If employees are required to drive as part of their work, the employer's OHS duties apply. In practice, however, OHS policy and practice rarely explicitly address driving for work – particularly in light vehicles. For this reason they recommended that OHS practice should take into account all at-work drivers, regardless of their work and vehicle-ownership arrangements.

According to Stuckey and LaMontagne [7], this includes employers providing a safe vehicle and ensuring that their employees are fit to drive and appropriately licensed. They also argued that self-employed workers are responsible and obligated for their own risk management under the OHS and Road Safety Acts, but fall outside of OHS preventive legislation and have no access to workers compensation if injured.

Finally, they suggested that to improve data collection and direct policy development, standardized surveillance systems are required. Such systems should report all at-work collisions – covering relevant vehicle, journey and work-arrangement information, which should be shared across all data-collecting and OHS regulatory agencies. Such data would be of value for research, policy and practice.

Further research by Stuckey et al. [8] focused on the remote work environment of drivers, typically away from direct supervision and support. They argued that vehicle safety standards for light commercial vehicles are often substandard to those for cars and that light vehicle users are not subjected to the regulatory regimes imposed on heavy vehicle users. They also identified that in Australia, relevant data is fragmented between state transport authorities, OHS/workers compensation agencies, compulsory third party (CTP) insurers, vehicle insurers and the fleets themselves.

These findings were supported by Pratt et al. [9]. Without the ability to integrate all such relevant surveillance data, the full extent and impact of the risks cannot be identified and project evaluation is highly complex. This analysis was used as the starting point to integrate traditional OHS and wider approaches into a model framework for developing policy, guidance and intervention research. This focused on the workers, their work environment and the wider societal context in which they drive for work. Mooren et al. [13] also advocated a similar health and safety systems-based approach as a model for fleet safety in Australia.

## State level policy and guidance-based responses in Australia

Several states in Australia have identified the extent of the work-related road safety risk and developed responses, often in the form of policy, guidance and demonstration projects based on the government's own fleet. Many such projects, including the Queensland Transport self audit for fleets and the Fleetsafe project undertaken by the Southern Sydney Regional

## Special Feature

Organisation of Councils (SSROC) project, were described by Murray et al. [4].

Typically, many of the state-level initiatives have been guidance based. As an example, research by Pope [10], working in Western Australian government, identified a lack of integration between OHS and road safety legislation. He cited previous research to suggest that integrating a fleet safety management system into an OHS framework can reduce the risk of injury, death and costs, and protect organisations in relation to OHS regulations.

Pope's research fed into a Fleet Safety Resource Kit [14]. This contained model policies based on best practice, to assist local government and business organisations in adopting fleet safety policies. Other recent examples have included WorkSafe Victoria [15], Transport Accident Commission Victoria [16] and Workplace Road Safety Western Australia [17].

These are promising guidance documents. To date, however, they do not appear to have been widely publicised, few appear to have been evaluated, there is typically only fledgling inter-agency cooperation and, in many cases, very limited and rarely integrated surveillance data. This is in-part because the relationship between OHS, road safety, compulsory third party insurance, public health, fleet management and occupational driving safety is fragmented, meaning that none of these groups focus enough attention on work-related road safety until a trigger event fatality or major incident occurs, and even then the courts rarely apply OHS regulations to fleet safety. This means that many organisations operating vehicles or requiring their people to drive for work often remain unconvinced of the need to identify, assess and control their road safety risks.

### Overseas comparisons

Similar issues and initiatives around the world are described by Murray et al. [11] and Pratt [18], particularly relating to Europe, New Zealand and the USA. In Europe [19] there is increasing discussion on 'vehicles as a place of work' and the interpretation of the Health and Safety Framework Directive 89/391/EEC, for example, in Sweden [20] and the UK [21]. In the UK, and despite only minimal enforcement activity, the Health and Safety Executive (HSE)/Department for Transport (DfT) *Driving at work* document has become a minimum benchmark standard for organisations to work to. It sets out clear management requirements for risk-assessed and documented safe systems of work for vehicles, drivers, journeys, sites and processes.

Organisations that have embraced such an approach (e.g., see [22, 23]) have obtained many positive safety and other outcomes. The Swedish Work Environment Authority [20] has determined that the roadway is part of the work environment and that employers bear responsibility for minimizing road risk for employees, regardless of the ownership of the vehicle. It advocates developing a road safety policy, focusing on the safe

organisation of work, travel planning, risk assessment, sample policy, monitoring, vehicle safety, journey management, private and hire car use on business, outcomes measurement, follow-up and improvement. Sweden is also leading the way in the development of ISO standard 39001 on Road Traffic Safety Management, which has an occupational health and safety theme. In Finland, the fleet safety research and case studies published by Salminen [24] have also been developed and led from an OHS perspective.

In New Zealand the vehicle is acknowledged as part of the workplace under its inter-agency *Your safe driving policy* document, which recommends that once an organisation has created a safe driving policy, it should be incorporated into overall health and safety policy to ensure all staff know about it [11]. Ongoing collaboration between the OHS, transport and workers compensation agencies in New Zealand is further developing this initiative, including updating the *Your safe driving policy*, providing better risk data and self-audit tools for fleet operators and government agencies leading by example in the proactive risk management of their own driver safety.

In the US, the occupational risks of vehicle operation have been incorporated into research, voluntary initiatives, guidance documents and advisory committees [18]. The National Institute for Occupational Safety and Health (NIOSH) publishes guidance documents related to occupational road safety, interacts with national and global stakeholders, initiates or supports research, and convened the first international conference on Occupational Road Safety during 2009 [18]. US presidents have used executive orders to influence the driving behaviour of federal workers. During the Clinton administration, an executive order required the use of seat belts by federal employees while on official business. Recently, the Obama administration has focused on managing driver distractions – for example, prohibiting employees from using mobile phones to call or send text messages while driving on federal business.

### Conclusions and opportunities for research, policy and practice

From the above review it appears that, despite the data, policy and regulation being fragmented, driving to and at work is a significant occupational risk in Australia, the vehicle can be classed as part of the workplace, and some states have acknowledged this and developed good practice guidance documents as a policy response. To date, however, there appears to have been very limited enforcement of OHS regulations in relation to work-related driving.

This suggests that at the policy level there may be some potential for OHS and other agencies, such as transport, to undertake more collaboration, data capture and linkage, leadership, enforcement and evaluation on work-related road safety. There is also some potential for work-related road safety researchers, policy makers and practitioners to engage with the

OHS community more closely. Based on the available statistics, there is no doubt that work-related road safety can be an opportunity for the OHS community to make a significant impact on worker safety. To date, however, it has rarely been seen as part of their core brief, and typically is not covered in their professional qualifications.

For researchers, there is an opportunity to review and compare the existing OHS and related data collection, regulations, guidance and enforcement around all the Australian states and federally. There is also an opportunity to focus more research attention on the extent to which organisations have managed work-related road safety as an OHS issue to date, and the outcomes from any program evaluation or successful OHS-led case studies such as Roche Australia [12] or overseas examples such as Wolseley [23], the Finnish electricity project [24] and others described in the Driving for Better Business program [22].

In relation to practice, there may be opportunities for organisations requiring their people to travel to encourage their fleet management and OHS specialists to work collaboratively on road safety initiatives. The beginning point for such collaboration is a work-related road safety gap analysis (see, for example, [11] and [23]) or initial status review [4], developing a sustainable business case and the formation of a cross-organisation fleet or work-related road safety steering group [23].

Despite the gaps identified in policy, surveillance, data collection, enforcement and evaluation, OHS offers an opportunity for further research, policy and practice in relation to work-related road safety in Australia and beyond. Even if surveillance, regulation and enforcement levels are varied, the OHS-led guidance documents [1, 10, 14-17, 20, 21], frameworks [4], systems [8, 11, 13], processes [3] and good practice cases [12, 22-24] identified provide the potential for organisations to review, understand and cut the frequency and costs of their work-related travel safety risks. Taking an OHS-led approach to work-related road safety also hints at the potential opportunity for closer collaboration, learning and actions between researchers, policy makers and practitioners in Australia – for example, to further apply, review and evaluate the existing approaches described throughout this paper.

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# The influence of safety ownership on occupational road safety outcomes

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## Abstract

Questionnaires and interviews were conducted with employees and senior managers from three Australian organisations to explore the relationship between perceived managerial ownership of safety responsibilities and occupational road safety. It was found that the perceived authority of the person primarily responsible for managing road risks and perceived shared ownership of safety tasks were both significant independent predictors of safer driving behaviours. It was identified that the position of the person accepting primary risk management responsibilities was typically a member of the occupational health and safety (OHS) team and typically in a management position. The extent that ownership was shared across members within the researched organisations varied, with personnel from OHS and fleet management typically accepting partial ownership of managing occupational road risks. Based on the findings, several recommendations are made to assist practitioners in managing occupational road risks.

## Keywords

Occupational road safety, Work-related road safety, Safety ownership, Driver behaviour questionnaire

## Introduction

The success of organisational change initiatives appears to be influenced by the owners of the change initiative. Workplace Health and Safety Acts generally advocate a duty of care to all parties. For example, in accordance with the Queensland Workplace Health and Safety Act 1995, duties of care to workers and third parties are shared by everyone [1]. Therefore ownership of occupational road safety must be embraced by all members of an organisation.

Whilst general safety responsibilities are often readily adopted by industry, it currently appears that ownership of occupational road safety is often only adopted by employees operating in specific positions such as Workplace Health and Safety Manager or Fleet Manager. This paper explores safety ownership with respect to the position of the primary change owner and the extent to which ownership is shared across members of an organisation.

In relation to primary ownership of managing occupational road risks, it is suggested that the organisational position of the employee may be related to the effectiveness of the safety

initiative. A recent case study revealed that changes in management level and the department of the person primarily in charge of safety were associated with changes in the safety behaviours of employees [2]. Barrett et al. noted that employees initially reported only minimal adherence to safe working practices as they believed that the Health and Safety Manager did not carry the necessary authority or respect to achieve compliance with safety procedures and rules. Upon the Health and Safety Manager's resignation, the Production Director assumed primary ownership of safety. With his authority to fire employees immediately for non-compliance to rules or procedures, health and safety compliance increased within the organisation.

The importance of position authority has also been recognised in earlier research. For example, De Michiei et al. [3] observed that responsibility for safety procedures in high incident-rate mines was often delegated to safety personnel who lacked the authority to enforce safe work procedures. Findings from these studies suggest that management department and level of authority may be related to achieving effective implementation of safety initiatives.

More specifically, the job description and authority of the primary change owner may restrict their ability to execute or influence others to execute key safety management practices. For example, it is suggested that within an organisation, the position of Fleet Asset Manager may require different priorities, competencies, authority levels and circles of influence to the position of Occupational Health and Safety (OHS) Manager. The appropriateness of a safety owner's position may also vary in relation to the safety initiative. For example a risk management strategy comprising the selection of safe vehicles may be better suited to leadership from within a fleet department rather than a health and safety department.

Currently the influences of safety ownership have not been researched with respect to occupational road safety. To address this gap, this paper explores whether the position of the person primarily responsible for managing road safety is related to road safety outcomes.

In addition to the position of the primary owner of managing occupational road risks, it is suggested that the extent to which ownership is shared across members of an organisation may also be related to the success of a safety initiative. It has long been recognised in the safety literature that managers at different hierarchical levels within an organisation have different roles in the overall management of OHS [4]. Senior managers

are typically responsible for organisational strategies such as managing organisational structure and developing policy. Middle-level managers are typically responsible for interpreting and implementing policies and programs. Lower-level managers, including supervisors and team leaders, are typically responsible for operational matters such as coordinating and facilitating work tasks [5].

As managers operating within different positions and levels within an organisation typically have different responsibilities, each manager may be able to provide a unique and valuable role in managing safety. Furthermore, research conducted across a range of Westernised countries, including New Zealand, Canada and America, supports the utility of a decentralised risk management approach to enhance occupational safety [6-8]. For example, research has found that the reorganisation of a coal mine work section into an autonomous work group resulted in increased employee knowledge of safe practices and procedures, beneficial communication and increased employee responsibility for safety [8].

To manage OHS performance effectively, it is suggested that ownership of safety management tasks should be shared by employees in all safety-critical positions. Safety-critical positions may vary between organisations but will typically include Managing Director/Chief Executive Officer, Senior Manager, Operations Manager, Project Manager, Site Manager, National OHS Manager, State OHS Manager, Regional OHS Manager, Site OHS Advisor and employees [9]. The sharing of safety responsibilities may allow an organisation to draw upon the expertise of employees whose competencies and position responsibilities are best aligned with each safety management task.

Recent research findings pertaining to manufacturing companies support the formalisation of safety management responsibilities. More specifically, research investigating the characteristics of over 400 manufacturing companies found that organisations with low rates of lost time injuries typically defined health and safety responsibilities in all managers' job descriptions and included health and safety topics in performance appraisals [10].

As previously noted, the influences of safety ownership have not been researched with respect to occupational road safety. To further address this gap, the current research explores whether the level of shared ownership of safety management tasks by employees in safety-critical positions is related to road safety outcomes.

## Method

To comprehensively explore the relationships between safety ownership and occupational road safety outcomes, a combination of qualitative and quantitative techniques was used. Firstly, a brief questionnaire was utilised to gain exploratory data from a large sample of employees. Interviews were then conducted with a smaller sample of employees and

managers to gain more in-depth data. This provided a robust methodology that allowed the researchers to clarify and validate the data obtained through questionnaires with the data obtained through interviews.

## Questionnaire

An online questionnaire was administered to 444 employees sourced from three Australian organisations. These organisations included a cross-section of private and public organisations, profit and not-for-profit organisations, and medium and large vehicle fleet organisations. More specifically, these organisations were responsible for a combined workforce of approximately 42,000 and a combined fleet of approximately 19,000.

Participating organisations operated fleets that comprised a mixture of vehicle models and required their employees to operate vehicles in both rural and urban environments.

Given the real-world context of this study, the selection of participants was a convenience sample with a minimum of 100 participants being sampled from each of the organisations. All employees with access to the internet within the participating organisations were sent an email invitation to participate in the questionnaire. As participation was voluntary, a self-selection bias may be present in this sample. A majority of the participants were male (69 per cent). Participants ranged in age from 20 to 65 years ( $M = 44$ ,  $SD = 10$ ). All participants reported regularly driving a vehicle for occupational purposes.

The questionnaire collected demographic, safety ownership and safety outcome data. Time restrictions were imposed by the participating organisations for their employees to complete the questionnaire. Therefore, to achieve a brief questionnaire, two items were utilised to explore differences in safety ownership. These items were developed to further investigate previous research findings that suggest that the department and level of authority of the person taking primary ownership of safety tasks [2, 11] and the extent to which ownership of safety tasks is shared [9, 12] may be related to organisational safety outcomes.

Participants were asked to indicate their level of agreement with the following two statements. The first statement, 'The people predominantly responsible for road safety in my organisation carry the necessary authority and respect to achieve compliance', was developed to assess employees' perceptions in regard to the person primarily responsible for managing road risks in their organisation. The second statement, 'Responsibility for achieving work-related road safety is shared across members in my organisation, was developed to assess employees' perceptions of the extent to which safety was shared across members of the organisation. Items were measured using a five-point Likert scale, ranging from 1 representing 'strongly disagree' to 5 representing 'strongly agree'.

Consistent with previous occupational road safety research, the modified Manchester Driver Behaviour Questionnaire (DBQ) [13] and self-reported involvement in driving incidents [13-14] were collected for use in the current study as safety outcome

## Special Feature

variables. Participants were presented with a list of 34 items and were required to indicate how often they had committed each of the driving behaviours over the past six months on a seven-point Likert scale. Response options ranged from 1 representing 'never' to 7 representing 'always'. Incident involvement was measured via the frequency of crash involvement (any incident involving a motor vehicle that resulted in damage to a vehicle or other property, or injury regardless of who was considered to be 'at fault') experienced during the past 12 months while driving for work.

To ensure participant anonymity, all completed questionnaires were sent directly to the researcher. Questionnaire data was analysed using the Statistical Package for the Social Sciences version 15. Before commencing analyses, the data was screened for accuracy. An examination of histograms confirmed the absence of outliers and an examination of residuals scatterplots confirmed that the assumptions of normality, linearity and homoscedasticity were not violated.

The sample size was considered sufficient as the cases-to-IV ratio exceed the level of 40 to 1 as recommended by Tabachnick and Fidell [15] for conducting statistical regression analyses. When conducting post hoc comparisons, a Bonferroni adjustment was applied to the significance level. As only a small number of planned comparisons were being made, an alpha value of .025 was selected to reduce the probability of making a type I error. In applying this more stringent level of significance, the authors recognise that the associated loss of power may result in true differences in the treatment population not being identified.

### Interview

Interviews were conducted with 18 participants sourced from the same three organisations that participated in the questionnaire. Participants from within each organisation comprised four front-line employees and two senior managers. The selection of participants was a convenience sample with care taken to ensure that the participants selected were representative of each organisation's driving workforce and that they had not previously participated in the questionnaire. Participants ranged in age from 24 to 58 years. As the majority of the drivers within the researched organisations were male, 83 per cent of the employees selected for interviewing were male. All participants reported regularly driving a vehicle for occupational purposes.

Several structured questions were asked to all participants to explore employees' perceptions in relation to safety ownership. Participants were asked to identify the position of the person primarily responsible for managing occupational road safety in their organisation. To identify the extent to which safety was shared across members within an organisation, participants were presented with a list of seven task categories and asked to indicate the positions of anyone in their organisation who were accepting responsibility for actioning the safety tasks with respect to each category. The task categories were selected based on previous

research findings in the construction industry that identified links between the categories and workplace safety [12].

The task categories enquired about in the interviews comprised proactively identifying, assessing and determining appropriate controls for OHS hazards and risks; communicating and consulting with stakeholders regarding OHS risks; monitoring, reporting and evaluating safety program effectiveness; engaging with subcontractors in OHS performance management; identifying and implementing relevant components of the OHS and workers compensation management systems; understanding and applying workers compensation and case management principles; and providing leadership and management to staff and subcontractors in OHS performance.

After piloting the interview with two managers and two employees from another organisation to ensure the content was understood and interpretation of the categories was consistent, face-to-face interviews were conducted in private offices on the premises of each organisation. Participation was voluntary and written consent was obtained from all participants. Participants were interviewed individually to minimise any contamination of data arising from potential group bias. Upon completion of the interviews, a thematic analysis was conducted. A coding manual was developed and key points and significant statements were identified through reviewing the notes taken by the researcher in combination with the verbatim transcripts. Finally, conclusions were drawn after interpretations of the data were verified against the questionnaire results and the existing literature.

## Results

This section presents the findings from the questionnaire data followed by the interview data. Mean and standard deviation scores are presented for each of the safety ownership items. Bivariate correlation scores between each of the safety ownership items and the road safety outcome measures are then presented. To examine the utility of the safety ownership items for predicting road safety outcomes, regression analyses were conducted in relation to driver behaviours and crash involvement.

Driver behaviours were measured using the 34-item modified driver behaviour questionnaire. A factor analysis of this scale extracted the following four factors: errors, fatigue and distractions, violations and unsafe driving preparations. Factor four failed to achieve an acceptable reliability coefficient cut-off level of .70 [16] and was therefore excluded from further analyses. Crash involvement was a dichotomous variable with employees grouped according to whether they reported being involved in no vehicle incidents, or being involved in one or more vehicle incidents, while driving for work during the past 12 months.

### Mean and standard deviation scores

Mean and standard deviation scores were calculated for both safety ownership items. Potential responses ranged from 1 to 5,



with higher scores indicating safer perceptions. Participants indicated moderate agreement with the first item, 'The people predominantly responsible for road safety in my organisation carry the necessary authority and respect to achieve compliance' ( $M = 3.18$ ,  $SD = .98$ ). Participants indicated slightly higher agreement with the second item, 'Responsibility for achieving work-related road safety is shared across members in my organisation' ( $M = 3.38$ ,  $SD = .99$ ). Before examining safety ownership perceptions in regard to safety outcomes, analyses of variances were conducted to determine if perceptions varied between the three organisations. It was identified that the mean scores did not differ significantly among the organisations in regard to perceived authority ( $p = .07$ ) or perceived shared ownership ( $p = .85$ ).

### Correlations and regressions

Bivariate correlation scores were calculated for the two ownership variables and the road safety outcome variables. It was found that the two safety ownership variables were significantly correlated ( $r = .54$ ,  $p < .01$ ). Table 1 presents the correlation statistics between the ownership variables and the road safety outcome variables.

**Table 1. Bivariate correlations between safety ownership variables and road safety outcome variables**

	Overall driver behaviour	Errors	Fatigue and distractions	Violations	Vehicle crashes <sup>a</sup>
Authority	-.13 <sup>b</sup>	-.07	-.19 <sup>b</sup>	-.03	.04
Shared	-.09	-.05	-.11 <sup>c</sup>	-.04	.02

<sup>a</sup>1 = No crashes, 2 = One or more crashes; ; <sup>b</sup> $p < .001$ ; <sup>c</sup> $p < .05$

As can be seen in Table 1, it was found that individuals' perceptions of authority were negatively associated with both overall driver behaviours and the second driver behaviour factor (fatigue and distractions). Furthermore, individuals' perceptions of shared ownership were negatively associated with fatigue and distractions. While these correlations are significant, it is important to note that they are relatively weak. Details pertaining to these correlation analyses and the follow-up regression analyses are provided below. No significant relationships were observed among employees' safety ownership perceptions and self-reported driving errors, driving violations or vehicle crashes.

#### Authority

Correlation results reveal that perceived authority was negatively related to overall driver behaviours ( $r = -.13$ ,  $p < .001$ ). This finding indicates that participants who perceived that road risks were managed by personnel with authority and respect reported engaging in overall safer driving behaviours. A hierarchical regression was conducted to investigate the capacity of perceived authority to predict overall driving behaviours.

In predicting overall driving behaviours, age, gender and average hours driven each week for work were entered into the

equation as control variables at step 1. To examine the influence of perceived authority on driving behaviours beyond these variables, this variable was entered separately at step 2. The overall model (including all predictors) was significant ( $F(4, 459) = 14.42$ ,  $p < .001$ ). The first step accounted for 6% of the variance in overall driving behaviours ( $F(3, 460) = 18.24$ ,  $p < .001$ ). Inspection of the Beta ( $\beta$ ) coefficients revealed that age ( $p < .001$ ) and hours per week ( $p < .001$ ) made a significant contribution to the overall regression model. Older participants and participants that reported lower volumes of driving for work reported engaging in overall safer driving behaviours. Perceived authority did not predict overall driving behaviours, over and above the control factors ( $R^2_{Cha} = .01$ ,  $F(1, 459) = 2.72$ ,  $p = .10$ ).

Correlation results reveal that perceived authority was negatively related to driving behaviours pertaining to fatigue and distractions ( $r = -.19$ ,  $p < .001$ ). This finding indicates that employees who perceived that road risks were managed by personnel with authority reported lower tendencies to engage in driving while fatigued and lower multitasking while driving. A hierarchical regression was conducted to investigate the capacity of perceived authority to predict driving behaviours pertaining to fatigue and distraction.

In predicting driving behaviours pertaining to fatigue and distraction, the control variables were entered into the equation at step 1. To examine the influence of perceived authority on driving behaviours pertaining to fatigue and distraction beyond these variables, this variable was entered separately at step 2. The overall model (including all predictors) was significant ( $F(4, 473) = 17.23$ ,  $p < .001$ ). The first step accounted for 19% of the variance in driving behaviours pertaining to fatigue and distraction ( $F(3, 474) = 18.99$ ,  $p < .001$ ). The second step accounted for a significant additional amount of variance in driving behaviours pertaining to fatigue and distraction ( $R^2_{Cha} = .02$ ,  $F(1, 473) = 10.76$ ,  $p < .01$ ).

Inspection of the Beta ( $\beta$ ) coefficients revealed that age ( $p < .001$ ) and hours driven per week ( $p < .001$ ) made a unique significant contribution to the overall regression model. Older participants and participants that reported lower volumes of driving for work reported lower tendencies to engage in driving while fatigued and lower multitasking while driving. Perceived authority also emerged as a significant independent predictor of driving behaviours pertaining to fatigue and distractions ( $r = .36$ ,  $p < .01$ ). Although significant, perceived authority only explained an additional 2 per cent of the variance. Table 2 provides a summary of this analysis.

**Table 2. Summary table of hierarchical regressions for perceived authority as a predictor of driving behaviours pertaining to fatigue and distractions**

	$R^2$	$Adj R^2$	$\Delta R^2$
Block 1 - Control variables	.11 <sup>a</sup>	.10	
Block 2 - Perceived authority	.13 <sup>a</sup>	.12	.02 <sup>a</sup>

<sup>a</sup> $p < .01$

### Shared ownership

Secondly, in regards to shared ownership, correlation results reveal that perceived shared ownership was negatively related to driving behaviours pertaining to fatigue and distractions ( $r = -.11, p < .05$ ). This finding indicates that participants who perceived that responsibility for managing road risks was shared across several organisational personnel reported lower tendencies to engage in driving while fatigued and lower multitasking while driving. A hierarchical regression was conducted to investigate the capacity of perceived shared ownership to predict driving behaviours pertaining to fatigue and distraction.

In predicting driving behaviours pertaining to fatigue and distraction, the control variables were entered into the equation at step 1. To examine the influence of perceived shared ownership on driving behaviours pertaining to fatigue and distraction beyond these variables, this variable was entered separately at step 2. The overall model (including all predictors) was significant ( $F(4, 474) = 15.70, p < .001$ ). The first step accounted for 19% of the variance in driving behaviours pertaining to fatigue and distraction ( $F(3, 475) = 18.92, p < .001$ ). The second step accounted for a significant additional amount of variance in driving behaviours pertaining to fatigue and distraction ( $R^2_{\text{Cha}} = .01, F(1, 474) = 5.48, p < .05$ ).

Inspection of the Beta ( $\beta$ ) coefficients revealed that age ( $p < .001$ ) and hours driven per week ( $p < .001$ ) made a unique significant contribution to the overall regression model. Older participants and participants that reported lower volumes of driving for work reported lower tendencies to engage in driving while fatigued and lower multitasking while driving. Perceived shared ownership also emerged as a significant independent predictor of driving behaviours pertaining to fatigue and distractions ( $r = .34, p < .01$ ). Although significant, perceived shared ownership only explained an additional 1 per cent of the variance. Table 3 provides a summary of this analysis.

**Table 3. Summary table of hierarchical regressions for perceived shared ownership as a predictor of driving behaviours pertaining to fatigue and distractions**

	$R^2$	$Adj R^2$	$\Delta R^2$
<b>Block 1 - Control variables</b>	.11 <sup>a</sup>	.10	
<b>Block 2 - Perceived shared ownership</b>	.12 <sup>b</sup>	.11	.01 <sup>b</sup>

Notes: <sup>a</sup> $p < .01$ , <sup>b</sup> $p < .05$

### Perceived influence of safety ownership

To further explore the influence of safety ownership on road safety outcomes, interviews were conducted. The purpose of the interviews was to: identify which organisational positions were primarily responsible for managing occupational road safety and to explore the extent to which safety responsibilities were shared across members within organisations.

### Position accepting primary ownership of managing occupational road risks

Road safety responsibilities were not formally stated in job descriptions in any of the researched organisations. An analysis of the interview transcripts revealed that the position of the person accepting primary ownership of managing occupational road risks varied among organisations. In two of the organisations (organisation A and organisation B), a member of the OHS team was identified as the person primarily responsible for managing occupational road safety. More specifically, in organisation A the person primarily responsible was a manager. In comparison, in organisation B the person was a senior employee who did not have as much authority within the organisation as a manager. In the third organisation (organisation C), the person primarily responsible for managing road safety was the Strategic Procurement Manager.

The authors, when reviewing the interview transcripts in relation to primary ownership, made two interesting observations. Firstly, it was observed that some employees preferred primary ownership of occupational road risks to come from within the OHS department. These employees believed that management of road risks was more of an OHS issue than a fleet issue. For example, one employee from organisation A commented that management from within the fleet team could 'be seen as too far removed'.

Secondly, it was observed that organisational practices and processes varied with regard to the position of the person primarily responsible for managing occupational road safety. For example, in organisation C, where the Strategic Procurement Manager was the primary safety owner, the organisation's road safety practices and processes were most developed in the areas of vehicle selection and monitoring vehicle incident data. This finding makes sense, as these types of safety tasks align with the competencies and responsibilities required for a procurement manager. In comparison, in organisation A, road safety practices and processes were most developed in the area of safety policy. Again, this makes sense as the competencies and responsibilities required for OHS managers are well suited to tasks including the development of safety policies.

### Shared ownership of managing occupational road risks

Across the organisations, employees from a range of positions were accepting partial ownership of managing occupational road risks. These positions included General Manager, OHS Manager, OHS Senior Advisor, OHS Coordinator, Insurance Compensation Manager, Business Unit Manager, Strategic Procurement Manager, Risk Management Officer, Fleet Manager, Fleet Technical Officer, Supervisor and Driver.

The extent that ownership was shared across members within an organisation varied. For example, participants from organisation B reported cooperative sharing of safety responsibilities among several positions within the organisation.

Employees in the positions of General Manager, OHS Manager, OHS Coordinator, Business Unit Manager, Fleet Technical Officer, Supervisor and Driver accepted partial ownership of safety management tasks. In comparison, participants from organisation C reported limited sharing of safety responsibilities. Employees in the positions of Fleet Manager, Risk Management Officer, Supervisor and Driver accepted partial ownership of safety management tasks.

The authors made two interesting observations when reviewing the interview transcripts in relation to shared ownership. Firstly, it was observed that the sharing of ownership for managing occupational road risks may cause some role ambiguity within the workforce in regard to who is responsible for specific aspects of risk management. For example, one employee from organisation B commented, 'It's all pass the buck. When they say something's wrong with the vehicle, oh, go and talk to so and so.' The authors also identified that in some organisations, this ambiguity appeared to be used strategically by some personnel to defer responsibility to other departments.

Secondly, it was observed that a shared approach was perceived as necessary to comprehensively manage occupational road risks. For example, one manager from organisation C commented that although the manager currently accepting primary risk management responsibility was 'passionate about improving work-related road safety, the amount of work needing to be done in this area would be too large for him to manage and more support would be needed from other members of the organisation.'

## Discussion

This study pioneered research into a new area of occupational road safety by exploring whether differences in safety ownership related to self-reported occupational road safety outcomes. Participants who perceived that road risks were managed by personnel with authority reported engaging in overall safer driving behaviours and less driving while fatigued or multitasking. Similarly, participants who perceived that responsibility for managing road risks was shared across several organisational personnel reported engaging in overall safer driving behaviours and less driving while fatigued or multitasking.

Although only accounting for a small amount of unique variance, perceived authority and perceived shared ownership were both significant independent predictors of safer driving behaviours in regard to fatigue and distractions. The finding that perceived safety ownership is associated with self-reported road safety outcomes is consistent with previous research that has linked safety ownership to safety outcomes [2].

Examination of the interview results provides insights into how occupational road risks are being managed in Australian organisations. It was observed that the position of the person accepting primary risk management responsibilities was typically a member of the OHS team and typically in a

management position. The extent that ownership was shared across members within an organisation varied.

In the researched organisations, managers and/or employees from OHS and fleet management were accepting partial ownership of managing occupational road risks. The authors suggest that the potential integration of safety knowledge, skills and abilities from a range of employees gained through shared ownership of safety responsibilities may facilitate the development of superior safety practices and procedures.

In conclusion, the findings from the current study suggest that organisations may have more influence over employees' driving behaviours pertaining to fatigue and distractions, rather than driving behaviours pertaining to errors and violations. This is an important finding, as it indicates that organisations can have a real protective influence. In the work setting, employees may be exposed to occupational pressures that encourage drivers to engage in unsafe behaviours such as driving while tired or multitasking to complete work in a productive timeframe. Organisations have the ability to manage work demands to ensure that employees can safely drive without being exposed to fatigue or occupational distractions. Furthermore, the current study found that organisations may be able to reduce the likelihood of employees engaging in unsafe driving as a result of fatigue or distractions through increasing ownership of safety management tasks.

Based on these findings, the authors propose that organisations should aim to foster cooperative sharing of occupational road risk management tasks among organisational personnel. To formally facilitate shared ownership, the authors recommend that employees and managers should be educated about their OHS responsibilities. To minimise potential role ambiguity associated with shared ownership, the authors recommend that responsibility for occupational road safety management tasks should be explicitly stated in job descriptions across all safety critical positions.

Given that the findings from this research have important applications for enhancing road safety outcomes, it is recommended that future studies expand upon this exploratory research in three key ways. Firstly, investigating what characteristics of shared ownership facilitate safer driving behaviours pertaining to fatigue and distractions could, for example, lead to better management of work demands or more comprehensive safety policies and procedures. Secondly, future research may expand upon this study through the development of a scale to more comprehensively measure perceived authority and perceived shared ownership. Finally, by applying the same methodology with a more diverse sample, future researchers should explore other possible variables that could be accounting for additional variance in traffic-related outcome measures.

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# Forecasting negative effects of monotony and sensation seeking on performance during a vigilance task

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## Abstract

The driving task requires sustained attention during prolonged periods and can be performed in highly predictable or repetitive environments. Such conditions could create hypovigilance and impair performance towards critical events. Identifying such impairment in monotonous conditions has been a major subject of research, but no research to date has attempted to predict it in real-time. This pilot study aims to show that performance decrements due to monotonous tasks can be predicted through mathematical modelling, taking into account sensation-seeking levels.

A short vigilance task sensitive to short periods of lapses of vigilance, called Sustained Attention to Response Task, is used to assess participants' performance. The framework for prediction developed on this task could be extended to a monotonous driving task. A Hidden Markov Model (HMM) is proposed to predict participants' lapses in alertness. A driver's vigilance evolution is modelled as a hidden state and is correlated to a surrogate measure: the participant's reaction time.

This experiment shows that the monotony of the task can lead to an important decline in performance in less than five

minutes. This impairment can be predicted four minutes in advance with an 86% accuracy using HMMs. This experiment showed that mathematical models such as HMM can efficiently predict hypovigilance through surrogate measures. The presented model could result in the development of an in-vehicle device that detects driver hypovigilance in advance and warns the driver accordingly, thus offering the potential to enhance road safety and prevent road crashes.

## Keywords

Monotony, Fatigue, Vigilance, Hidden Markov Models, Sensation seeking

## Introduction

Drowsiness at the wheel has been identified globally as a major cause of road crashes. Inattention and fatigue are reported as contributing factors in 6% and 5% of fatal crashes, respectively, in Australia between 1992 and 2006 [1]. It is difficult to reliably measure the influence of such contributing factors so that such estimates are likely to be underestimated. This is

supported by the survey conducted by McCartt et al. [2] where 55% of 1000 drivers had reported to have driven while drowsy and 23% had fallen asleep while driving without having a crash.

Boredom, fatigue, monotony and sleep deprivation are factors that induce sleepiness and drowsiness. It results in decreased attention and impaired information processing ability, and impairs decision-making capability. These factors increase crash risk due to driver inability to react to emergency-type situations.

Most research on vigilance-related impairments focuses on sleep-deprived participants. However, there is evidence from crash data and from simulated driving studies that vigilance decrement could occur during daytime, especially on monotonous roads [3]. Driver hypovigilance is often attributed to fatigue, but it can emerge independently of time on task; it is more frequent in monotonous road environments, where task demand and stimulus variability are low and moderate sustained attention [3, 4]. Also, the profile of drivers has an effect on the likelihood of being involved in a crash due to hypovigilance; extraverts and high sensation seekers are at a higher risk [3].

Driver self-assessment questionnaires have been used to evaluate their vigilance state. Such a subjective approach is not applicable on monotonous roads [5], suggesting the need for an objective mathematical model to predict vigilance decrement during driving. The most reliable assessment of vigilance is obtained by electroencephalography (EEG) [6]. However, such a device is too obtrusive to be deployed in vehicles.

Driving performance is impaired during vigilance decrement and surrogate measures from the driver, the car and the environment can be used to assess such impairment. This paper presents a pilot study designed to assess the feasibility of predicting performance decrement during a monotonous task. A low-demand, lab-based vigilance task is used to isolate and simulate impairments due to monotony in a vigilance task. A theoretically sound measure of sustained attention called Sustained Attention to Response Task (SART) is used in a controlled lab-based vigilance task experiment. The SART is a computer-assisted paradigm where participants are asked to respond to non-targets and not respond to targets [7]. Our aim is to predict decline in performance during a short, monotonous vigilance task using surrogate measures (reaction times). Such prediction also takes into account inter-individual differences through sensation seeking levels.

## Background

### Monotony, vigilance and performance

Vigilance is defined as the ability to sustain attention to a task for a period of time [8]. Vigilance fluctuates and is an issue in terms of road safety when decreasing. This particularly applies to monotonous environments where driving is largely reduced to a visual vigilance task (lane-keeping task). Vigilance tasks are the paradigm used to study sustained attention and its vigilance decrement. Vigilance can be classified to define whether an individual is able to perform a task with the expected

performance. Duta et al. [9] developed such a classification from the classification of the sleep-wake continuum obtained with an EEG [10]:

- Alert: corresponds to responsive participant, capable of performing a task with full to acceptable performance
- Hypovigilant: corresponds to the participant no longer able to perform a task at an acceptable level of performance
- Sleeping participant
- Unknown.

Vigilance level is often assessed automatically by an algorithm through the estimated performance (from 0 to 1) of a vigilance task (particularly with neural networks). In this case, results from the model can be used to classify the vigilance level by using the following method [9]:

- Alert: 0.7-1
- Intermediate: 0.3-0.7
- Hypovigilant: 0-0.3.

Hypovigilance can be assessed through psychomotor tests (for instance, by reaction time tests), since a reduction of performance in such tests is interpreted as a sign of decrease in vigilance [11]. A loss of performance usually implies that the individual suffers from a decreased ability to maintain vigilance. Such psychomotor tests are expected to perform particularly well as an index of vigilance in monotonous contexts. When the task is monotonous, responses are automated, leading to short reaction times and poor performance [12]; and such responses are direct consequences of a decline in vigilance. This is supported by the fact that performance during a sustained attention task is correlated to changes in the EEG power spectrum at several frequencies (relatively variable between subjects but stable within subjects) [13].

Factors that have an effect on vigilance can be divided into two categories: endogenous and exogenous factors. Endogenous factors are associated with long-term fluctuation of alertness that emanates from within the organism, whereas exogenous factors are linked to the task itself or the interaction between the driver and the outside environment.

Among the endogenous factors are physical and mental fatigue, sleep deprivation and task duration. Personality dimension (age, gender, mood and particularly sensation-seeking level), time of day (circadian rhythms), caffeine and other stimulants, and cognitive task demands are also endogenous factors [11].

Exogenous factors include complexity and monotony of the task, and environmental factors such as noise, ambient temperature, and frequency and variation of stimulation [10]. This is particularly the case when driving on a highly predictable highway where, because of lack of stimuli (or repetitive ones), the driver pays less attention to the road situation [14]. These numerous factors result in complex and strongly interrelated phenomena regulating vigilance. The impacts of the different factors leading to changes in vigilance performance are not of

the same order. Stressors such as heat, noise and circadian effects are of low impact on the performance compared to fatigue, monotony and/or boredom [15].

Each individual has their personal optimal level of stimulation and arousal required to perform well. This can be measured through the Sensation-Seeking Scale. Sensation seekers are people who need varied, novel and complex sensations and experiences to maintain alertness. They require greater arousal than non-sensation seekers to perform well [16].

The profile of drivers more likely to be involved in fatigue-related crashes was determined in a simulator experiment [3]. In this experiment, the impact of the driver's personality on decline in vigilance was studied. Sensation-seeking drivers are able to take physical and social risks to achieve varied, complex sensations and experiences. This factor can be more or less developed, but it leads to risk-taking driving and negative reactions to monotonous driving. High sensation seekers experience vigilance decrement faster than any other group [17].

In this experiment an adaptation of the vigilance task SART is used where participants are asked to respond to non-targets and not respond to targets. In such an experiment the vigilance as assessed by performance has been shown to depend on the level of monotony and is correlated to reaction times (RTs) [18, 19]. The SART was chosen since performance during this continuous task correlates significantly with everyday life attention failures [20]. The authors are aware of the research debate related to the validity of the SART as a vigilance proxy [21]. However, this study makes the assumption that the SART induces hypovigilance.

Such a vigilance task is used in this paper to show the feasibility of forecasting vigilance decrement using surrogate measures. This study uses reaction times and error measurements obtained from a SART experiment to validate a framework that predicts vigilance decrement before it occurs. Such a framework can be extended to a monotonous driving task using EEG measurements as a vigilance-level reference and various surrogate measures from in-vehicle sensors [19, 22]. Larue et al. [23] have shown on a driving simulator experiment that speed, lateral position of the vehicle and physiological measurements – such as heart rate variability, blink frequency and electrodermal activity – are potential surrogate measures of driving performance impairment during monotonous driving.

### Mathematical model for prediction

Vigilance decrement can manifest quite early on [24] and change quite abruptly during monotonous vigilance tasks. This can be well described by discrete modelling. Performance, defined as the accuracy of target detection, is categorised as presented before. We aim to predict this performance through surrogate variables that are correlated to the ability to sustain attention.

Research has shown that such performance models must be able to deal with inter-individual differences to be implemented

reliably in operational settings. Bayesian forecasting is widely used to overcome this limitation. Indeed such models can handle these differences even when prediction is applied to individuals not studied beforehand [25]. Among Bayesian models, Hidden Markov Models (HMMs) have been used to model numbers of real-life problems, such as driver manoeuvre recognition [26]. Larue et al. [19] have also shown that Bayesian models provide better estimates of performance from surrogate measures during the SART as compared to neural networks and Generalised Linear Mixed Models. HMMs combine independence assumptions making the model numerically computable with field knowledge that vigilance decrement is the cause of reaction-time variations [27].

A Hidden Markov Model is designed to model a sequence of  $T$  observations data (at time  $t=1,2,\dots,T$ ), which is the consequence of an unobserved (hidden) variable [28]. Here the unobserved variable is the vigilance level  $Vig_t$  at time  $t$ . This variable is the cause of other random variables, the surrogate measure  $RT_t$  at time  $t$  in this study as suggested by previous research done by Larue and colleagues [19]. These variables must have the following conditional independence properties for each time  $t$  [29]:

- given  $Vig_{t-1}$ , the sequences  $\{Vig_{t:T}, RT_{t:T}\}$  and  $\{Vig_{1:t-2}, RT_{1:t-1}\}$  are independent, where the notation  $A_{a:b}=(30)$  is used (Markov property of order one)
- given  $Vig_t$ ,  $RT_t$  is independent of the sequence  $\{Vig_{-p}, RT_{-t}\}$ , where the notation  $A_{-t}=\{A_{-1},\dots,A_{-t},A_{-t+1},\dots,A_T\}$  is used.

In the case of a Hidden Markov Model with discrete states and discrete observation sequences, the model is completely characterised in terms of [28, 31]:

- number of states in the model, say  $N$ . Here the random variable  $Vig_t$  takes its values in the set  $S=\{alert, intermediate, hypovigilant\}$  so that  $N=3$
- number of distinct observation symbols per state. Here it is the reaction times values once categorised
- transition probability matrix giving the probability to go from the state  $S_i$  at time  $t$  to the state  $S_j$  at time  $t+1$
- observation symbol probability distribution
- initial state distribution.

The training of the HMM is done through Bayesian learning from the given hidden and observation sequences. If the hidden state is not available during training, the Baum-Welch algorithm (adaptation of the EM-algorithm applied to HMM training) can be used. Then the model can be used for prediction (see Figure 1). The Viterbi algorithm is used to infer the value of the vigilance state given the reaction times [28]. This algorithm determines the states sequence, respecting the transition probabilities, that is the most likely to occur with the model used. Then predicting the next vigilance state can be done using the transition probability matrix.

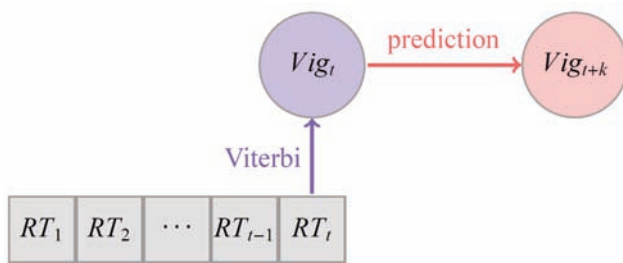


Figure 1. Prediction methodology with HMMs

## Method

### Participants

Forty students of the Queensland University of Technology (QUT), 8 males and 32 females (mean age = 22.6 years, SD = 9.2), volunteered to participate in this study. All subjects provided written consent for this study, which was approved by the QUT ethics committee. Students undertaking the first year psychology subject received course credit for their participation.

### Experimental design

Two 5-minute adaptations of a continuous sustained attention to response task (SART) [7] were run on an IBM-compatible computer using E-Prime. The conditions varied in terms of task monotony, with two different settings for target appearance: probability 0.11 (low target probability) and probability 0.5 (high target probability). The first probability creates a monotonous condition where a response can be predicted and leads to automatic responses. The second probability, with a markedly higher stimulation, is a non-monotonous condition and results in a non-automatic response mode associated with lower response predictability [4].

### Experimental conditions

This experiment was designed by Michael and Meuter [4]. Two hundred twenty-five single digits (ranging from 1 to 9, height of 29mm) were displayed randomly for 250ms in the middle of a computer screen. An inter-stimulus interval of 1150ms was used with a mask (height 29mm) consisting of an 'X'. The chosen target stimulus was the display of the number 3. When a stimulus different from the target stimulus was displayed, the participant was asked to press the spacebar as fast as possible, and when the target number was displayed, action required was to withhold the response (that is to say, not press the spacebar).

### Procedure

Participants were tested individually in a quiet room, between 9am and 3pm, in a session lasting approximately 45 minutes. They were randomly assigned to two groups, each of which performed five short vigilance tasks, as follows. Each participant performed a monotonous then a non-monotonous task, followed by one of various types of monotonous tasks (this task formed part of a larger study and will not be further described here). Finally, there was a repetition of the monotonous and

non-monotonous tasks, participants of the second group performing this sequence in a counterbalanced order with time.

Prior to each condition, participants received written instructions on the computer screen. The instructions asked them to respond as quickly as possible to all stimuli, and this with the highest accuracy possible. On completion, participants filled out short questionnaires: the Sensation Seeking Scale - Form V (SSS), the General Health Questionnaire (GH-28) to screen and eliminate participants for psychiatric morbidity (found to impair performance using the SART) and a general background questionnaire (control sleep pattern and caffeine consumption).

### Data analysis

The software Matlab version 7.4.0.287 was used to analyse data. Responses to target are used to assess vigilance fluctuations. They are converted into error rates in fixed time windows (also referred to as performance measure in this paper), defined as the fraction of targets not detected by the subject (i.e., lapses) within a fixed window. Due to the small number of targets in the monotonous setting, a window size of 45 stimuli (targets and non-targets) was chosen to obtain an average number of five targets in the window in the monotonous setting. This window size corresponds to approximately one minute.

The window size was chosen to be the same for the non-monotonous task. Pearson's linear correlation coefficient between the reaction times of two consecutive time windows is computed. The same coefficient is also computed for performance. This enables us to test whether assumptions required during HMM modelling are reasonable. Performance is then divided into states as described in the 'Vigilance' section. The predictor reaction time is computed as the mean response time to non-targets. Reaction times are normalised per participant and then categorised.

The sensation-seeking level of the participant is categorised into one of the following classes: low (less than one standard deviation (SD) in the available participants sample), normal (within one SD) or high (greater than one SD) [16].

Six different HMMs are fitted to take into account the impact of the monotony of the task (monotonous or not) and the sensation-seeking scale (low, medium and high level). Vigilance states and reaction times are known when the model is trained. That way, computing the joint distribution is only a matter of counting the different transitions from the different performance states and the probability of observation of the different reaction times for each vigilance state (Bayesian learning) [32].

A stratified 10-fold cross-validation is performed to assess the robustness of the modelling. In this technique, data are divided into 10 folds. The model is trained on nine and tested on the remaining one. This is repeated so that each fold is used as a test sample [33]. A stratified cross-validation was used to avoid putting high and low sensation seekers in the same fold.

Special Feature

The most probable performance state sequence at time  $t$  using the reaction times data until time  $t$  is computed with the Viterbi algorithm. This gives the probable vigilance state at this time. Future vigilance states are then inferred up to four minutes in advance using the transition probability matrix. The model's accuracy is evaluated through the capacity to detect hypovigilance occurrences reliably. Therefore sensitivity and specificity are reported. Sensitivity measures the proportion of actual hypovigilance states that are correctly identified as such, while specificity measures the proportion of non-hypovigilant states that are correctly detected. Their mean is also provided.

Results

The correlation between two consecutive performance measures (rate of accurate target detection in a time window) was  $\rho=0.70$  while the correlation between the mean reaction time of two consecutive time windows was  $\rho=0.18$ . This shows that vigilance evolution is progressive and depends on the previous state. Particularly, there is no need to use a Markov property of order higher than one. Such observation was not true in the case of reaction times. Reaction times are not equivalent to the performance level though they depend on it (a reaction time value does not correspond to a specific vigilance state). This supports the choice of HMMs, their assumptions being compatible with the data.

The non-monotonous setting of the SART did not create hypovigilance, with only two occurrences appearing when considering all the participants. However, the monotonous setting resulted in a total of 104 occurrences of hypovigilance when considering all the participants (out of 200 measurements). Therefore, there was no need to detect hypovigilance on the non-monotonous setting, and only results on the monotonous setting were further analysed.

Reaction times (continuous values) were categorised in order to be used in the HMM. Various numbers of categories were investigated in order to optimise the model's accuracy. For each number of categories  $N$ , the range of reaction time values was divided into  $N$  intervals of fixed width.

$\left( width = \frac{RT_{max} - RT_{min}}{N} \right)$  Best results in terms of prediction were obtained for 19 categories. The values of the transition probabilities for the corresponding HMM are shown in Table 1 for each level of sensation seeking.

Table 1. HMM transition probabilities (in percentage) for the monotonous setting

	Low SS <sup>†</sup>			Medium SS			High SS		
	alert <sup>‡</sup>	inter <sup>‡</sup>	hypo <sup>‡</sup>	alert	inter	hypo	alert	inter	hypo
alert	74	19	7	< 1	61	39	2	72	26
inter	20	40	40	18	39	42	19	52	30
hypo	6	24	70	3	31	66	< 1	22	78

Column: vigilance state at time  $t$ ; Row: vigilance state at time  $t + 1$

<sup>†</sup> SS Sensation Seeker

<sup>‡</sup> states: alert, intermediate (inter) and hypovigilant (hypo)

In this monotonous setting, only low sensation-seeking participants may stay in the alert state. However, each participant – independently of their sensation-seeking level – is highly likely (66% for medium sensation seekers) to stay in the hypovigilance state once they reach it. This is also apparent from Figure 2, which provides a graphical representation of the transition probabilities between the different vigilance states from time  $t$  to time  $t+1$ . This figure provides information on the likely vigilance state at the next time step, knowing the current vigilance state. The width of the different arrows is proportional to the probability of a transition. Figure 2a shows these transitions for the non-monotonous setting for medium and high sensation seekers. Probability transitions used to make this diagram for the non-monotonous setting are not provided in this paper but can be found in Larue et al. [19]. Figure 2b presents such transitions for the monotonous setting for medium and high sensation seekers.

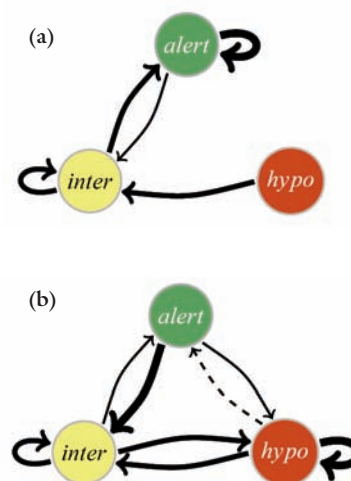


Figure 2. Transition between vigilance states for the (a) non-monotonous setting and (b) monotonous setting (arrow width is used to highlight the likelihood of transition)

The trained HMM has been used to make predictions using reaction times until time  $t$  up to four minutes in advance (as presented in Figure 1). The accuracy of these predictions is reported in Table 2. The prediction of vigilance at time  $t$  has a mean value of 80.0% (73.1% and 86.9% for sensitivity and specificity, respectively). This mean increases as prediction steps increase up to four minutes ( $t+4$ ), reaching 88.0% (100.0% and 75.9% for sensitivity and specificity, respectively). This increase is due to an increase in sensitivity (while specificity decreases) and results from the high likelihood of finishing the experiment in the hypovigilant state.

Table 2. Predictions accuracy (in percentage) for the monotonous setting for different time steps (up to 4 minutes in advance)

	Sensitivity <sup>†</sup>	Specificity <sup>‡</sup>	Mean*
at current time $t$	73.1	86.9	80.0
at time $t + 1$ minute	88.5	76.0	82.3
at time $t + 2$ minutes	95.5	72.3	83.9
at time $t + 3$ minutes	97.9	73.5	85.7
at time $t + 4$ minutes	100	75.9	88.0

<sup>†</sup> related to type II errors

<sup>‡</sup> related to type I errors

\* Mean between sensitivity and specificity



## Discussion

The state of low performance to targets is observed half of the time in the monotonous setting and almost never in the non-monotonous scenario. Therefore, this short vigilance task shows that the monotonous setting of the task can lead to hypovigilance, while such vigilance impairment is not observed in the non-monotonous setting. Furthermore, once the hypovigilance state is reached, it is very difficult to go back to better performance (as can be seen by the low transition probabilities on Table 1 and Figure 2).

Sensation-seeking level changes the way participants cope with the monotonous setting. High and medium sensation seekers are not able to maintain high vigilance, whereas low sensation seekers can. Also high and medium sensation seekers tend to have an immediate and fast decrease in vigilance, going from an alert to a hypovigilant state directly with 39% and 26% probability, respectively. By contrast, vigilance decrement for low sensation seekers is less abrupt and goes through the intermediate vigilance level (7% probability to go straight from the alert state to the hypovigilant state). These results on sensation-seeking levels impacting on vigilance decrement are in line with previous research conducted on a driving simulator by Thiffault and Bergeron [3] where steering wheel movements were used as a measure of driving performance.

The vigilance decrement can be accurately detected and predicted up to four minutes in advance through surrogate measures (here reaction times) using HMMs, with a mean around 80%. Although the increase in the accuracy as the prediction step increases is counterintuitive, it can be explained in this experiment. Independently of the sensation-seeking level, participants are highly likely to finish the experiment in the hypovigilant state when the setting is monotonous. Therefore, it is easier to predict the vigilance state closer to the end of the experiment, which results in better predictions.

## Limitations

Models were trained according to the Sensation Seeking Scale level, so that a population modelling approach has been used in this study. Adapting models to each participant should improve these results. Also, the sample of participants is heavily biased by age, gender and possibly intellectual capacity compared to the wider population, due to the sampling population being university students. Nevertheless, generalisation of the results found in this pilot study seems reasonable due to the simplicity of the task involved.

## Conclusion

We show on a short vigilance task that monotony can quickly lead to critical vigilance impairment. Such impairment depends importantly on the sensation-seeking level of the participant and is detected through task performance. In view of predicting hypovigilance during driving, this vigilance decrement has to be

detected through surrogate measures. Indeed, the most reliable and most often used method to assess vigilance is electroencephalography, which cannot be implemented in a real car.

This experiment shows that the vigilance decrement can be predicted using reaction times as surrogate measures with 80% to 86% accuracy and up to four minutes in advance. Such results support the idea of using HMMs to predict hypovigilance during driving using surrogate measures. Different measures, such as lane-keeping, steering wheel movements or eye-tracking performance, have been shown in the literature to be altered when driver vigilance is impaired. Such further research could be implemented in an in-vehicle device to predict driver vigilance decrement and therefore prevent crashes.

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## Motorcycling in South Australia

*Reviewed by Jaime Royals, Information Manager, Centre for Automotive Safety Research, University of Adelaide*

The Centre for Automotive Safety Research has released the report, *Motorcycling in South Australia: Knowledge gaps for research*, by MRJ Baldock and TP Hutchinson. It is available in full text online at <http://casr.adelaide.edu.au/publications/list/?id=1184>, or in hard copy from CASR.

The aim of this report is to provide an overview of knowledge regarding motorcycling that can be applied to South Australia. To this end, recent relevant literature published prior to 2010 was reviewed. Areas of interest include the number of

motorcyclists, the motorcycles they ride, riding exposure, motorcycle crashes, motorcycling injuries, attitudes, training and countermeasures. The report is not an exhaustive examination of these issues, but a general overview allowing for identification of knowledge gaps in South Australia that would be suitable for research. An analysis of the costs of motorcycle crashes in South Australia is provided in an appendix.

# Contributed Articles

## Holistic road safety report released

by Murray May\*, Paul Tranter\*\* and James Warn\*\*\*

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A 2010 report, *Towards a holistic framework for road safety*, prepared by researchers from the University of New South Wales with funding from the NRMA ACT Road Safety Trust, has recently been released [1]. While supportive of progressive initiatives such as Sweden's Vision Zero policy, the report argues for a broader paradigm shift for road safety, particularly drawing on new thinking in health and ecological sustainability. In essence, a deeper cultural shift is needed, using a broad holistic framework that extends beyond a narrow focus on drivers, vehicles and roads. The report addresses cross-disciplinary approaches for facilitating change. Below is the executive summary of the report, summarising its main themes and recommendations.

### Executive summary

Increasingly in recent years, research and public policy has been pointing to the need for a paradigm shift in the way the Australian community deals with road safety. Professor Don Aitkin, Chairman of the NRMA-ACT Road Safety Trust, has emphasised the need for a cultural change in relation to how people consider speed and the use of motor vehicles, in the same way that cultural shifts have occurred in relation to smoking and the issue of AIDS [2]. This research project sought to address the way in which road safety is perceived by the wider community and policymakers, and how it can be reframed using a holistic approach.

Given the almost universally acknowledged importance of speed as a major contributing factor in the number and severity of traffic crashes, a sub-theme is raised by the question: How can a holistic approach be applied in a way that reconnects road safety to communities that value social connectedness, quality of life and slower ways of being? A central assumption is that fundamental redesign of cultural arrangements is necessary in order to challenge the 'culture of speed' [3].

Current road safety programs and thinking are constructed within a paradigm that tends to accept existing cultural arrangements, especially in relation to mobility and travel.

Typically, programs favouring symptomatic solutions and technical and/or physical solutions are pursued as a way forward. We agree with the assessments of those practitioners in the road safety field who consider that large potential gains in road safety depend not on technical fixes, but on changes in social norms – that is, in changes in social values, awareness, attitudes and behaviour [4, 5].

This, of course, does not mean that technical innovations such as intelligent speed adaptation (ISA) and pedestrian avoidance technology are not valuable additions for road safety. The range of current car safety features and those under development also includes, for example, electronic stability control, adaptive cruise control, ABS brakes, various kinds of airbags, fatigue monitoring and warning systems, lane departure warning systems and so on.

Supporting the value of such technical innovations is the finding that the crashworthiness of new cars registered in Australia has improved progressively during the period 1983 to 2006 [6]. On the other hand, such technical approaches are still car-centric in orientation, and the term 'risks of safety' has been used to describe the often-repeated pattern of the actual drop in fatalities not living up to the hopes of various safety devices [7, p. 262]. That is, technical improvements are likely to be weakened by behavioural responses that allow motorists to trade off safety benefits as performance benefits.

Recent critiques suggest the need for a much wider cultural change than is implied, for example, by just developing public education programs to change community attitudes to speeding. The combination of two major global issues – peak oil and climate change – is increasingly likely to affect transport and travel behaviour. Popular books such as *In praise of slow* by Carl Honoré [8] question whether speed, busyness, and 'saving time' should be the hallmarks of modern life. The current report therefore addresses questions such as the following: What is the nature of the cultural shift that is required to overcome death and injury on Australia's roads? How can such a cultural shift be facilitated, both institutionally and in communities?

In the ACT, the Government has expressed a commitment to achieving a cultural shift in order to reduce deaths and injuries on its roads. It is exploring whether the Swedish Government's 'Vision zero' policy could be implemented in the ACT in the years ahead.

Our research leads to the following recommendations, which have important social, environmental and economic benefits from their uptake. The recommendations are relevant to the ACT, and more generally to road safety in Australia:

#### Recommendation 1 on broader understanding of the huge cost of traffic crashes

*We recommend that road safety agencies more effectively communicate the enormity of the problem of road deaths and injuries to both policy makers and the community. The annual economic cost of road crashes in Australia needs to be updated using appropriate measures and the collection of relevant data.*

A fresh understanding of the enormity of the problem of road deaths and injuries is required at both policy and community levels. The annual economic cost of road crashes in Australia was conservatively estimated to be at least \$18 billion in 2005 [9, p. 8], which is of a similar order to the annual defence budget. A commensurate level of political leadership, support and funding is required to address the cost issue. Complacency and lack of understanding of the size of the problem is also lacking at the community level.

#### Recommendation 2 on the value of the Swedish Vision Zero approach

*The adoption of 'Vision zero' approaches by the ACT and other governments in Australia is supported. Successful implementation will require broad public understanding and involvement for successful cultural change.*

Approaches such as the Swedish Vision Zero approach [10] provide a useful model for advancing road safety by adopting a proactive and preventive approach, with the goal that no person be killed or seriously injured for life in road traffic. In Australia, transport systems are not designed on the basis of human tolerance, but instead on what are considered to be safe speeds for motor vehicles.

Using Vision Zero principles such as setting speed limits in accord with the human body's tolerance against external violence enables speed to be considered in a new light by policy makers, road engineers, vehicle manufacturers and people driving vehicles.

So far in the ACT, the discussion surrounding the adoption of a Vision Zero approach has been very positive. Implementation of a Vision Zero approach requires broad public and stakeholder engagement in the vision in order that understanding of the principles involved is integral to cultural change, and to maximise commitment to such a vision.

#### Recommendation 3 on the deeper questioning of cultural priorities and the value of mobility management for road safety

*The questioning of cultural priorities such as the spread of car-dependent lifestyles should be part of road safety policy. Mobility management strategies should become integral to road safety policy and practice. For example, access to goods, services and social opportunities should be considered, rather than mobility per se as the only option.*

A distinction can be drawn between 'deep' sustainable change, which usually requires fundamental redesign of the systems involved, and 'shallow' compensatory change. For example, one critique of Vision Zero suggests that Sweden has done little to counter the spread of car-dependent lifestyles that result in more kilometres being driven [11, p. 25]. Mobility management (also called travel demand management) is currently not integral to road safety considerations. However, a strong case exists for mobility management strategies being of value in reducing overall crash risk, by reducing per capita vehicle travel (and hence exposure) [12]. That is, the *volume* of motorised traffic is a critical factor to consider in addition to speed.

Mobility management strategies are consistent with wider principles adopted for sustainable transport. These include access to goods, services and social opportunities, rather than mobility per se, and less movement of goods and services, for example, by appropriate urban design and access through telecommunications.

#### Recommendation 4 on vehicle manufacturers and slower, smaller and lighter vehicles

*Vehicle manufacturers should be actively included in the process of developing Vision Zero and Safe System approaches, so that their role in producing safe vehicles and advertising responsibly is made clear.*

To the extent that cars are still used, a strong case can be made on road safety and environmental grounds for slower, smaller and lighter cars [13, 14], in contrast with cars that are designed and marketed with an emphasis on speed and power. The increasing use of electric cars may offer an opportunity here.

#### Recommendation 5 on climate change, peak oil and links with road safety policy

*Policy and practice in road safety should be integrated with policy and strategies addressing climate change and peak oil, as there are considerable synergies involved in regard to road transport.*

The combination of two major global issues – peak oil and climate change – is increasingly likely to affect transport policy and travel behaviour. Climate change is generally considered to be a major sustainability emergency for humanity. With peak oil, there is significant risk of a crisis arriving before sufficient preventative action can take effect.

Efforts to cut greenhouse gas emissions from transport are linked to the reduction of single-person car use for urban trips, investment in world-class public transport systems, and the

design and redesign of local neighbourhoods [15, 16]. There is also evidence for the management of driving speeds as an effective carbon abatement policy [17]. In the ACT, separate roundtables convened on road safety and sustainable transport should be considered as having overlapping agendas.

### Recommendation 6 on encouraging a shift to active modes of transport

*Findings from behavioural science on understanding behaviour change need to be used to facilitate the shift to non-motorised modes, given a range of behavioural and practical constraints.*

*Infrastructural and other policies are also needed to facilitate the shift.*

Recent public policy reports on road safety, and those on climate change and peak oil, typically encourage a shift away from default car use to walking and cycling, as well as to public transport. The multiple health, environmental, economic, transport and community liveability benefits of active travel are now well established [18]. However, behavioural and infrastructural issues need to be addressed to facilitate a shift to active travel. The need for redesign is exemplified by the Gehl report for Central Sydney [19]. It concluded that the city is not geared to the needs of pedestrians and is dominated by cars. There needs to be a reorientation of road space and road rules to give pedestrians priority over motor vehicles.

More generally for public transport, increased funding is needed to address the requirements of effective public transport such as service quality (frequency of service, ease of interchange, comfort and safety), integrated timetabling and route planning, as well as responsiveness to customer needs.

### Recommendation 7 on community programs significant for road safety

*Much greater attention and support should be given to community travel behaviour change initiatives by policy makers. TravelSmart travel behaviour change programs and Walking School Bus (WSB) programs have significant value for road safety and deserve to be expanded.*

Currently, community programs are typically rated as being of low effectiveness in the range of possible speed management programs, as in the Global Road Safety Partnership's 2008 *Speed management: A road safety manual for decision-makers and practitioners* [20]. 'Soft' transport policy measures that encourage voluntary behaviour change unfortunately do not yet have mainstream status.

TravelSmart travel behaviour change programs have significant value for road safety and deserve to be expanded. Their advantages include modal shifts and reduced car use, and involvement by a high proportion of participants contacted in the target population. Professor Peter Newman suggests that the importance of the TravelSmart program in bringing about a transition to more resilient cities should not be underestimated [21, p. 111]. In the TravelSmart Belconnen project run in 2006-2007, car travel was reduced by 12.7%, in terms of vehicle kilometres travelled [22]. This is significant in road

safety terms when travel demand management is accepted as a valid road safety objective.

Walking School Bus programs have multiple social, health and safety benefits, including addressing obesity and low fitness levels in children, promoting child pedestrian and road safety, the development of social and community networks, environmental improvements, and encouraging sustainable travel choices [23, 24]. The outcomes from our research on WSB in the ACT support other research on the benefits of the Walking School Bus. However, the discussions also highlighted the need for much better funding, marketing and support if this approach is to be more than a marginal approach to road safety.

Travel behaviour change programs are, of course, greatly facilitated by infrastructure spending on walking, cycling and public transport.

### Recommendation 8 on whole-of-community change and integrative management

*A separate Office of Road Safety in the ACT with a budget and staffing commensurate with the costs of road crashes to the community is recommended. Such an office should adopt a holistic and whole-of-government approach that extends beyond a narrow focus on road safety to include a wide range of fields and skills relevant to road safety, including health, environment, sustainable transport, planning, behavioural change and education. The same approach deserves to be applied more broadly in Australia, given the enormous cost of road crashes in Australia.*

Recent road safety inquiries in the UK recommended that a high level body or independent road safety commission be established to work across the whole of government to integrate efforts from fields such as health, environment, sustainable transport and behavioural change [25, 26]. The complexity of the cultural change required with respect to road safety points to the value of holistically oriented management systems in facilitating whole-of-community change. 'Vision zero' approaches need to be integrated with a common vision for a sustainable transport system developed in conjunction with energy, transport, health, environment and education agencies.

With respect to organisational direction and integrative management, policies can frequently fail if responsibility is shared among too many players. A study discussed in our report, namely *Halving roadway fatalities: A case study from Victoria, Australia 1989-2004*, provides useful lessons in terms of 'success factors' for organisational effectiveness in relation to road safety [27]. The value of influential 'champions' to create political and community saliency for more fundamental change in relation to road safety was underlined.

There could be value in having a network of ACT champions for road safety, in addition to the road safety roundtable already convened. Chief Minister Jon Stanhope has championed the Vision Zero idea for the ACT, and significant others championing road safety objectives from other areas, including health, environment and police, could form part of a champions network to facilitate cultural change.

## Recommendation 9 on promoting slower ways of being and civility in society

*For a wider cultural shift, greater attention should be given to the Slow City movement – an ecological and humanistic response favouring local, traditional cultures, a relaxed pace of life and conviviality [28]. Time costs shape travel choices and behaviour and should be addressed as part of wider policies to facilitate road safety.*

In discussing such priorities, David Engwicht refers to the 'Great Civility Outbreak' – a cultural revolution in which it becomes the social norm to be 'civilized' and 'a good citizen' [29]. So-called 'time pressure' is emerging as a modern malaise, with implications for people's driving behaviour on the roads, as borne out by surveys by the insurance company AAMI on the increasing prevalence of road rage [30].

Time costs also shape travel choices. Organisational practices related to flexitime and telework, for example, are relevant. Although the issue of time may seem too hard or complex, and outside the scope of environmental and public health policy, the need for a deeper cultural shift suggests that time as an issue should be addressed as part of road safety policy. The work of Dr Lyndall Strazdins, National Centre for Epidemiology and Population Health at the Australian National University, considers the issue of 'time' and its relevance for a range of policy considerations [31].

## Availability of the report

An electronic copy of the report can be downloaded from the NRMA – ACT Road Safety Trust website at <http://www.roadsafetytrust.org.au/c/trtt?a=da&did=1004593>. For a hard copy of the report, email Associate Professor Paul Tranter at [p.tranter@adfa.edu.au](mailto:p.tranter@adfa.edu.au) with a postal address.

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# National Alliance communiqué: Safe driving with a disability

*Compiled by Delia Gray, Royal Rehabilitation Centre Sydney, and Dr Guy Bashford, South Eastern Sydney and Illawarra Area Health Service, from an initial workshop held on 25 June 2010 in Sydney*

A rapidly ageing population is making assessment and rehabilitation of drivers with disease and injury-related physical and psychological impairments an increasingly important social and political issue. Rational assessment and training of drivers with disabilities may reduce the down-stream social and economic costs of reduced independence that is a result of the loss of driving and driving licence, whilst maintaining road safety.

In June 2010, an influential and expert collaboration group from across Australia came together to develop an approach to work with governments in finding sustainable solutions to the growing social problem and to make service models and provision nationally equitable and evidence-based. The collaboration group's objectives were to:

- Develop long-term state and national policies and funding strategies that ensure equity and access to driver assessment and training services for older drivers and people with (acquired) disability
- Develop national occupational therapy driver assessment credentialing pathways and equitable and accessible referral systems
- Build capacity within the health, community care and transport sector to provide equitable access to services for all regions where demand exists
- Conduct an annual conference to promote and report upon the establishment of driver assessment services and the safe driver outcomes achieved.

## The case for sustainable national driver assessment for people with a disability

Numerous studies reveal an increased crash rate per kilometre driven in groups with a variety of medical illnesses. Many of these are age related or obesity related and are increasingly prevalent. Current approaches to the assessment of driving fitness are often arbitrary and left to health professionals who are ill equipped to make such decisions.

The issues for individuals, their families and communities are overwhelming and require a shared strategy by policy makers and funders, peak bodies and consumer groups, medical specialists and GPs, occupational therapists and other relevant allied health professionals, driver training and driver assessment authorities, transport providers and the car manufacturing industry.

Many people whose ability to drive is affected in this way are required to declare a change in the status of their health to the transport authority and undergo a recognised formal assessment if they wish to get back behind the wheel. Existing services vary greatly between states and within regions, but again, this is a

shared responsibility of the individual, transport agencies, health services, disability services and community groups in every jurisdiction, as well as professional bodies across Australia, and government at all levels.

## Access, equity and cost

When a person has to declare a change in their health status and needs to undergo a driving assessment, there are issues of access, equity and cost. For many people the impact of losing their licence includes isolation and depression, and this is particularly so for men. Losing your licence is an equivalent loss to the loss of a partner and can be worse than the injury or health condition that has led to the loss of licence. People need access to a comprehensive assessment in a safe and supportive environment either to help them regain their driving skills and confidence or support them in their transition to stop driving altogether. These services are not funded equitably, nor are services equally accessible across Australia.

The social impact and personal cost to tens of thousands of people in our communities varies enormously depending on which state they live in, whether they live in the country or the city, and whether they are rich or poor. For some, services are fully funded; others bear prohibitive costs; there are those who lose their jobs because they don't have access to a service or can't afford it. For a large number of people, losing their licence and being unable to drive also means losing their independence. Thousands of people live in fear of losing their licence, so they continue to drive unsafely and pose a danger on the road.

A significant issue is the enormous inconsistencies between jurisdictions. Funding for driver assessment and rehabilitation varies greatly between states and rural, regional and urban areas. The cost of a driver assessment to the client varies enormously from government-funded or grant program-subsidised initial assessment fees, to self-funded private fees of up to \$800. Small Medicare and health insurance rebates are possible for some people.

From a review of direct and indirect costs of assessment services provided in the public sector, the approximate cost of an initial assessment is \$1000. By reviewing the national fees arrangements, a conclusion can be drawn that the future of these services is at risk and inequities will increase without financial planning and management. It is also considered that these costs are tiny by comparison to the social costs of inappropriate withdrawal of licence in those who are safe to drive or crash-related costs in those who are not.

There is growing political awareness and increasing political goodwill surrounding safety and driver assessment for people with cognitive or functional impairments. Progress is only likely to be made by meaningful recognition of the roles of different governments and departments.

## A plan of action

The collaborative group, comprising medical practitioners, providers, peak bodies, road safety experts and clients, has agreed to work together to focus on ways to ensure people have access to suitable assessment and training. This group has developed a draft action plan:

1. Establish a National Alliance

2. Conduct an annual conference in tandem with a national road safety conference
3. Establish a common accessible communication portal
4. National Assessment Framework
5. Policy and service development to achieve access and equity to assessment and vehicle modifications
6. Equitable and accessible services for all Australians with appropriate funding.

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# Western Australia's Safe System Working Group

by Sarkis V Petrossian\* and Brendan J Marsh\*\*

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Mr Kim Chance MLC Western Australia recently stated in the Legislative Council that the 'fear of failure breeds mediocrity'. What it means for engineers is that we should go beyond standards to achieve the Safe System philosophy.

In a major stakeholder workshop in February 2007, the Commissioner of Main Roads, Mr Menno Hennevel, demonstrated the importance placed upon road safety by Main Roads. He supported the ambitious minimum condition of satisfaction for the New Perth Bunbury Highway (NPBH) project requiring a 10% reduction in serious injuries and deaths compared with current WA best practice. He then set the project aspiration to be 'zero deaths in the first five years of operation'.

The NPBH represented Main Roads WA's highest-value road project, costing approximately \$700m to complete 30km of freeway and 40km of dual carriageway rural highway connecting Perth and the regional centre of the southwest of WA, Bunbury. The Southern Gateway Alliance (SGA) was established to design and construct the road (see Figure 1).

To help the project set a new benchmark for road safety in WA, Mr Hennevel established the Safe Systems Working Group (SSWG1), independently chaired by committed senior engineer, Mr Sarkis Petrossian CPEng, who represented Engineers Australia. Other members appointed to the SSWG included:

- Mr Des Snook, Main Roads Executive Director (responsible for road safety within Main Roads)
- Mr Iain Cameron, Office of Road Safety Executive Director
- Mr David Moir, RAC WA Executive Director
- Mr Ashley Wright, Southern Gateway Alliance Engineering Manager
- Mr Antony Missikos, Main Roads Sustainability and Partnerships Manager
- Mr Brendan Marsh, Main Roads Team Leader Network Operations

- Mr Linton Pike, Estill and Associates (independent facilitator).

On behalf of SSWG, Mr Marsh MIEAust developed the Vision Zero Logical Framework to connect the project's aspiration with tangible targets the road designers could focus upon and to enable appropriate inputs to be determined. During regular fortnightly meetings (usually early morning), the framework was improved and endorsed, and then approved by Mr Hennevel. This led to the Vision Zero Workshop, held in November 2008, which applied the framework to the project.

In addition to Mr Hennevel, the members of the SSWG and key road design and safety personnel within the SGA and Main Roads, the workshop attracted several eminent experts in road safety, including:

- Mr Roger Johansson, Swedish Road Administration
- Dr Bruce Corbin, Monash University Accident Research Centre
- Dr Raphael Grzebieta, University of New South Wales
- Dr Joseph Affum, ARRB Group.

The workshop received a number of presentations (including from the experts) and then proceeded to identify potential road safety solutions for the key serious injury and death crash risks associated with the project in accordance with the framework. During his presentation, Mr Johansson compared United States and Swedish road design standards and noted the similarities between Australian and United States standards. He then referenced the higher rates of serious injury and death in Australia and the United States compared with Sweden.

The workshop and SSWG report was accepted by Mr Hennevel and the SGA, and resulted in the following significant changes on the project:

- improved geometrical approaches to major at-grade intersections along the Forrest Highway section of NPBH





Figure 1. New Perth Bunbury Highway project overview (Photo used with permission of Main Roads WA)

- increased application of wire rope road safety barriers, including protection of several major hazards just beyond the traditional clear zone
- installation of optical fibre cable along the full length of the project, variable message signs, vehicle detection stations and CCTV cameras (for improved management of the road's operation)
- application of tactile (audible) edge lines across the full project length and on both sides of each carriageway
- recognition of the Vision Zero Logical Framework, which was awarded the Institute of Public Works Engineers (WA) award for Innovative Practice in Traffic Safety and Management in 2008.

As a result of the positive outcomes at NPBH, a second iteration of the SSWG (SSWG2) was established to assist SGA with the design and construction of a second project, referred to as the Mandurah Entrance Road (MER), which provided a 6.9km road link from Kwinana Freeway to the City of Mandurah. The SGA decided to engage with the SSWG1 shortly after award of the MER project to the SGA to enable more opportunities to be pursued.

A number of improvements were achieved in the project, including the following:

- the conversion (over the railway line) of the major intersection at the City of Mandurah from traffic signals to a roundabout – see Figure 2
- significant treatment of roadside hazards with wire rope barrier
- installation of optical fibre cable along the full length of the project, variable message signs, vehicle detection stations and CCTV Cameras (for improved management of the road's operation).



Figure 2. Mandurah Entrance Road – Mandurah Road roundabout intersection (Photo used with permission of Main Roads WA)

As a result of these two positive outcomes, a third iteration of the SSWG (SSWG3) was established to assist South Metro Connect (SMC). SMC is an alliance-styled planning arrangement between Main Roads and AECOM, tasked with the development of the Roe Highway Extension (RHE) project and concept design. This project is loosely estimated to cost

\$550m and is proposed to traverse sensitive terrain between Kwinana Freeway and Stock Road, providing a primary freight connection with the Port of Fremantle.

The SMC design team warmly embraced the SSWG3 and rapidly identified with the Vision Zero Logical Framework. Recognising the valuable learning that had occurred since the framework had been established, the bipartisan adoption of the state’s Towards Zero road safety strategy and the alignment with Towards Zero, the framework was updated and retitled the Towards Zero Framework (Table 1).

A smaller collaborative workshop was held in April 2010 to apply the Towards Zero Framework to the RHE project, which:

- identified a carriageway configuration that improved road safety and minimised the environmental footprint of the project
- identified road safety barrier needs on both sides and down the median of the project
- identified interchange concept adjustments to decrease the severity of crashes and improve traffic efficiency

**Table 1. Towards Zero Framework, Roe Highway Extension concept design**

CRITERION	NARRATIVE
<p><b>GOAL: Towards Zero Road Safety</b></p> <p>The Concept Design output enables realistic and ongoing pursuit of zero deaths and serious injuries within the first five years of Roe Highway Extension's operation, in spite of human fallibility, due to sustainable solutions preventing the possibility.</p>	<p>The Commissioner of Main Roads goal for this project is to be equivalent to worlds best practice with a goal of no deaths or serious injuries within the first five years of operation.</p> <p>The most progressive international and national road safety policy directions are based on the idea that serious injury and death on the road network should not be tolerated. These policies include Sweden's Vision Zero, The Netherlands' Sustainable Safety and Australia's Safe System. The Towards Zero road safety strategy for WA 2008 - 2020, which received bipartisan support in State Parliament, also includes these principles and recommends a safe system transformation of the network where possible including major highways radiating out from Perth and major regional centres.</p> <p>A key element of the Towards Zero Policy is the development and application of Sustainable Solutions that can reliably prevent death and serious injury, in spite of human fallibility, and provide simultaneous triple bottom line community benefits. This aligns with the project's Multi Criteria Assessment of the project options.</p> <p>Administrative and regulatory controls are applied in support of sustainable solutions and to hazards where sustainable solutions have not been developed.</p>
<p><b>OUTCOME</b></p> <p>Collision energy/impulse reduced to within human tolerances for eliminating serious injury and death through sustainable solutions, when foreseeable crash scenarios arise.</p> <p>Optimal driver engagement and care observed, particularly at identified 'Towards Zero' hazards without sustainable solutions.</p> <p>Public Trust in Road Safety Management</p>	<p>Sustainable solutions reduce potential collision energy/impulse to within human tolerances for serious injury and death during possible crash scenarios and in anticipation of human behaviour.</p> <p>Design and operation features promote optimal driver engagement and care to reduce the risk of serious injury and death, particularly at known 'Towards Zero' risks including:</p> <ul style="list-style-type: none"> <li>- Run-off road and Head-on</li> <li>- Intersections;</li> <li>- Unprotected Road Users; and</li> <li>- Other Operational Hazards.</li> </ul>
<p><b>OUTPUTS</b></p> <p>Road safety treatments applied in accordance with the following hierarchy of Control:</p> <ol style="list-style-type: none"> <li>1. Forgiving road and roadside design features that prevents serious injury and death within a sustainability context.</li> <li>2. ITS pre-crash warning/intervention systems wherever reasonable to reduce 'Towards Zero' risks to a level that is "As Low as is Reasonably Practicable".</li> <li>3. Warning, regulatory and guidance driver aids.</li> </ol>	<p>Road and roadside design features that prevent the possibility of serious injury and death are applied as the first hazard mitigation preference.</p> <p>Reliable warning/intervention systems that detect high risk conditions and provide specific warnings (e.g. ITS).</p> <p>Warning, regulatory and guidance treatments are applied to remaining risks.</p> <p>Education and Enforcement of the regulatory system is at a level commensurate with the level of 'Towards Zero' risks.</p>
<p><b>INPUTS</b></p> <p>'Towards Zero' hazard identification and risk mitigation seeking sustainable solutions.</p> <p>SSWG3 resources and recommendations.</p> <p>Road Safety Audits amended to incorporate 'Towards Zero' principles.</p> <p>Involvement of Safe Systems experts.</p> <p>Training in 'Towards Zero' principles and approaches.</p>	<p>Risk management that identifies 'Towards Zero' hazards and seeks sustainable solutions engaged and resourced within the project.</p> <p>Open engagement with the SSWG3 to maximise 'Towards Zero' project outcomes.</p>

- identified an innovative interchange configuration where it appeared a roundabout ramp-arterial intersection may have insufficient capacity
- recognised the importance of Intelligent Transport Systems for the project.

independent SSWG (1, 2 and 3) with robust and knowledgeable experts has enabled WA to take a significant step towards its vision of eliminating serious injury and death arising from road crashes.

The visionary leadership of Mr Henneveld in challenging past road safety paradigms and encouraging the development of innovative road design solutions should be recognised as a pivotal moment in Western Australian road safety, particularly within the road engineering domain. The establishment of the

INDICATOR	VERIFICATION
<p>No. of crashes causing serious injury or death to persons that could have been prevented with sustainable solutions.</p> <p>No. of incidents that could have caused serious injury or death (had luck not been with those involved) that could have been prevented with sustainable solutions.</p> <p>Minimisation of 'Towards Zero' risks in general (e.g. legal liability).</p>	<p>Crash statistics collected from the first five years of operation.</p> <p>Crash Investigations and Assessment of potential consequences.</p> <p>SMC records relevant to 'Towards Zero' Policy implementation.</p> <p>Road Safety Audits incorporating 'Towards Zero' principles.</p> <p>Sustainability Assessments.</p> <p>Community and Stakeholder Feedback.</p>
<p>SSWG3 rating of:</p> <ul style="list-style-type: none"> <li>- Percentage of 'Towards Zero' risks that are expected to operationally achieve the 'Towards Zero' crash criterion; and</li> <li>- Percentage of 'Towards Zero' risks that are expected to operationally achieve the 'Towards Zero' crash criterion or provide targeted, enhanced and effective warnings to drivers regarding the risk.</li> </ul> <p>Reasonably expected that drivers will be observed to take 'appropriate care' at locations where 'Towards Zero' risks were unable to be reasonably prevented due to the absence of a sustainable solution.</p>	<p>SSWG3 review of the RHE Concept Design.</p> <p>'Towards Zero' KPI's</p> <p>Sustainability KPI's</p> <p>Community and Stakeholder Accolades</p>
<p>Freeway and highway road design that prevents frontal or transverse conflicts between road users and other 'Towards Zero' hazards (e.g. roadside furniture, trees and animals); a driving environment that promotes optimal alertness and safe speed.</p> <p>Where possible conflicts exist, the road geometry, road features and roadside is designed to ensure:</p> <ol style="list-style-type: none"> <li>1. At unprotected road user conflicts, vehicle speed exceeding 30km/h through conflict points is prevented;</li> <li>2. At transverse conflicts, vehicle speed exceeding 50km/h through conflict points is prevented;</li> <li>3. At frontal conflicts between cars, vehicle speed exceeding 70km/h through conflict points is prevented.</li> </ol> <p>Warning, guidance, educational and regulatory/enforcement measures are applied in support of and to enhance the benefits of the sustainable solutions.</p>	<p>Safe Systems Working Group 3 review and discussions of 'Towards Zero' road safety for RHE Concept Design.</p> <p>SMC management system, design and risk management records.</p> <p>Road Safety Audits.</p> <p>Value Management Reports.</p> <p>Sustainability KPI's.</p> <p>Community and Stakeholder Feedback.</p>
<p>Best practice road safety risk management process compliance, e.g. Dutch Sustainable Safety document.</p> <p>Austrroads Guideline for Safe Systems compliance.</p> <p>Evidence of 'Towards Zero' road safety principle application and implementation of Safe Systems Working Group 3 recommendations.</p>	<p>SMC management system, design and risk management processes.</p> <p>Safe Systems guideline compliance audit.</p> <p>SSWG3 records.</p> <p>Road Safety Audits - Corrective Action Responses (CAR's).</p> <p>Value Management Reports.</p> <p>Stakeholder Reference Group records.</p>

# ARRB Group at 50

by Peter Cairney, Principal Behavioural Scientist, ARRB Group

This year, ARRB Group celebrates its 50th anniversary. This article is a short summary of the organisation's contribution to road safety over the period. An article this length can be no more than a superficial survey. The interested reader is referred to Jones [1] for an account of the history of the organisation as a whole. A more detailed history of ARRB Group is planned for the near future.

## Foundation

The organisation was founded as the Australian Road Research Board (ARRB), which held its first meeting in March 1960. The board had a broad range of objectives, including providing a centre for road research information and coordination, ascertaining road research requirements, encouraging research and the dissemination of findings, undertaking research and the publication of research findings.

ARRB was established as a not-for-profit company, owned jointly by Australia's state and territory road authorities (SRAs), the Commonwealth Department of Transport and the Australian Local Government Association. This model has served ARRB well over the years, enabling it to cope with and benefit from dramatic changes to its funding base, to its strategic directions and technical content, and to the scope and geographic spread of its business.

When ARRB was founded, the SRAs were essentially road-building authorities whose primary concern was to complete the roll-out of a sealed road network built to standards appropriate for 'modern' traffic across Australia. While the SRAs were concerned to build roads of an acceptably safe standard and to maintain them in a safe condition, management of vehicles, licensing and driver behaviour were the responsibility of other organisations.

## The early years

During its early years, ARRB contributed to road safety through its own research activities, funding of research at universities, developing standards, providing library services and indexing activities, and holding seminars and conferences.

### Major research activities

Much of the research program in this period was focused on a number of specialised facilities and pieces of equipment. Experiments on lighting and sign legibility were conducted in a splendid 'dark tunnel' that effectively excluded all sources of external light, and was illuminated by variable-intensity mercury vapour lighting, bright enough to simulate natural daylight (Figure 1). Overtaking behaviour was measured by video cameras mounted on an articulated truck that ARRB owned and operated. A 'tilt deck' was used to tilt articulated trucks until one wheel lost contact with the deck surface – strong

chains and even stronger nerves were essential (Figure 2). Two generations of instrumented cars were used to test driver curve negotiation behaviour with different delineation treatments.



Figure 1. The ARRB dark tunnel – with the lights on! Can you identify the two people who are currently prominent in academic life?



Figure 2. The tilt deck in action – strong chains and stronger nerves required!

As well as carrying out research, ARRB funded some substantial projects at universities. This included work at the University of Melbourne on crashes with utility poles, on traffic signal and sign visibility, and on delineation. A major in-depth crash study was carried out at the University of Adelaide.

### Achievements

The main safety benefit of early ARRB research was to provide Australia with a body of standards and guidelines for roads and traffic management that matched or exceeded best practice elsewhere in the world, or were specially developed for Australia's unique conditions. Specific items relating to road safety included road lighting standards; lane and shoulder width; traffic signal displays and siting; traffic sign legibility, reflectivity and comprehension; delineation treatments (Figure 3); overtaking lanes; truck stability and suspension matching of

prime mover and trailer; skid resistance management guidelines (Figure 4); roundabout design; and local area traffic management standards and guidelines.



Figure 3. The 'snapping turtle' occluding helmet was used to test delineation treatments by periodically interrupting drivers' vision and seeing how well they could stay on path. Note the dual controls in the car – just in case!



Figure 4. A British Pendulum Tester being calibrated in the laboratory. This was (and still is) used to measure skid resistance.

ARRB also contributed to road safety in other ways in this period. The journal *Australian Road Research* provided an outlet for Australian work. The biennial ARRB conference provided the only national forum for road builders and managers to catch up with developments in research and practice; this included strong representation from local government engineers. In addition, a series of two to three regional symposia per year brought new thinking and findings to practitioners in many areas outside the capital cities. ARRB's library services developed Australia's premier road transport library collection, maintained an index of all Australian work on roads and road transport, and prepared Australian material for input into international bibliographic databases.

## The 21st century

The latter years of the 20th century saw major changes in the SRAs, which amalgamated with other organisations to assume responsibility for driver testing and licensing, vehicle registration and other functions. At the same time, business practices changed within the newly formed road and traffic authorities, with much work being outsourced.

These changes caused a major reorganisation of ARRB's business model, with less reliance on direct funding of research programs and more reliance on research and consultancy work on a fee-for-service basis. Revitalised by these changes, ARRB entered the next century well-prepared to deal with its challenges. The following have been some of its most important contributions to road safety in recent years.

### Risk management

ARRB has taken a leading role in developing a risk management approach to road safety engineering in Australia. This has been principally through a six-year project for Austroads, which examined the risk associated with different road stereotypes and features, and the risk reduction that could be expected from a range of remedial measures. This work is intimately related to other aspects of ARRB's program.

### Software tools

ARRB has developed a range of software to assist road safety practitioners in their decision making. Experience was originally gained with the X-LIMITS set of programs to assist with speed limit selection. Road Safety Risk Manager was originally developed to assist practitioners to prioritise the remedial actions suggested by road safety audits, but has recently been expanded to incorporate the findings of the risk management project. It provides guidance regarding the extent to which different treatments will reduce crash risk in different situations. Road Safety Toolbox provides guidance as to which treatment is most appropriate in different situations. Both these products are used in conjunction with the road survey products described below and are widely accessed by practitioners across the globe.

### Austroads guides

The ARRB team has undertaken the bulk of the work in drafting Austroads guides covering all areas of road authority activities. This includes the nine volumes in the *Austroads Guide to road safety*. The *Austroads Guide to road design* and the *Austroads Guide to traffic management* also have substantial safety content. The Austroads guides are acknowledged as leaders in their field, and have influenced the design and content of similar publications in other countries, particularly in the Asian region.

### Safe System

Safe System was adopted by the Australian Transport Council as a guiding principle in the *National road safety action plan 2005 and 2006*. Since that time, ARRB has been among the leading contributors to the interpretation and development of the doctrine. Workshops have been held to explore the implications for infrastructure provision, the management of speed, the management of road users and the implications for local government. Projects are underway to help road authorities and local government come to grips with the practical implications.

### AusRap and iRAP

By 2005, as the culmination of many years' research and development, ARRB had produced a network survey vehicle (Figure 5) that could create a three-dimensional map of the road along which it travelled while surveying the road and

roadsides using the Hawkeye video camera system. Road and shoulder cross-section, offset to roadside objects, and the presence of signs and road markings could all be determined from the video images and related to their exact location on the road map.



Figure 5. A network survey vehicle equipped with Hawkeye video cameras are mounted on the roof. The apparatus at the front of the van is a battery of laser sensors for measuring road surface characteristics.

These vehicles were used to conduct the Australian Road Assessment Program (AusRAP) surveys, funded by the motoring organisations, which allocated star ratings to major roads according to the level of safety the road offered. Since then, the ARRB Hawkeye system has been widely used in the International Road Assessment Program (iRAP), with surveys conducted in several countries using this equipment and the associated procedures for rating the safety of roads.

In recognition of ARRB's contribution to iRAP, the establishment of an International iRAP Centre of Excellence at ARRB was announced at ARRB's conference in October 2010. The role of the Centre of Excellence will be the continued development of survey technology and analytic procedures for iRAP, and training of personnel from user countries in the conduct, analysis and interpretation of surveys.

### Behavioural research

ARRB has continued to conduct behavioural research in a number of areas. The safety of young drivers has been an ongoing theme, including monitoring the accumulation of supervised driving experience by learner permit holders, redevelopment of a computer-based hazard perception test, contributions to the development of practical on-road tests in several states and investigations of factors contributing to risk-taking by novice drivers. With the assistance of subcontractors, ARRB developed an educational program to reduce recidivism among convicted drink drivers; an independent evaluation found the program to be of high quality and much more effective than other programs with similar aims.

Motorcycle safety has also been a continuing theme, with work on crash analysis, training and licensing requirements, and rider's views and acceptance of new technologies. Work has continued with road signing but has evolved to tackle new conventions for complex direction signing and issues relating to variable message signs and changeable speed limit signs. ARRB has also been active in community and local government road safety, principally at the level of developing and reviewing programs, supplemented by 'hands-on' experience with local communities.

### Other areas

ARRB has contributed to other areas of road safety. These include road surfacing, where the ability to assess aspects of surface condition using low-cost laser measurements has raised fundamental questions about the best strategies to manage Australia's extensive road network. Work to ensure stability and other aspects of safe performance of new heavy vehicle designs continues. Acceleration and braking of heavy vehicles at railway crossings has been a particular concern, as part of a wider body of work on railway level crossings, including an assessment of the Australian Level Crossing Assessment Model (ALCAM) currently used to assess the safety of individual crossings. ARRB has also carried out work related to the safety benefits of different types of intelligent transport systems (ITS) technologies – both in-vehicle and roadside – in Australia.

### The future

ARRB's 50th anniversary is a time when the land transport system is faced with substantial changes and enormous challenges. Major changes in the way road travel is powered seem imminent, with as yet unknown effects on the mix of vehicles using the network. Efforts to achieve sustainability and shortages of some traditional road-building materials are forcing changes in the way roads are built and managed, while climate change has implications for drainage and the resilience of structures and roadside furniture. The implementation of Safe System principles with limited budgets requires careful consideration. Rapid motorisation confronts developing countries with the prospect of an enormous casualty toll, the containment of which requires knowledge transfer on a very large scale.

ARRB's team looks forward to the challenge of the next 50 years. For the Safe System team in particular, the challenge will be to assist progress towards Safe System goals, while addressing these other factors and constraints. In pursuing this challenge, ARRB would be wise to rely on its traditional strengths – capable and enthusiastic people, close working relationships with its customers, a wide mix of disciplines and expertise available within the organisation, and opportunities to pursue new ideas.

### Acknowledgement

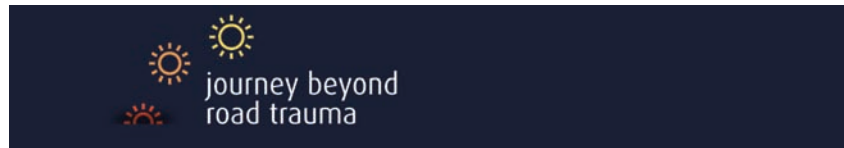
Preparation of this paper was greatly assisted by notes compiled by Max Lay (former Executive Director, ARRB) and John Metcalfe (former Deputy Director, ARRB) with input from many staff members, past and present. Comments on the original draft of this paper from the author's colleague at ARRB Group, John Catchpole, were also of considerable help.

### Reference

1. Jones D. 50 years of road engineering and scientific research. *World Highways* 2010; 19(7):20-22.

# Journey Beyond Road Trauma online community

by Michelle Kelly



The Journey Beyond Road Trauma (JBRT) online community (<http://journeybeyondroadtrauma.org>) has had an astounding response since the official launch at Easter 2010, with people sharing stories about recent losses and about loved ones lost 20 years ago. Emergency services personnel, people living with serious injuries and counsellors have also joined.

Thousands of people are affected by road trauma every year through death, serious injury and their work in the emergency services, legal professions and disability sector. The ripple effect of each and every crash is incalculable.

People affected by road trauma – either by a serious injury or a fatality – often feel voiceless and need to be heard. Also, quite often people affected by road trauma become passionate campaigners and want one good thing to come out of it to make sense of the senseless.

Co-producers Sandra Cook and Kerry Sunderland spent two years researching and developing the community and how it could meet those needs. They conducted in-depth research into the road safety sector to understand how the project could be effective in road safety education.

With more than 1700 members on the main site and the Facebook spinoff, and around 19,000 visits and 162,000 page views, it is an active and passionate movement which is finding its voice and strength.

## Making an impact

Youth Justice conference convenor Lorna Edwards from Newcastle in NSW used the online community in a powerful way for a young man charged with dangerous driving. Ms Edwards chose a story from the JBRT site about a man who accidentally killed a young child through dangerous driving when he was 18 years old. This story was read out by a police officer at the initial conference.

An outcome plan, which was the sentencing option, stipulated that the young man charged with dangerous driving had to visit the JBRT site and select three stories to print out and send off to the Department of Juvenile Justice. Ms Edwards says it was a 'great' conference and has recommended using this process in the future for driving-related cases.

Neurosurgical nurse at the Royal Hobart Hospital Tasmania, Linda Nichols, presented a paper at the Australasian Neuroscience Nursing Conference in Christchurch titled 'Moral and ethical decision making'. The paper focused on the factors that influence decisions made by parents following motor vehicle and motorbike accidents involving young persons.

Ms Nichols promoted JBRT as an avenue for parents who have lost children or who are supporting the seriously injured, to tell their stories so as to have a voice and make a change. The community is regularly contacted by welfare workers, schools and university students who want to include JBRT in their education programs.

## Speaking out

The producers put out a call asking for community members who were willing to tell their stories across different media. Within days they had an extensive database of committed people ready to speak publicly about their experiences.

This cross-platform story sharing strategy has seen the community represented across various media outlets including the 7.30 Report, the Conversation Hour and Channel 7 Sunrise. The Sunrise segments ran over a period of five weeks and featured JBRT community members speaking on different topics such as fatigue, serious injury, repeat offenders and young people dying on the roads.

JBRT has partnered with road trauma support groups, disability service providers and community-based lobby groups nationwide.

With more funding, the campaign section in the website will include sophisticated group functionality for campaigning, event organising tools, online petitions and downloadable templates for petitions and letters. The campaign section will also include educational advice from road safety experts who will interact with community members via live chats on road safety, news feeds, statistics and links.

JBRT is following the MADD (Mothers Against Drunk Driving) model. From its humble beginnings 25 years ago, MADD has evolved into one of the most widely supported and respected non-profit organisations in America. What began as a handful of angry mothers with a mission to stop drink driving has evolved into an educated and effective group of road safety campaigners. These mothers, by collaborating with each other and utilising the guidance of road safety experts, have now helped save thousands of lives.

In early 2011 a teachers' guide will be available on the site so that schools around Australia can more effectively and easily use the community and the stories of the members to educate future drivers about the effects of careless driving. A press kit, FAQs and images are also available on the site. For more information, contact producer Sandra Cook, phone 0413 146 013, or Michelle Kelly, phone 0431 011 050.

# Peer Reviewed Papers

## Data and graphing errors in the Voukelatos and Rissel paper

by Tim Churches, Medical Epidemiologist, Epping, NSW 2121. Email: tim.churches@gmail.com

I am writing to you regarding a peer-reviewed paper titled 'The effects of bicycle helmet legislation on cycling-related injury: The ratio of head to arm injuries over time' by Alex Voukelatos and Chris Rissel, which appeared on pages 50-55 of the August 2010 issue of the *Journal of the Australasian College of Road Safety*.

The paper as published contains serious arithmetic and data plotting errors. These are:

a) The all-ages total counts of hospital admissions for head and arm injuries in cyclists by financial year in Table 2 do not equal the sum of the age-group-specific counts in the rest of the table. Some of the totals in the table are higher than the sum of the age-specific counts, and some are lower – thus this discrepancy cannot be explained by inclusion of records with missing age-group in the totals (the source hospital admissions data contains a very small percentage of missing ages, in any case). It may be that either the totals are correct and the age-group-specific counts in the table are wrong, or the age-group-specific counts are correct and the totals are wrong – it is impossible to determine which from examination of the published paper, although the latter seems more likely.

What is certain is that the data presented in the paper are arithmetically incorrect. As a result of these errors, at least some of the corresponding head-to-arm injury admission ratios in Table 3 of the paper must also be incorrect – probably those for all ages – because they have been calculated from the hospital admissions counts as they appear in Table 2. Most importantly, as a result of these unequivocal data errors, the time-series of all-ages head-to-arm injury admission ratios plotted in Figure 2, upon which the conclusions of the paper appear to be principally based, is also almost certainly incorrect.

b) The data points for the proportions of adult and child cyclists observed to be wearing helmets in NSW Roads and Traffic Authority (RTA) surveys are incorrectly plotted some 15 months too late in Figure 2. The RTA surveys were conducted in September 1990 and in April of 1991, 1992 and 1993 [1-4]. The hospital admissions ratio data plotted in Figure 2 are based on financial year counts, and thus each data point in the time-series should properly be plotted on the x-axis at 1 January of the second of the calendar years in each financial year.

For example, the third data point from the left in the Figure 2 head-to-arm admission ratio time-series represents the ratio for the 1990/91 financial year, and thus the horizontal position of the plotted point corresponds to 1 January 1991. The first of the RTA survey points (September 1990) should therefore be 3

months to the left of this third head-to-arm ratio data point, not 12 months to its right as it appears in the published paper. The other RTA survey data points are similarly misplaced. In addition, the caption for Figure 2 labels the helmet law compliance data as 'self-reported helmet use'. This is incorrect: the data were collected by observation of cyclists by trained observers, as clearly described in the report by Smith and Milthorpe [4], which the authors cite as the source of these data.

c) The authors have also made a pre-press version of their paper which states that it was '...accepted for publication in the *Journal of the Australasian College of Road Safety*, August 2010', available at several locations on the Internet. This pre-press version contains an additional data plotting error. As noted above, the data points for the head-to-arm-injury ratio in Figure 2 are the mid-points of financial years, that is, 1 Jan of each calendar year. Therefore, the shaded bar representing the 6-month period in which the adult and then child cycling helmet laws were introduced in NSW should be positioned immediately to the right of the third data point, not immediately to the left of the fourth data point as shown in the pre-press version of the paper.

The concern is not just that the tabulated data and the key graph in the paper contain significant arithmetic and data plotting errors, but that the combined effects of these errors have led the authors to draw erroneous conclusions from the data on which they have based their study. Assuming, as seems most likely, that the age-group-specific admission counts in Table 2 are correct, and that it is the all-ages totals that are wrong, then Figure 2 should appear as shown in Figure 1 below (which I reproduced from the data in Table 2 after recalculating the all-ages totals).

Please note that at the time of writing, I have not yet been able to verify the accuracy of the age-specific hospital admission counts presented in the paper by Voukelatos and Rissel, and there may be other errors in their data. Thus Figure 1 should be viewed with this possibility in mind.

On the basis of these results, the authors' conclusions do not appear to be supported by the data, when it is correctly plotted. For example, they state:

*'The main conclusion of this examination of the ratio of head to arm injuries over time is that there was a marked decline in head injuries among pedal cyclists before the introduction of mandatory helmet legislation and behavioural compliance, most likely a result of a range of other improvements to road safety.'*



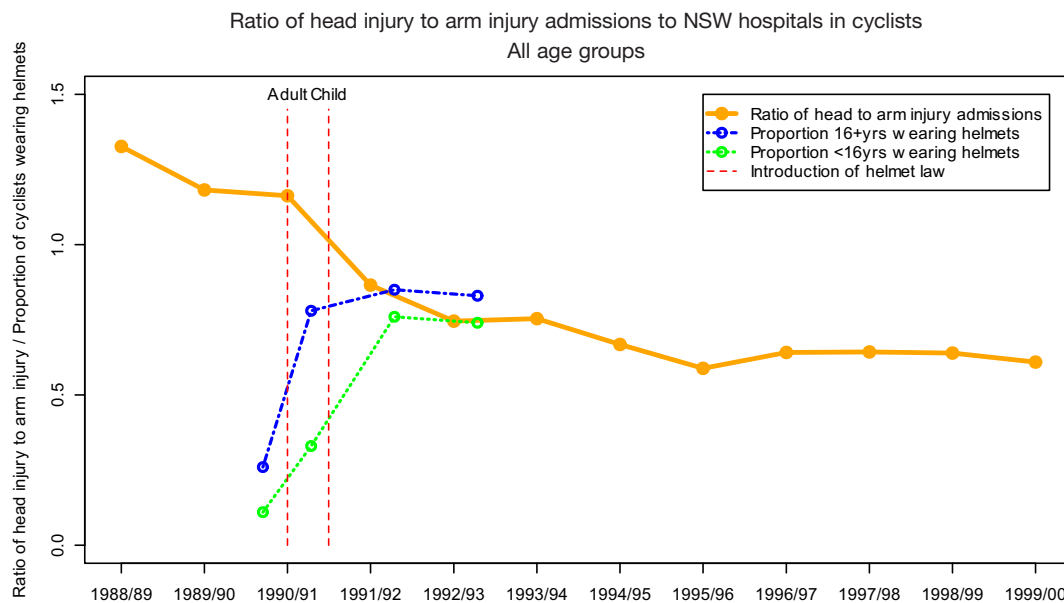


Figure 1. Ratio of head injury to arm injury admission to NSW hospitals in cyclists

The authors also discuss both age-group-specific and total counts and the ratios derived from them in their results section: at least some of that discussion must also be incorrect. In addition to these unequivocal errors, there may also be a problem with comparability of the very first data point in the head-to-arm-injury time-series. The authors state in the Methods section of their paper:

*'The data were categorised according to principal diagnosis using ICD10 codes. Only codes representing head injuries and arm/hand injuries were used in the study (see Table 1). Cases that had both head and arm injuries were counted in each group.'*

It should be noted that the first and third sentences are logically incompatible, because there can only be one principal diagnosis code for each record, representing only one type of injury. However, the third sentence suggests that the authors checked multiple diagnosis code variables on each admission record for codes indicating head or arm injuries, rather than just the single principal diagnosis variable.

Ordinarily, checking multiple diagnosis code variables on each record is good practice. The potential comparability problem arises because for the 1988/89 financial year data, and only for that year, there is just one diagnosis code variable available on each record – in all later years of the hospital admissions data collection, there are up to five or more diagnosis code variables on each record. In cases in which both head and upper limbs have been injured, the head injury is more likely to be recorded as the singular principal diagnosis, which may lead to an artefactual increase in the head-to-arm injury ratio for 1988/89. This possibility can be easily investigated by the authors tabulating or plotting the head-to-arm injury ratio by month or quarter rather than by year – a sudden drop in the ratio time-series at July 1989 would indicate a comparability problem.

There are several more methodological points that require consideration by any readers of the paper.

The first relates to the ICD-9-CM codes used by the authors to select hospital admission records prior to 1999/2000. The actual codes used are not reported in the paper, and the authors state that they used an ICD-10-AM to ICD-9-CM back-mapping provided by the National Centre for Classification in Health. This back-mapping is an excellent starting point, but it is always wise to manually check for additional relevant ICD-9-CM codes, and the paper would be strengthened by stating exactly which ICD-9-CM codes were used to select hospital admission records.

A minor point is that the NSW hospital admissions data are coded using ICD-9-CM (Australian version) and ICD-10-AM, not 'ICD9' and 'ICD10' as stated in the paper. ICD-9 and ICD-10 are code sets published by the World Health Organisation, which in Australia are primarily used for coding mortality data – they are not the same as the ICD-9-CM and ICD-10-AM code sets.

It is not clear if the available weighting factor was used to adjust for the temporal sampling used for the data collected from smaller public hospitals and some private hospitals prior to 1994. Failure to adjust for the sampling is unlikely to have affected the head-to-arm injury ratio substantially, but nevertheless it should be done.

Finally, it is not clear if the authors excluded inter-hospital transfers from the data, to avoid double-counting. This is relevant because the NSW Trauma Plan was introduced in 1993, which had the effect of reducing inter-hospital transfers for more severe trauma cases. It is theoretically possible that this may have introduced a minor systematic shift in the time-series data, albeit well after the cycling helmet laws were introduced.

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1. Walker MB. Law compliance and helmet use among cyclists in New South Wales. Consultant Report 6/90. Rosebery, NSW: Road Safety Bureau, NSW Roads and Traffic Authority, 1990.
2. Walker MB. Law compliance and helmet use among cyclists in New South Wales, April 1991. Consultant Report 1/91. Rosebery, NSW: Road Safety Bureau, NSW Roads and Traffic Authority, 1991.
3. Walker MB. Law compliance among cyclists in New South Wales, April 1992: A third survey. Rosebery, NSW: NSW Roads and Traffic Authority, 1992.
4. Smith NC and Milthorpe FW. An observational survey of law compliance and helmet wearing by bicyclists in New South Wales - 1993. Rosebery, NSW: NSW Roads and Traffic Authority, 1993.

## Note from Professor Raphael Grzebieta, Peer Review Editor

On the receipt of Tim Churches' letter, a copy was sent to the authors Dr Alexander Voukelatos and A/Prof. Chris Rissel on 7 October 2010 seeking their response. A reply letter was subsequently received from the authors on 20 October 2010. Both Tim Churches' letter and Dr Voukelatos and A/Prof. Rissel's reply letter were sent to four independent reviewers along with the original paper. Three of the reviewers are Australian and one is German. The reviewers' qualifications range across the professions of psychology, engineering, medicine and science, while their extensive expertise ranges across the areas of epidemiology, bio-statistics, cycling safety, transport engineering, hospital and crash databases, and crash investigations.

The outcome of the review to date is that all reviewers unanimously indicated that Tim Churches' letter should be

published in the journal and all supported that his criticisms, his graph and comments appear valid.

Concerning Dr Voukelatos and A/Prof. Rissel's response, all reviewers agreed it was deficient and required further elaboration and re-review to address adequately Tim Churches' concerns. The reviewers were particularly critical in regard to the scientific evidence Dr Voukelatos and A/Prof. Rissel presented in their reply as support of their main conclusion that *'mandatory bicycle helmet legislation appears not to be the main factor for the observed reduction in head injuries among pedal cyclists at a population level over time'*. The editors have decided to further communicate with the authors and seek another written reply that addresses all reviewers' concerns. This reply will be further assessed by the reviewers.

It should be noted that at this point in time Dr Voukelatos and A/Prof. Rissel have stated in their response: *'Mr Churches is quite correct in writing that the paper titled 'The effects of bicycle helmet legislation on cycling related injury: The ratio of head to arm injuries over time' has serious arithmetic and data plotting errors. We sincerely apologise for these unintentional errors and any confusion that this may generate.'*

Unfortunately, at the time this issue of the journal went to publication, there was insufficient time to further relay the reviewers' assessment to Dr Voukelatos and A/Prof. Rissel for them to reply adequately to the reviewers' concerns. It is hoped that a consensus position will be reached by the authors and the reviewers, which can subsequently be published in the February 2011 issue of the journal.

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# A prospective study on pedestrian injuries in an urban Australian population

by Dr Jenson CS Mak MBBS FRACP FAFRM (RACP) BMedSc<sup>1,2</sup>, Claire Law BMedSc<sup>3</sup> and Associate Professor Steven Faux MBBS FRACGP FAFRM (RACP) FFPM (ANZCA)<sup>1</sup>

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## Abstract

Pedestrian injuries are associated with substantial morbidity, mortality and cost, with very little published work on this topic in Australasia over recent years. The objective of this study was to examine the demographics, injury profile, relationship with alcohol and intoxication, motor vehicle, and environmental

factors of pedestrian versus motor vehicle collisions (MVC) in a central city hospital in Sydney. The method comprised a descriptive study with structured questionnaire of 35 pedestrians involved in a MVC admitted to a tertiary hospital in inner-city Sydney over a five-month period, during which 97 pedestrians involved in injuries were treated.

The mean age was  $48.5 \pm 19.7$  years, and 65.7% were females. Mean emergency length of stay (LOS) was  $8.9 \pm 6.5$  hours, with a trend towards longer LOS for older patients (11.0 vs. 6.71 hours,  $p=0.056$ ). Peak injuries occurred between 1500-1800 on weekdays, and 1800-0300 on weekends, with 53% occurring at sites other than a crossing. Twenty per cent of those injured had pre-existing disabilities involving gait abnormality. Dark-coloured clothing worn above the waist was associated with MVCs at night-time. Alcohol consumption was associated with a higher cost of radiological investigations and length of stay, resulting in an estimated additional \$7755 per hospital admission.

This study demonstrates that readily defined and clinically relevant characteristics are associated with pedestrian injuries in an urban Australian population. Pedestrian intoxication is associated with increased utilisation of hospital resources contributing to the burden on health systems. This information may be used to help design effective public health strategies to educate the community on the cost of care.

## Keywords

Pedestrians, Road traffic injuries, Motor vehicle collisions, Descriptive study, Prevention

## Introduction

Collisions between pedestrians and road vehicles present a major challenge for public health, trauma medicine and traffic safety professionals. More than a third of the 1.2 million people killed and the 10 million injured annually in road traffic crashes worldwide are pedestrians [1]. In New South Wales, the number of pedestrian injuries occurring in 2007 was 2119, with an annual average fatality of 75.7 in 2006 to 2008 [2]. The total direct cost for trauma patients admitted to a large metropolitan Australian trauma centre over a three-month period was estimated at around \$3 million [3]. In particular, direct medical costs for admitting a pedestrian trauma patient has been estimated to be \$16,320 per admission, and for patients who died, to be \$28,831 [4].

There have been very few papers published on pedestrian injury in Australasia over recent years. Of existing studies, most have focused on paediatric and older pedestrian trauma [5-7] in a retrospective manner [4]. There has been no Australasian review of adult pedestrian trauma in inner city urban environments conducted prospectively with an a priori protocol.

The primary aim of this descriptive study was to examine the demographics, injury profile, morbidity and causative factors of adult pedestrian trauma in a central city hospital in Sydney, with the secondary aim of examining the effect of blood alcohol concentrations (BAC) on severity of injury and cost of treatment.

## Method

The study was carried out at St Vincent's Hospital, Sydney, which is located on the edge of the Sydney central business district. The study was a review of all adult pedestrians injured by motor vehicles and admitted to the emergency department (ED) during a five-month period from June to October 2009. A review of patient records and a structured questionnaire was conducted on consented pedestrians (previous accident history, alcohol consumption, colour of clothing during time of accident, usage of electronic device, warning of oncoming vehicle), including information on environmental factors at the time of accident (whether a crossing was used, proximity to a pub). See Table 1. Exclusion criteria included patients who were unable to speak English, medically unstable, or cognitively and/or speech impaired. Ethics approval was obtained from the ethics review board of St Vincent's and Mater Health.

**Table 1. Demographics of those consented to questionnaire**

	Gave consent	
	N (%)	Mean $\pm$ SD
<b>Age (years)</b>	35	$48.5 \pm 19.7$
15-29	11 (31.4)	
30-44	5 (14.3)	
45-64	8 (22.9)	
$\geq 65$	11 (31.4)	
<b>Gender</b>	35	
Male	12 (34.3)	
Female	23 (65.7)	
<b>Marital status</b>	34 <sup>a</sup> (97.1)	
Single	13 (38.2)	
Married	12 (35.3)	
De facto	5 (14.7)	
Divorced	4 (11.8)	
<b>Language spoken at home</b>	35	
English	23 (65.7)	
Non-English	12 (34.3)	
<b>Country of birth</b>	35	
Australia	19 (54.3)	
Others	16 (45.7)	
English speaking	3 (8.8)	
Non-English speaking	13 (37.1)	
<b>BAC (%)</b>	14 <sup>a</sup> (40.0)	$0.0886 \pm 0.105$
$< 0.03$	9 (64.3)	
$\geq 0.05$	5 (35.7)	
<b>GCS on admission</b>	31 <sup>a</sup>	$14.5 \pm 0.4$
<b>LOS in ED (hours)</b>	30 <sup>a</sup>	$8.9 \pm 6.5$
<b>LOS (if admitted)(days)</b>	13 (37.1)	$11.7 \pm 10.6$
<b>LOS ICU (if admitted) (days)</b>	1	9.42
<b>ISS</b>	35	$14.1 \pm 3.5$

<sup>a</sup>Unaccounted numbers are unknown or missing cases

Patients were identified from the Emergency Department Information Systems (EDIS) database. The subjects were a convenience sample in that (1) those who were in hospital while the researcher was present were approached for consent once medically cleared by the treating team, and the questionnaire was administered prior to discharge; and (2) those who were discharged from hospital were mailed an information sheet, consent form, questionnaire and stamped addressed reply envelope, and subjects with returned questionnaires were included in the study analysis.

Medical records were used to gather relevant demographic data such as age, gender, postal code, marital status, language spoken at home, country of birth, admission Glasgow Coma Scale (GCS), Injury Severity Score ISS [8], LOS in ED, LOS in hospital if admitted, LOS in intensive care unit ICU if admitted, time, date and location of accident, estimated impact speed, and injuries sustained. MediWeb™ [9] was used to determine tests performed and BAC taken by emergency personnel. A BAC less than 0.05% was considered non-intoxicated, and greater than or equal to 0.05% was considered intoxicated, in accordance to current NSW drink-driving laws [10].

ISS [11] was scored from information gathered from ED and Trauma Registry. Types of vehicle were classified into (1) passenger cars including sedans and hatch-backs; (2) light truck vehicles including four-wheel drives, sports utility vehicles, small pick-ups, mini-vans, buses and trucks; and (3) motorcycles, scooters, bicycles and push-bikes. Clothing colours such as black, blue and grey were considered 'dark', whilst green, red, orange, yellow, white, pink and purple were considered 'light'. Blue, if indicated 'light' or 'pale', was recorded as a light colour. The Australian Bureau of Meteorology website was used to determine 'daylight' or 'darkness' on the day of accident [12]. The sample population was compared with the population of Sydney Statistical Division (SD) obtained from the Australian Bureau of Statistics, which is most relevant to an urban population in Sydney [13].

An independent sample t-test or z-test was used to compare means of continuous outcomes of a normal distribution with two categorical factors of the same group. A non-parametric independent sample test (Mann-Whitney U) was used to compare means of continuous variables that were not normally distributed. Crosstabs were used to determine frequencies between two categorical variables. All statistical analyses were carried out using SPSS software [14]. P-values of less than 0.05 were considered statistically significant.

## Results

Of a total of 97 pedestrians admitted to ED from 19 May to 30 September 2009, 35 (36.1%) consented to complete the questionnaires. Fifteen patients were approached personally, of which 14 (93.3%) consented. Eighty-two letters with stamped addressed reply envelopes were mailed out, of which 21 (25.6%)

recipients responded. Analysis revealed that patients who consented were likely to be older, to be married, to have greater physical injury (higher ISS), and to have a longer ED and total LOS. The ≥65-year age group was 16.1% higher as compared to the Sydney SD population ( $z=2.64, p<0.05$ ).

### Participant demographic characteristics

Demographic characteristics of the 35 injured pedestrians are indicated in Table 1. Their age ranged from 20 to 84 years, with an average age of  $48.5 \pm 19.7$  years. The highest frequency was in the age range 15-29 years and ≥65 years (31.4% each); females accounted for 65.7% of injuries. The mean GCS on admission was  $14.5 \pm 0.4$ . Mean ED LOS was  $8.9 \pm 6.5$  hours (range 2.5-73.75 hours), and mean hospital LOS (37.1% of subjects) was  $11.7 \pm 10.6$  days (range 1.0-45.0 days). One pedestrian was admitted to the ICU with a LOS of 9.42 days.

Those ≥65 years accounted for 30.8% of hospital admissions, with a trend for longer ED LOS compared to 15-29 year olds ( $11.0$  vs  $6.71$  hours,  $p=0.056$ ), as well as longer hospital LOS ( $7.63 \pm 6.29$  vs  $3.50 \pm 3.54$  days), although not statistically significant ( $p=0.452$ ). See Table 2.

Table 2. Time spent in hospital according to age group

Age group (years)	N=30 <sup>a</sup>	LOS in ED in hours (mean)	p-value	N=13	LOS (if admitted) (mean ± SD)	p-value
15-29	7	6.71	-	2	3.50±3.54	-
30-44	5	7.90	0.250	3	6.67±4.62	0.478
45-64	8	9.13	0.296	4	23.5±17.4	0.203
≥65	10	11.0	0.056	4	7.63±6.29	0.452

<sup>a</sup>5 unknown or missing cases

### Crash circumstances

More pedestrian collisions occurred on Tuesdays, 4.2 times the number on Sundays (Figure 1). Overall injuries were more common during 1500-1759 on weekdays (Figure 2); pedestrians ≥65 years were more likely to be injured during daytime and those 15-29 years between the hours of 1500-1759 and 0000-0259 (Figure 3). The early morning hours had the least number of injuries, which were rare from 0300-0559.

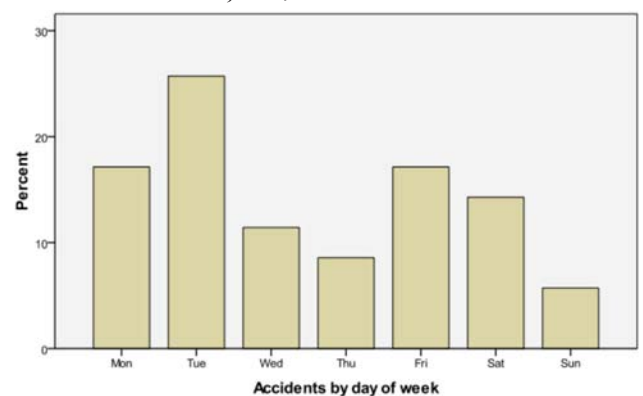


Figure 1. Distribution of pedestrian injuries by day

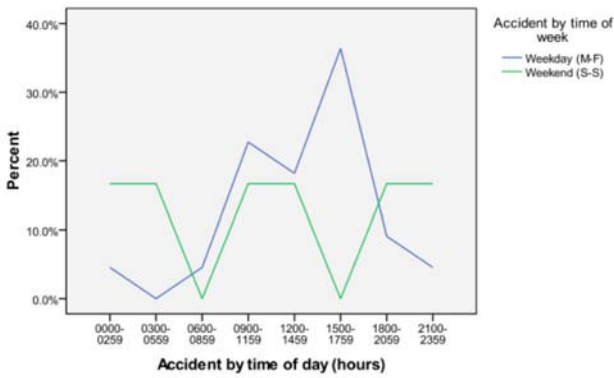


Figure 2. Comparison of proportions of injuries by time of day according to time of week

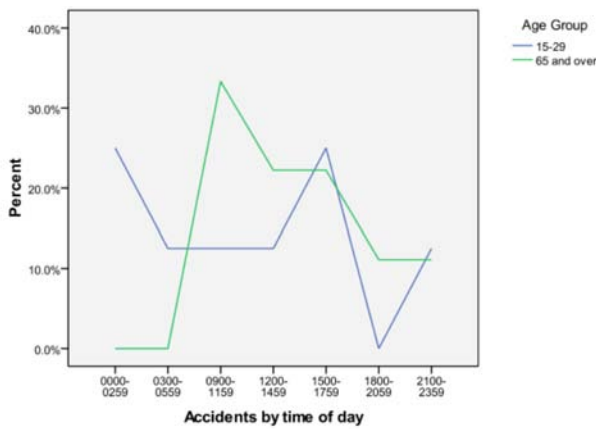


Figure 3. Pedestrian injuries by time of day according to age group.

Sixteen respondents (53.3%) were not using any pedestrian crossings at the time of accident (Figure 4). Thirty respondents (85.7%) reported that ‘it wasn’t raining at the time’ of the collision, and two (5.7%) said the rain just stopped. Of the four accident locations recorded in those found intoxicated, all were located within 100 metres of a pub, and one location had three or more pubs within a 50-metre radius.

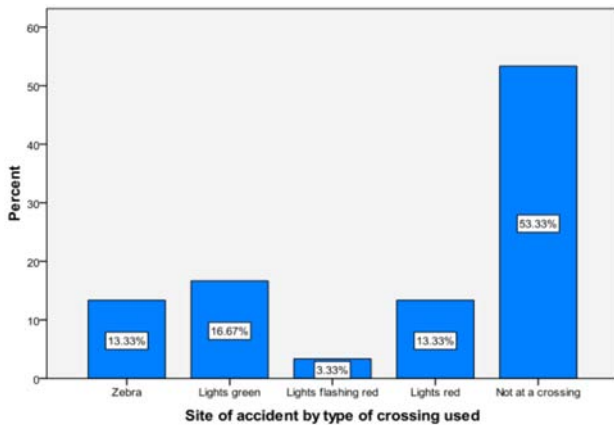


Figure 4. Distribution of type of crossing used at time of injury

A history of prior motor vehicle injuries was reported in 11.4% of respondents, and 28.6% had pre-existing disabilities of which 70% reported to have an abnormal gait. Dark-coloured clothing worn above the waist was reported in 70.8% of pedestrians injured, and dark-coloured clothing worn below the waist was reported in 78.6% cases. Dark-coloured clothing worn above the waist was associated with injuries at night-time, although not statistically significant (83.3% vs 58.3%,  $p=0.185$ ) (Table 3).

Table 3. Colour of clothing by time of injury

	N (%)	Daylight N (%)	Darkness N (%)	p-value
<b>Colour of clothing above waist</b>				
Dark	24 <sup>a</sup> (80.0)	12 (50.0)	12 (50.0)	0.185
Light		7 (58.3)	10 (83.3)	
<b>Colour of clothing below waist</b>				
Dark	28 <sup>a</sup> (82.4)	15 (53.6)	13 (46.4)	0.600
Light		5 (41.7)	2 (16.7)	

<sup>a</sup>Unaccounted numbers are unknown or missing

Fifteen respondents (51.7%) reported not noticing the oncoming vehicle, and 20.0% of those reported not ‘looking at all’. Only one of the five intoxicated pedestrians reported having seen the vehicle. Patients  $\geq 65$  years made up the largest proportion (33.3%) of those who did not notice the vehicle. The majority (85.7%) who saw the vehicle said that it was ‘too late to have evaded the accident’. Four of 32 respondents (12.5%) were using an electronic device during the accident. Three used an MP3 player, and one was having a conversation on a mobile phone. All four were aged 30 or less.

Seventeen respondents (48.6%) identified themselves as alcohol drinkers, and eight (22.9%) reported to have consumed alcohol on the day of the accident. Fourteen BACs were recorded at ED staff request, with a mean of  $0.0886 \pm 0.105\%$  (median less than 0.03; range, 0.03-0.33%). Six of the eight who consumed alcohol that day had their BACs recorded, where five (83.3%) had levels ( $BAC \geq 0.05\%$ ) that would have rendered them intoxicated and unsuitable to control a motor vehicle. None was 65 years or older. Two-thirds who identified themselves as non-alcohol drinkers were women.

**Effect of a positive BAC on LOS and cost**

A total of 41 X-rays and 27 CT scans were performed on the 14 pedestrians who had their BAC recorded. The mean number of X-rays and CT scans was higher, with a trend towards more X-rays amongst those intoxicated (3.6 vs. 2.56,  $p=0.056$ ) (Table 4). Whilst five (71.4%) CT scans of the head in non-intoxicated cases yielded positive findings, only one (25.0%) of intoxicated cases did.

Table 4. Diagnostic investigations performed according to BAC<sup>a</sup>

	N (%)	BAC<0.03	N (%)	BAC≥0.05	p-value
X-rays (mean±SD)	23 (56.1)	2.56±1.01	18 (43.9)	3.60±0.55	0.056
CT scans (mean±SD)	15 (55.6)	1.78±1.30	12 (44.4)	2.4±1.14	0.390

<sup>a</sup>Reported values from MediWeb<sup>TM</sup> included BAC values <0.03 and ≥0.05 only

Intoxicated pedestrians had a higher mean hospital LOS, although not statistically significant ( $17.7\pm 4.23$  vs  $11.5\pm 12.7$  days,  $p=0.671$ ). The estimated cost of a single intoxicated pedestrian was an extra \$7755 (calculated by the extra cost of 6.2 hospital days: \$7551.04 using a daily rate of \$1217.91 (\$16,320 at average length of stay: 13.4 days) [3] and costs of additional radiological investigations of \$203.64 (1.04 extra X-rays and 0.6 extra CT scans [15]) compared to their non-intoxicated counterparts per admission.

### Motor vehicle factors

Passenger cars were involved in the majority (68.6%) of injuries involving pedestrians. Twenty-nine (82.9%) impact speeds were recorded, of which 18 (62.1%) occurred at ≤25km/h, 8 (27.6%) at 26-39km/h and 3 (10.3%) at ≥40km/h.

### Discussion

This five-month descriptive sample from St Vincent's Hospital Sydney provides an overview of the circumstances and major injuries of pedestrians admitted to ED. We found a similar mean age (48.5) to the inner Sydney sample from Small et al. [4] conducted five years before at the same institution. In addition, we found a disproportionately high percentage of younger and older pedestrians injured, location, gender, time of day of week, pedestrian controls, lighting, alcohol, as well as the use of electronic and mobile communication devices as contributors to pedestrian injuries, similar to recent findings from the Staysafe Committee's report on pedestrian safety [16].

There was a higher frequency of pedestrian injuries in those aged between 15-29 years and ≥65 years (31.4% each). Older pedestrians have been reported to be vulnerable to injuries, consistent with other studies [17-19], evidenced by longer ED and hospital LOS, for several reasons. Owing to their reduced mobility and vision (one-third of respondents), usual traffic conditions may not allow sufficient time to cross the roadway safely, which may be contributed to by crosswalk controls themselves being set for a pace of transit crossing speed that many older people may not be able to achieve [20-21]. In addition, older individuals may be less likely to perceive a hazard and may be less likely to escape (one-third of those injured had a disability, of which 70% was related to an abnormal gait). Once injured, older road users are at extremely high risk of severe injury because of their greater susceptibility to injury (frailty) compared to younger people [22].

In this cohort, younger pedestrians who were injured were more likely to be engaged in risk-taking road-crossing behaviour, which may be further compounded in those intoxicated. All of those who reported using an electronic device at the time of the accident were aged 30 or less. Hatfield has shown that the use of electronic devices may be associated with increasing exposure to potential pedestrian injuries [23].

Injuries were more common during 0600-1759, consistent with previous studies showing injuries occurring in daylight hours [4, 24]. In our study, two peak accident periods were observed, consistent with Small [4]. The first was between 1500-1759, which corresponds to peak traffic time. Peak hour injuries can be attributed to high vehicular and pedestrian flow, increasing exposure to risk of injuries [25]. Sunset occurring at those times could also play a role in compromising drivers' vision leading to these pedestrian injuries and explain why this phenomenon is seen less commonly in the morning peak hour. The second was observed between 0000-0259 on weekends, especially for the age group 15-29, which may correspond to a time of high pedestrian flow in entertainment precincts of the city.

Intoxicated pedestrians suffer metabolic changes that could impair judgement, leading to reckless behaviours and inability to take quick evasive actions as compared to their sober counterparts [26]. Males were found to be more likely to consume intoxicating levels of alcohol as compared to their female counterparts, consistent with observations of older non-intoxicated and young and middle-aged intoxicated males as high-risk groups of adult pedestrians for serious injury and mortality [4].

We reported a higher total cost (extra \$7755) of treating intoxicated pedestrians, consisting of a longer ED and hospital LOS, as well as higher numbers of investigations yielding a lower positive CT result (25.0% vs 71.4%). This not only shows that intoxicated pedestrians use up more of the hospitals' resources, but also that these resources are not used as efficiently. Longer overall hospital stays can be attributed to requiring more care and more time spent on associated social issues with alcohol [27].

Indeed, there is dissociation between the public health message (drink-driving laws) and support for those who 'do the right thing' and the services that support them. Whilst fatalities associated with drinking-driving have decreased, the morbidity has remained the same for drivers [28]. Paradoxically, there may be a hidden cost of the impact of an intoxicated pedestrian who has chosen 'not to drive' by virtue of public health campaigns

and education. The total annual estimated costs of healthcare attributed to alcohol was \$A1.98 billion dollars. Another consequence often overlooked in injuries involving intoxicated pedestrians may be the undue emotional stress placed on the driver involved.

All intoxicated cases occurred within 100 metres of a drinking outlet, which indicates that intoxicated pedestrians may be vulnerable to injuries in these areas. Lee and Abdel-Aty [29] showed that night-time crashes were more likely to be the pedestrian's fault than the driver's if alcohol was involved. Current NSW regulations restrict vendors from supplying liquor to those already intoxicated. Having three or more drinking outlets within a 100-metre radius also raises the issue of pub-hopping. However, people who may be refused alcohol in one outlet as they appear intoxicated may walk several metres to the next outlet where vendors are unaware of their level of intoxication and recommence drinking.

Further, the majority of injuries in our study occurred not at a proper pedestrian crossing, consistent with Koepsell [30]. Crossing the road at a non-designated area may create a more dangerous situation, as drivers may not expect pedestrians at those sites. As those areas are well defined, they may be suitable sites for protection devices to prevent inappropriate road crossing. Road dividers with elevated fencing or barriers may be of benefit in high-density areas to deter pedestrians from inappropriate crossings [31].

Dark-coloured clothing worn above the waist may be associated with injuries during times of poor visibility such as the evening/night but not during daytime. Our finding is consistent with the observation that poor street-lighting leads to severely compromised visualisation (5%) of pedestrians wearing black clothing and at low beam [32]. Given that 85.7% of our cohort of pedestrians saw the vehicle approaching but was unable to evade the collisions, improving existing street-lighting or enhancing crossings with flashing lights to increase detection and recognition by drivers close to pubs and other traffic black spots may prevent pedestrian injuries [33]. Implementing improved lighting could coincide with peak accident times in a similar manner used in school zones in NSW, particularly those with flashing lights, which have shown to be effective in reducing mean speed of vehicles [34].

## Limitations

Several limitations are acknowledged: modest sample size, incomplete BAC records, BAC collected only at ED staff request and observational study conducted at a single site. In addition, most of the pedestrians surveyed were discharged from hospital and those who consented and completed surveys had more severe injuries. The study could be improved with a larger sample size over several sites, as well as retrieving driver factors such as BAC and license validity through linkage with police records.

## Conclusion

This is the first prospective study linking pedestrian factors to in-hospital progress and supports results from previous retrospective studies. It identifies the role of intoxication and the proximity of collisions to alcohol outlets, which are potential sites for protective measures such as enhanced lighting and barriers. Larger studies with data linkage of in-patient, environmental and police data are required to co-ordinate safety measures to target preventative strategies.

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## Pedestrian injury in Victoria

*Reviewed by Nancy Lane, Managing Editor, JACRS*

The Winter 2010 issue of *Hazard* (no. 71) consists of the paper entitled 'Traffic-related pedestrian injury in Victoria (1): Hospital-treated injury' by Cassell, Clapperton, Alavi and Jones. The authors analysed nearly 3500 hospital-treated pedestrian traffic-related injury cases in Victoria from 2006 to 2008, with respect to variables including gender, age, language and driving

conventions in country of birth, alcohol involvement, seasonal variation, type of vehicle involved, injury type and site, injury severity and hospital costs (for admissions only). *Hazard* is published by the Victorian Injury Surveillance Unit at the Monash University Accident Research Centre, email [visu.enquire@monash.edu](mailto:visu.enquire@monash.edu), phone (03) 9905 1805.

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## The cost of road crashes

*Reviewed by Nancy Lane, Managing Editor, JACRS*

The global consultant firm LECG and the Australasian Railway Association released the study *The cost of road crashes: A review of key issues* by Dr Richard Tooth in August 2010. Its objective is to review important issues relating to road crash costs and the extent to which they are incorporated into people's decisions. It is available for free download at <http://www.ara.net.au/UserFiles/file/Publications/TheCostofRoadCrashesReport.pdf>.

The study provides background on the costs associated with road crashes and how they are used to formulate policy.

In particular, it addresses the debate on costs associated with loss of life, including the methodologies used for this calculation in other countries. It also examines the extent to which these costs are internalised, that is, borne by the users who contribute to them. One of the main findings is that the costs of road crashes in Australia have been consistently underestimated. The additional costs identified relate to costs of loss of life and quality of life, much of which is not borne by the road users responsible.





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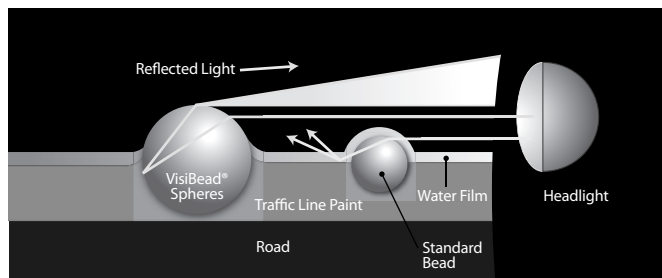
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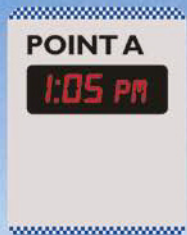


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