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Formerly RoadWise — Australia's First Road Safety Journal

In this edition —

Contributed articles

Peer-reviewed papers

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Peer-reviewed papers Editorial Board

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The policy of the publisher is to provide a medium for expression of views and for debate, within the traffic safety community, on a wide range of issues. The journal provides authors of papers with the opportunity to have their work submitted to the Editorial Board for peer review. Encouragement also is given to interested persons and organisations to submit articles, photographs or letters for publication. The publisher reserves the right to reject submissions or, with approval of the author, edit articles. No payment is offered for articles submitted.

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Cover photo: A Monash University driving simulator for research on display at the November 2009 Road Safety Research, Policing and Education Conference in Sydney. There is an article on the usefulness of simulators for driver training in this edition.

Contents

From the President

Dear ACRS Members,

Welcome to this first edition of the Journal for 2010.

We have appointed a new editor, Dr Nancy Lane, who will join us early this year after a long career including time with the Australian Academy of Science. Nancy has been working with Geoff Horne and will take over from the next edition. Geoff has made an excellent contribution to the College in many areas and we wish him well in his next round of retirement activities. Hopefully we will be able to use his wisdom in the ACT and Region Chapter.

On reflection of the College's activities I find myself thinking of the "curate's egg" - that is, it has been good in parts!

We have had excellent Journals, with particularly valuable editions, one of which encouraged the Sydney Chapter to lead a seminar on the direction of the next National Road Safety Strategy. (I hope other Chapters will follow suit.) This edition has papers on the same theme.

We had a valuable Conference in Perth, and the concept of the College as a "translator" of road safety research, developed in the final plenary session, has been well received and I think will help us with the direction of our Business Plan.

Membership remained static and we did not achieve our sponsorship targets. Overall, though, we can be pleased with the College results and I am looking forward to continuing improvement with help from all members in 2010.

The new National Road Safety Council will meet in February after what has been a long gestation period. Unfortunately we have seen slippage in our national road safety performance against our target, which means more are dying and being injured than we had anticipated. The task for reform of our road safety performance, then, must be seen as urgent; and while the new Council cannot be held responsible, it will have a key leadership role in getting us on track to achieve world best practice. We in the College have offered to assist in a range of areas, particularly in "translating" their message to our members and the community and also in reducing the need to duplicate activities. I am sure that we all wish them well in their deliberations and their projects.

It was inspiring to be in Moscow for the First UN Ministerial Conference on Road Safety and have some of the enthusiasm from the 60-plus Ministers who attended. While the Conference of 1600 was not in the same 'news league' as the Climate Conference in Copenhagen, it did resolve unanimously to recommend to the UN General Assembly in March this year that it declare a "Decade of Action on Road Safety" for 2011-2020 to save 5 million lives. This was a very positive step and one I will be encouraging the Australian Government to actively support. There is some more detail on the conference in the Journal.

You may recall the Journey Beyond Road Trauma project. I am pleased to let you know they have an operating web site at http://journeybeyondroadtrauma.org/.

Recently I met with a group of road engineers from the Hunan Province in China. They were looking for advice on how to make their rural roads safer, as their new 10 lane highways were much safer. I feel we need to keep abreast of the changes in the world as much as our visitors. The one disappointment for me in Moscow was to be reminded that our comparative position on the OECD road safety performance table is still slipping.

However, we have a lot to do and as always I encourage you to send in your ideas and suggestions, to encourage others to join us and to actively participate in your Chapter's activities.

Let's make this a Happy 2010.

Lauchlan McIntosh AM, FACRS
President

New Managing Editor

Following Geoff Horne's retirement as Managing Editor of the ACRS Journal, the Executive Committee is pleased to announce the appointment of Dr Nancy Lane as the new Editor, starting with the May issue. For the past several months, Nancy has been a consultant to Questacon - The National Science and Technology Centre, assisting in the development of a science communication policy for Australia. In 2008-09, she worked in Bangkok for the Asia Regional Office of the community development organisation, Plan International, where she was involved in writing and editing a number of publications, as well as articles for the Plan website.

Prior to this, she has held a variety of positions in management, public relations, publishing and fundraising - for

Lauchlan McIntosh making a presentation to Geoff Horne in Canberra in December 2009 the International Centre of Excellence for Education in Mathematics at the University of Melboune, Pacific Resources for Education and Learning in Honolulu, and the Australian Academy of Science in Canberra.

Nancy's interest in road safety stems initially from work she did at the Academy in conjunction with the NRMA - ACT Road Safety Trust, developing topics for teachers on road safety for the Nova: Science in the News website (www.science.org.au/nova). Her experiences working and travelling in Asia and the Pacific made her much more aware of the problems of road safety faced by people in developing countries, and the difficulties of overcoming them in nations with little funding for infrastructure or education.

RRSP Profile

Following the introduction of this feature in the May 2009 Journal, we are continuing to profile in each edition an ACRS member, who is on the ACRS Register of Road Safety Professionals. To be on the Register applicants must satisfy some stringent qualification and experience criteria in road safety. (For details see page 65). To be an 'RRSP' is an indication that an ACRS member has worked for at least five years at a senior level in their particular field/s of road safety work, has relevant academic qualifications and is acknowledged as being an expert by his or her peers working in that field/s . This edition's focus is on Mr Donald Veal, whose expertise is in Road Safety Audit and who is based in Melbourne.

Donald Veal, RRSP (Road Safety Audit)

Donald Veal is an Associate Fellow of ACRS. He is a highly experienced road safety auditor and, as a member of the Institute of Public Works Engineers Australia (IPWEA) Road Safety Panel, contributes to organising training courses for road safety auditors and reviewing applications for auditor registration in Western Australia. A key supervisory role is in mentoring road safety audit staff. He is also actively involved in conducting road safety audits, having completed some 30 audits over the last two years.

Mr Veal is the Immediate Past President of the WA Branch of the Australian Institute of Planning and Management (AITPM) and through this organisation has assisted in organising various conferences and seminars in WA, including the 2002 and 2008 National Conferences. He is a board member of the Trips Database Bureau based in New Zealand that provides a central database for trip rate and parking demand information for a wide range of land uses. He also continues his membership of the Institution of Highways and Transportation and of the Chartered Institute of Transport and Logistics Australia.

We asked Donald Veal the following questions:

How long have you been a member of the ACRS?

Since January 2006.

What do you value most about your membership of the ACRS?

Membership has opened up a new network of people working in the field of road safety and provides me with regular exposure to new ideas and research.

Tell us about your particular expertise in road safety.

As a transport planner and traffic engineer my interest has always been that of the environment to which travellers are exposed. Road safety is an integral part of all transport planning and traffic engineering projects and features heavily in my work, whether developing a structure plan or designing a car park. Our work in roadwork traffic management in particular requires careful assessment of road safety issues. Road Safety Auditing provides me with the opportunity to assess an existing road or proposed design purely from a safety viewpoint and step away from other constraints such as budgets and scope of works. The challenge is always to try and identify possible solutions for the designer to consider without being prescriptive.

What is a typical working day for you?

One of the attractions of working in the consultancy business is the constant variety of work. Most days start in the office attached to home, which cuts out any commuting time. Our business undertakes a wide range of traffic and transport projects for public and private sector clients. These include structure planning, traffic impact studies, designs and audits of roadwork traffic management plans, conducting video count surveys, providing expert witnesses for State Administrative Tribunal cases as well as conducting road safety audits.

With five staff based at our office and four others working remotely, the first task is to check all are progressing on the projects at hand and discuss any issues that arise to keep things on track. By mid morning I can get on with any projects I am working on directly or review other reports about to be issued.

Some days are spent all day in the office but on average a couple of days a week are spent on site or attending meetings. At the end of the day it's a simple step through the doorway and I am home again. A great way to solve the peak hour congestion problem!

Diary

31 August to 3 September 2010 Australasian Road Safety Research, Policing and Education Conference to be held at the National Convention Centre, Canberra.

Correction

The Editor apologises for an error that occurred in a peer reviewed paper of the November 2007 Journal. Page 38 of that Journal shows an incorrect Figure 5. The correct Figure 5 can now be seen on the website version of the November 2007 Journal.

Obituary

Pam Leicester

Longstanding road safety advocate, Pam Leicester passed away on January 20, 2010, two days before her 46th birthday.

During most of her highly active career, Pam not only had to contend with being an insulin dependent diabetic, but has had a continual battle with her health since being diagnosed with breast cancer in 1998. Pam was passionately involved in her physical fitness and became deeply involved in breast cancer research fund raising activities. She was a special person who changed the lives of many and touched people with her laughter, her positive outlook, her bright spirit and her enormous generosity.

After completing a degree in Behavioural Science, Pam began her first road safety position with VicRoads in Victoria. She was one of the first local council Road Safety Officers in the country, taking a position with Fairfield (NSW) Council in 1994, followed by South Sydney Council. This position involved using her behavioural skills to address local road safety issues by working with local Traffic Engineers and the community.

Pam began her 14 year career as the face of NRMA Road Safety in 1996, initially in NRMA Motoring and Services as a Behavioural Scientist and later as Road Safety Manager for NRMA Insurance. Pam's skills as a media "talent" and her obvious deep knowledge of behavioural issues affecting road safety, made her a popular choice for media organisations around the country. Pam made hundreds of appearances on television, radio and in the print media on a diverse range of topics and participated in many state and national road safety initiatives.

Following a spate of child deaths and injuries in driveways, Pam was the instigator of the "Reversing Visibility" testing that was developed jointly by her and the then NRMA Insurance Research Centre. This program has helped to dispel the popular myth that lack of rearward visibility is a "4WD only" issue by showing that many modern vehicles have the potential to injure children in driveways. The program has received international recognition and led to the high awareness of the issue in Australia and New Zealand.

Pam moved to the IAG Insurance Research Centre in 2006 and became an enthusiastic contributor to the Centre's activities and was IAG's principal Road Safety representative until a need to concentrate on her medical treatment postponed her involvement in 2008.

A service was held on Thursday 28th January at Sydney's Eastern Suburbs Memorial Park and in typical Pam style, she had made a final request that everyone wear bright colours rather than black as she preferred the event to be a celebration rather than a mourning. She was farewelled by her father Geoff, brother Ken, sister Jan, partner Dave and by her workmates, friends and colleagues.

Apart from being passionate about her road safety profession, Pam was a keen advocate for the National Breast Cancer Foundation and asked that donations be made to PO Box 4126, Sydney NSW 2001.

Quarterly News

Chapter News

Australian Capital Territory and Region

Following the very successful October 2009 seminar on 'Safe Systems and Speeding', the Chapter used sponsorship from the NRMA-ACT Road Safety Trust to run advertisements in 'The Canberra Times' to publicise key messages from the seminar.

Ads on five Saturdays over the holiday period promoted community involvement in road safety, and invited readers to visit the ACRS website, and particularly the seminar information. The Chapter is planning another seminar in early 2010 and will hold its AGM in March. *(Robin Anderson, ACT and Region Chapter Representative on the ACRS Executive Committee))*

NSW (Sydney)

The final Chapter meeting for 2009 was held in December, looking at issues in relation to the new national road safety strategy for 2011 to 2020. A full report on this meeting is given on page 20.

South Australia

A cycling dialogue was held in November 2009 and four seminars are being planned for this year. *(Jeremy Woolley, South Australian Chapter Representative on the ACRS Executive)*

Victoria

A seminar is planned for mid-March on Older Road User Safety with a visitor from the USA (Elin Schol-Davis) examining the issue of choosing an appropriate safe car.

A seminar is planned for late April in which high-profile road safety professionals will present their views on road safety as it impacts upon vehicles, roads and behaviours in 20 years time. A seminar on Motorcycle Safety is being considered for June. *(David Healy, Co-Vice President and Victorian Chapter Representative on the ACRS Executive)*

Western Australia

A joint seminar with AITPM is planned for 18 February on Motorcycle Safety. *(Paul Roberts, WA Chapter Representative on the ACRS Executive)*

Australian News

Report on the Australasian College of Road Safety Conference 2009

By Linda Cooke ACRS Executive Officer

The conference facts and figures

122 delegates attended the successful national conference held 5-6 November 2009 in Perth. The conference theme was Road Safety 2020: Smart Solutions, Sustainability, Vision. The conference comprised 4 plenary sessions involving five keynote speakers and 8 concurrent break out sessions in which 28 research and practitioner papers were presented. Being timed for a week ahead of the annual Australasian Road Safety Research, Policing and Education Conference the conference attracted some overseas delegates who were heading to the Sydney conference the following week as well as delegates from every state and territory apart from the Northern Territory.

The presentation by Dr Soames Job was a popular one and is now available from the ACRS web site http://www.acrs.org.au/acrsconferences/2009roadsafety2020perth.html

The conference was the first ACRS conference to be held in Western Australia and was organised in response to a request that the conference be more accessible to road safety practitioners and researchers in the west. As a result of the work of the WA Chapter of ACRS and with support from the Community Road Safety Grants Program, which is funded by the Road Trauma Trust Fund administered by the Road Safety Council, seminar WA participants could apply for assistance to attend the conference and of the 85 WA delegates attending the conference, 19 were funded by grants.

One of the benefits of the scale of the conference was the ability for good interaction between delegates and between delegates and key note speakers and presenters. The food and friendly atmosphere also contributed to its success!

Conference proceedings

As they become available the conference proceedings will be posted to the ACRS web site http://www.acrs.org.au/acrsconferences/2009roadsafety2020perth.html. A small number of CDs of the proceedings, which were made available to conference delegates, will be posted to anyone requesting a copy. Please phone 0262902509.

Conference supporters

ACRS is extremely grateful for the generous assistance provided by its supporters. This enabled a high calibre of guest speakers and modest registration fees in the high quality venue of the five star Duxton Hotel. Our supporters were Main Roads Western Australia, the Road Safety Council of WA, the Community Road Safety Grants program funded by the Road Trauma Trust, Curtin Health Innovation Research Institute, Curtin University of Technology and the NRMA-ACT Road Safety Trust.

Media

ACRS President Lauchlan McIntosh did interviews with ABC Drive (National program), 6PR and Curtin FM. The primary motoring writer for the *West Australian* newspaper, Stephen Williams, attended the keynote and the breakout sessions on day 2 of the conference.

Looking ahead: 2010 conference in Canberra

We are seeking to work with the organisers of the Australasian Road Safety Research, Policing and Education Conference to be held at the National Convention Centre, Canberra from 31 August to 3 September 2010. We would like to be able to showcase demonstrations/case studies in the Canberra region. The aim of the demonstrations/case studies would be a focus on the translation aspect which follows research to practice as advocated by Dr David Sleet in his very well regarded presentation to our Perth conference . As he said, solutions will depend on successfully applying theory-driven approaches to improve traffic and transportation safety. This is one of the main objectives of the College and your contribution to its success is vital. Any case studies you can suggest which demonstrate successful achievement of that aim would be most welcome.

ACRS Sponsors Poster Award

This year, the Australasian College of Road Safety was pleased to sponsor the 2009 Practitioners Award for Best Poster at the Australasian Road Safety Research, Policing and Education Conference. Held annually, this conference is the pre-eminent conference for road safety researchers and practitioners and attracted over 500 delegates at this year's event.

Designed to recognise poster research which best reflects a completed road safety program or campaign that both tackles a road safety area of significant importance and shows originality in development and delivery, the award also supports research that demonstrates links between the identified need for the program, and the development and evaluation of the delivered program.

Professor Barry Watson, co-Vice President of the College, was pleased to present the winners certificate and prize to Dr Lisa Buckley, from the Centre for Accident Research and Road Safety – Queensland (CARRS-Q) for her poster research titled Looking Out for Friends as an Intervention Strategy for Young Adults' Risky Driving.

Co-authored by Rebekah Chapman and Professor Mary Sheehan, also of CARRS-Q, this research poster was drawn from a research paper with the aim of conducting a systematic review on intervening in risky driving behaviour including the situations in which it is likely or unlikely to occur, factors associated with individuals who might or report having intervened and any evaluated programs that make use of such strategies.

In addition a study was conducted with 247 first year university students (32% males) to examine whether young adults report engaging in protective behaviour with their peers in South-east Queensland. In particular, if they intervene if their friends are about to drive after drinking, drive after taking illicit drugs or when speeding. It examines any differences in reported likelihood of discouraging such illegal and dangerous behaviour (in the past 12 months prior to the survey).

Findings showed that young adults (17-25 years) did indeed report protective behaviour in relation to friends' drink driving, drug driving, speeding and binge drinking with conclusions drawn regarding important considerations in developing positive strategies and advertising campaigns that encourage positive behaviours (e.g. 'don't let mates drink and drive').

The College was delighted to be associated with the sponsorship of this poster prize, and look forward to further collaboration with the Conference in the future.

Further information on both the winning poster, and full research paper the poster information was drawn from, can be found at *http://eprints.qut.edu.au/28674/*.

Joint Research on Level Crossing Safety

The Cooperative Research Centre (CRC) for Rail Innovation and the CRC for Advanced Automotive Technology (AutoCRC) have signed a Memorandum of Understanding (MOU) in relation to Australian road-rail research. The MOU will facilitate collaborative research activities in the area of road and rail technology, particularly in relation to level crossings. A project from AutoCRC, *Intelligent Transport Systems (ITS) to Improve Safety and another from the CRC for Rail Innovation, Integrating Driver and Traffic Simulation to Assess In-vehicle and Road-based Level Crossing Safety Interventions,* have been identified as the initial projects of mutual interest.

(Source: Jennifer Perry at *www.railexpress.com.au* 2 Dec 09)

Changes to child restraint laws

Over the next year, new standard child restraint laws are being introduced in all States/Territories. Children under 6 months must use an approved rearward facing restraint such as a baby capsule. Children between 6 months and 4 years must use an approved rearward-facing or forward-facing child restraint. Children aged from 4 to 7 years must use an approved forward-facing restraint or an approved booster seat that is properly positioned and fastened.

There are also new laws for children's seating location in a vehicle. If a car has two or more rows of seats, children under 4 years must not be seated in the front, and children between 4 and 7 years may not be seated in the front unless all other seats are being used by children under 7.

The State/Territory laws are scheduled to come into effect as follows:

- Victoria– 9 November 2009
- New South Wales– 1 March 2010
- Queensland– 11 March 2010
- ACT – 15 March 2010
- Western Australia– March 2010
- Tasmania– 30 November 2009, and further laws 30 November 2010
- South Australia– mid-2010
- Northern Territory– early to mid-2010

Drivers will be fined and incur demerit points if passengers under 7 years are not wearing an approved child restraint that meets the requirements of the Australian/New Zealand Standard 1754:2004. *(Source: http://www.kidspot.com.au/School-Eat-Changes-to-child-restraint-laws+2210+35+article.htm)*

Queensland's 2010-11 Action Plan

The Queensland Government has embarked on one of the most stringent and coordinated road safety campaigns in the State's history. New types of speed cameras and measures for an unprecedented drink driving crackdown are included in the new safe4life Road Safety Action Plan 2010-2011. A copy of the plan is at *www.transport.qld.gov.au/.../Pdf_road_safety_action_plan_2010_2011_web.pdf.*

The Government's plan focuses on 51 specific actions covering safe roads and roadsides, safe vehicles, safe speeds, safe road users and enhanced delivery. Among the actions emphasised by the Premier in launching the report were:

- A system of alcohol ignition interlock devices for drink drivers
- The introduction of point-to-point camera systems for the first time in Queensland
- The introduction of special digital cameras that capture speed and red light non-compliance

- Up to 30 per cent of mobile speed camera enforcement using covert vehicles

Alcohol interlock devices will be mandatory for offenders convicted of driving with a blood alcohol content of 0.15 or more, failing to provide a specimen of breath or blood, with two or more drink driving offences in five years, or convicted of operating a motor vehicle dangerously while under the influence. International research indicates that re-offences can be reduced by up to 73 per cent when alcohol interlockers are used.

Existing red light cameras will be replaced with digital cameras that have the ability to detect speed and whether the motorist has broken the red light. An estimated 30 per cent of mobile speed cameras would now be used in covert vehicles in a variety of models, makes and colours.

(Source: http://www.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=67853)

Roundabout confusion increases insurance claims

According to RACT Insurance, Tasmanian motorists are increasingly finding roundabouts confusing. Insurance claims for crashes occurring when drivers are approaching or in roundabouts has increased by 40 per cent in the last three years, compared to the previous three years. The three most common problems are cars being rear ended when slowing or stopping on the approach to a roundabout, crashes when vehicles entering the roundabout fail to give way to traffic already in the roundabout, and crashes on multi-lane roundabouts where vehicles change lanes.

The average cost of repair for a crash occurring when a vehicle is approaching or in a roundabout is over $2,000. New national road rules recently introduced include a requirement that before entering a roundabout, a driver must give a change of direction signal long enough to warn other drivers and pedestrians.

(Source: http://www.ract.com.au/news_and_issues/press_releases/press_release/19477)

Calls for hardline measures in Victoria

Following the crash that killed five young people in Mill Park, Victoria, a number of suggestions have been put forward for road safety reform. Premier John Brumby indicated that the State Government would consider measures such as crushing or selling the cars of hoon drivers, while Police Deputy Commissioner Ken Lay suggested that some people should not be allowed to drive. Lay said that, based on research findings, young people who suffered from limited attention span, poor school behaviour, hyperactivity or a propensity for crime were more likely to cause harm on the roads. He said that the police needed to collaborate with health professionals, academics and others to identify such young people before they started driving.

The RACV's general manager of public policy, Brian Negus, echoed these concerns, saying that 'we need to get into the minds of people who decide to take risks'. The RACV has joined with the Department of Health and Shire of Melton to carry out a long-term research study of dysfunctional behaviour in children aged 8 to 13, as this can later translate into dysfunctional behaviour while driving.

Professor John Reid, from Monash University's School of Psychology, Psychiatry and Psychological Medicine, has suggested using brain imaging technology to identify persons likely to cause danger to themselves and others while driving. Melbourne University Professor of Psychology, Nick Allen, has noted that it is difficult to identify such people with any precision.

(Source: Julie Szego, The Age, 21 January 2010, http://www.theage.com.au/national/the-need-for-speed-20100120-mlsj.html)

Driving drives unacceptable behaviours

The Transport Accident Commission Victoria has released key findings of a survey that looked at how driving behaviours compare to other non-driving behaviours in terms of their social unacceptability. "Of the 10 most unacceptable behaviours, six relate to driving, highlighting the impact of public education campaigns about various driving behaviours," said TAC Acting Chief Executive Officer Philip Reed. The survey sample, which was representative of the Victorian community, included 1,500 respondents aged between 18 and 60 years. Key findings of the survey included:

* Driving with a BAC of 0.10 (ranked #1) and driving under the influence of ecstasy (ranked # 2) are considered as socially unacceptable as violence against women (ranked #4) and gambling (ranked #5).
* Driving under the influence of ecstasy (ranked #2) and marijuana (ranked #7) are considered more socially unacceptable then selling marijuana (ranked #10), taking ecstasy before going to a dance party (ranked #16) and smoking marijuana in your own home (ranked #39).
* Driving while talking on a handheld mobile (ranked #28), tailgating (ranked #27) and sending a text message while driving (ranked #23) are considered more socially unacceptable then exceeding the speed limit by 10 km/h in a 40 km/h zone (ranked #36), 60 km/h zone (ranked #34) or 100 km/h zone (ranked #41). For all speeding behaviours, the degree of social unacceptability increases with age.

"When it comes to speeding, this survey shows that there is still a way to go before we reach the same levels of social unacceptability that we see with drink driving and drug driving," Mr Reed said.

(Source: http://www.tac.vic.gov.au/jsp/content/NavigationController.do?areaID=23&tierID=1&navID=63CC12CD7F00000101A5D19311EC6AC2&navLink=null&pageID=1926)

Grain and grape harvest warnings

The South Australian Government warned road users to take extra care over the summer months, with a significant increase of heavy vehicles expected during this season's grain and grape harvests. The Department for Transport, Energy and Infrastructure's General Manager Transport Safety Regulation, Trent Rusby, said there was the potential for a significant increase in truck movements on South Australian roads this harvest, in addition to the traditional increase in traffic over the summer months. "Because we're looking at a 70 to 80 per cent increase in yield from last year's harvest, it's likely more trucks will be on our roads," Mr Rusby said. "Heavy vehicle movements will continue on the roads until the end of the grain and grape harvest season." "The State Government has joined forces with SAPOL, the trucking industry, pastoralists and businesses to ensure the road is safe for all road users during this year's grain harvest," he said. "This year we have been focusing on educating heavy vehicle drivers and their employers about fatigue and their responsibilities, both to themselves and to other road users."

(Source:http://webapps.transportsa.com.au/news/templates/news_template.aspx?articleid=1183&zoneid=1)

Key highway link upgraded

A major upgrade of the Victoria Highway between Western Australia and the Northern Territory was opened recently. The $50 million upgrade will help prevent the national road link being closed during wet season flooding. The Victoria Highway is a key link in the Perth to Darwin corridor for tourism, defence, mining, cattle and transport industries. The project delivered four new higher-level bridges and raised 7.5 kilometres of road to make the highway more reliable in the wet season. Historically, these sections of the road have closed on average for five days due to flooding, and extreme rainfalls have caused the road to close for weeks at a time. With the upgrade, average closure times are expected to be reduced to less than eight hours rather than weeks during extreme rainfall. *(Source: http://newsroom.nt.gov.au/index.cfm?fuseaction=viewRelease&id=6398&d=5)*

DVD to help manage whiplash

New South Wales Minister for Finance, Michael Daley, has encouraged people involved in car accidents to use a new educational DVD designed to help them with whiplash. The free DVD was produced by the Motor Accidents Authority (MAA) to help people recover more quickly. "Whiplash is the most common injury from crashes on our roads, affecting more than 5,000 people in NSW each year and is a factor in around 45 per cent of all motor accident claims. Apart from causing pain for the sufferer, treating whiplash injuries costs the Compulsory Third Party (CTP) scheme over $140 million each year," he said. The DVD is intended for anyone who suffers a whiplash injury, as well as for health professionals who treat patients with whiplash. The DVD provides information about managing whiplash, options for treatment and exercises for people to use at their convenience. It can be viewed at www.maa.nsw.gov.au.
(Source:http://www.maa.nsw.gov.au/default.aspx?MenuID=357)

Socio-economic strength and road safety

Queensland has one of the worst records for road fatalities in Australia (7.6 for every 100,000 residents in 2008), but researchers have suggested that this may be a partial function of the State's socio-economic strength. Mark King, from Queensland University of Technology's Centre for Accident Research and Road Safety, found that when the road toll was going up in Australia in 2006-07, it was going up the most in Queensland and Western Australia, where there was a very strong resources sector. This increase may be related to more companies doing well and more people being employed, which means that more goods are being bought and moved around.

Max Cameron, of Victoria's Monash University Accident Research Centre, said that Queensland's population growth – approaching 3 per cent a year – compounded its plight. He noted that underlying the number of road fatalities are population, amount of travel and economic prosperity.

(Source: Matthew Fynes-Clinton, Brisbane Courier Mail, 4 January 2010, http://www.news.com.au/couriermail/story/0,,26549776-5011340,00.html)

New Zealand News

Safety code for cyclists

The NZ Transport Agency (NZTA) has launched a new and completely free resource to help cyclists keep safe on the roads. The official New Zealand code for cyclists can be downloaded free at http://www.nzta.govt.nz/resources/roadcode/index.html. The new code for cyclists is a user-friendly guide to New Zealand's traffic law as it relates to cyclists. It also includes lots of useful information on safe cycling practices. The code is particularly useful for people who are just learning to cycle or are teaching someone else to ride. More experienced cyclists can also take advantage of the code to brush up on their knowledge of the road rules and safe cycling practices.

The new code includes sections on:

* Learning to cycle
* Road rules
* Signs
* Tips for cycling defensively
* How to do 'hook turns' and use roundabouts
* Checking and maintaining your bike.

Because the number of cyclists on NZ roads is increasing, it is vital that they understand the rules that apply to them and learn how to share the road safely with other vehicles. The new code is part of a suite of resources being developed by the NZTA, which includes new cyclist training guidelines available at www.nzta.govt.nz/resources/cyclist-skills-training-guide and a national cyclist skills training qualification for bicycle instructors, currently under development.

(Source: http://www.nzta.govt.nz/about/media/releases/506/news.html)

European News

EU Urged to Adopt Serious Injuries Reduction Targets

The European Transport Safety Council has urged the European Union to give more consideration in setting road safety targets to reducing series injuries in road crashes, rather than concentrating only on reducing road deaths. In addition to the 39,000 people killed annually in road crashes in the EU, about 1,700,000 people are recorded as injured in police reports, among them 300,000 that are considered to be serious. In other words, for every road death in the EU, at least 44 road injuries are recorded, of which eight are serious. Although the definition of a serious injury varies between difference nations, a large number of EU countries consider an injury to be serious if the person has to spend at least one night in hospital.

(Source: ETSC Media Release 12 Nov 09)

UK Campaign for Lower Residential Speeds

A community-based campaign is underway for 20 mph (32 kph) to be the default speed limit on all residential roads in the UK. The rationale claimed for this is that:

- More than half the road deaths and serious injuries occur on residential roads, where the current speed limit is 30 mph (48 kph);
- Britain has the highest percentage of pedestrian road fatalities in Europe 20%;
- Britain has one of the lowest levels of children walking or cycling to school in Europe;
- Speed limits on Britain's urban roads are 60% higher than Europe; (30 mph compared to 18.5 mph);
- British parents consistently cite traffic speed as the main reason why their children are not allowed to cycle or walk to school;
- Lowering urban and residential speed limits to 20 mph has been found to increase a 15 minutes car journey by just 60 seconds;
- Lowering urban and residential speed limits to 20 mph has been found to decrease child pedestrian accidents by 70%;
- Recent DfT Guidelines have relaxed the requirements for 20 mph limits in residential areas. It is no longer mandatory to impose physical measures such as speed bumps (thus reducing the cost of introducing 20 mph limits).

(Source: www.20splentyforus.org.uk)

UK Approves New Average Speed Enforcement System

The Home Office has just approved a new 'distributed average speed' camera system, which makes it possible to calculate the average speed of a vehicle across an entire area rather than a single section of road. A network of Automatic Number Plate Recognition (ANPR) cameras send encrypted number plate information to a central station over a public communications network, with each camera able to work as an entry or an exit point. When a vehicle is located at two positions in a shorter time than it would take to travel at the posted speed limit, an offence file is created with images from the entry and exit cameras. Distributed average speed systems will eventually be spread across the road network. *(Source: ETSC Speed Monitor November 09)*

European Commission Road Safety Action for 2011-2020

On 2 December 2009 the European Commission held a Road Safety Action Programme Conference as the official close to public consultation on the next European Road Safety Action Programme 2011 – 2020. The program had two main focuses: the safety of vehicles and infrastructure (including motorcycles, vehicles of the future, climate change and infrastructure adjusted to all road users) and the European citizen's role in road safety (including road victims, professional drivers, public authorities, traffic police and doctors). *(Source: http://ec.europa.eu/transport/road_safety/events/2009_12_02_ersap_conference_en.htm.)*

Progress on EU Alcohol Strategy

The European Union Directorate General for Health and Consumers has issued its First Progress Report on the Implementation of the EU Alcohol Strategy. The strategy was adopted by the European Commission in 2006. Section 3.2.3 of the report addresses progress in relation to drink-driving. The number of Member States reporting drink-driving awareness-raising activities has almost doubled since 2006, and almost all are implementing national campaigns. All but three Member States now enforce a BAC level of 0.5 g/l, and approximately half have set a 0.2 g/l or zero BAC level for inexperienced drivers or selected categories of professional drivers.

Random breath testing has become more widespread, with positive results. For example, in Ireland between 2006 (when RBT was introduced) and 2008, there was a 25% decrease in road fatalities. Other measures to prevent drink-driving include restrictions on the sale of alcoholic beverages in petrol stations, and the introduction of alcolocks by about one-third of Member States for commercial or public service transport, or as a component in rehabilitation programmes.

(Source: First Progress Report on the Implementation of the EU Alcohol Strategy, (http://ec.europa.eu/health/ph_determinants/life_style/alcohol/documents/alcohol_progress.pdf)

Creating Sustainable Roads

The European Union Road Federation (ERF) and the International Road Federation (IRF) – Brussels Programme Centre have recently released their discussion paper, Sustainable Roads and Optimal Mobility. The paper defines sustainable roads as 'effectively and efficiently planned, designed, built, operated, upgraded and preserved roads by means of integrated policies respecting the environment and still providing the expected socio-economic services in terms of mobility and safety.'

The paper evaluates the impact of having sustainable roads; illustrates some best practices with respect to road planning and design, and road construction, operation and preservation; and assesses whether financing sustainable roads is a luxury or a necessity. Among its recommendations are the development of a common approach for sustainable roads between European institutions and road stakeholders, communicating a new approach based on the criteria of performance, promoting and expanding the EU's research activity aimed at reducing the environmental impact and stimulating the socio-economic benefits of roads; and informing European citizens about the sustainable road infrastructure improvements achieved so far.

(Source: http://www.irfnet.eu/media/wg_sustainableroads/SUSTAINABLE%20ROADS_Final%20Version_Version%20to%20Print.pdf or www.erf.be/section/positionspapers)

North American News

Seniors 'self test' for safe driving now online

The American Automobile Association has recently developed a screening tool http://roadwiseonline.org/AAARoadwisePlayer.exe to help seniors measure mental and physical abilities important for safe driving. It is called Roadwise Review Online and it is available free of charge on the AAA Foundation for Traffic Safety's Senior Drivers website. Using the self test takes about 30 minutes, and the results enable seniors to identify and seek guidance on physical and mental skills needing improvement. The test is available at *http://www.seniordrivers.org/driving/driving.cfm?button=roadwiseonline.*

Anti-skidding technology for Canada

Canada's Transport Minister has announced that from 31 August 2011, auto manufacturers must install Electronic Stability Control (ESC) in Canadian vehicles to help drivers maintain control and avoid collisions. This technology automatically applies braking when a vehicle is skidding and may also cut engine power.

ESC helps drivers control their vehicle in emergency manoeuvres (such as swerving or braking to avoid an obstacle) and in turning corners on slippery surfaces. Transport Canada data show that vehicles with ESC are involved in fewer major collisions caused by loss of control, corresponding to significantly fewer deaths and injuries.

The new standard will apply to passenger cars, multi-purpose vehicles, trucks and buses weighing 4,536 kilograms or less. The timeline for installation in Canada coincides with the United States timeline.

(Source: Transport Canada media release No H 177/09, http://www.tc.gc.ca/eng/mediaroom/releases-2009-h177e-5771.htm)

Asian News

Launch of Road Safety Year 2010 in Thailand

The Thai Government has designated 2010 as the year for road safety in an effort to reduce road accidents and ensure public safety. The objective is to decrease the number of road accidents by 50 percent within the next 10 years.

Prime Minister Abhisit Vejjajiva cited a study by the Asian Development Bank, which showed that Thailand faced a higher death toll than its ASEAN partners. A study by the Prince of Songkla University indicated that traffic fatalities caused about 200 billion baht in economic loss in a year, or about 3 percent of the country's GDP.

In September 2009, the Thai Government approved the Master Plan on Road Safety, 2009-2012. The master plan consists of several strategies, which focus on safe systems, safety culture, and ultimate outcome.

Prime Minister Abhisit said that the Government had allocated an additional fund of three billion baht under the Thailand: Investing from Strength to Strength program for the Department of Highways. The fund will be used to improve various roads across the country to ensure public safety and reduce casualties.

(Source: http://thailand.prd.go.th/view_inside.php?id=4663)

Singapore's Heavy Vehicle Road Safety Campaign

'Think Safety, Drive Safely' was the theme of Singapore's Heavy Vehicle Road Safety Campaign in 2009. The campaign was a collaborative effort of the Traffic Police and sponsor SOXAL. This campaign, combined with the Traffic Police's approach towards heavy vehicle road safety, has proved successful. In the first nine months of 2009, the number of fatal accidents was 124, compared to 161 in the same period of 2008. Similarly, the number of persons killed in accidents was 133, compared to 169.

SOXAL has a fleet of 100 heavy vehicles; this provided a strong incentive to promote road safety, which leads ultimately to more efficient deliveries. In addition to its partnership with the Traffic Police, SOXAL has held a series of in-house competitions to select the safest driver. This has resulted in a decrease among SOXAL drivers from 10.7 road incidents per million km travelled in 2008 to 5.8 road incidents per million km travelled in 2009.

(Source : http://www.soxal.com/en/local-news/local-news-1/soxal-heavy-vehicle-road-safety-campaign-2009.html)

Contributed Articles

Please note that the May edition of the Journal will have a special emphasis on Roads. Members are invited to contribute articles on various aspects of road safety in relation to roads (closing date 22 April 2010).

The following article was prepared for the Special November 2009 Edition of the Journal on 'Motorcycle and Scooter Safety', but due to a production error was only published in part. The Editor apologises for the error, and is providing the full article below.

A New Strategic Approach to Advance Motorcycle Safety And Mobility In Victoria

By Nicola Fotheringham, VicRoads

Abstract

Victoria recently released a new strategic action plan for Victoria's motorcycle and scooter riders. As part of its ongoing commitment to improving rider safety, Victoria already had a significant number and range of motorcycle safety projects currently being developed or delivered. The plan provides a new strategic focus as well as identifying a comprehensive set of actions aimed at improving both road safety and mobility for riders. Key focus areas within the plan include research and evaluation, the road network and environment, rider and pillion passenger safety, and vehicle safety and protective clothing. This paper provides an overview of the key safety actions identified in the plan and some of the projects in motion to address them.

Introduction

In August 2009, Minister for Roads and Ports Tim Pallas MP launched a new strategic action plan for Victorian motorcycle and scooter riders, *Victoria's Road Safety and Transport Strategic Action Plan for Powered Two Wheelers 2009-2013.* The plan integrates both the road safety and mobility needs of riders and is the first of its kind for an Australian State Government. The plan recognises the role of motorcycles and scooters in Victoria's transport future. Its objectives are twofold: aiming to significantly reduce serious casualties to riders and pillion passengers and ensure that powered two wheelers (PTWs) are given appropriate recognition in transport and road use policy and planning.

Background

Since 2002, *the Victorian Motorcycle Road Safety Strategy 2002 – 2007* guided the direction of motorcycle safety in Victoria. Over the life of the previous strategy, considerable gains in motorcycle safety were achieved. These contributed to a 20 per cent reduction in motorcyclist fatalities in Victoria at the same time as motorcycle registrations increased by 41 per cent.

Alongside targeted enforcement activities and the introduction of a Learner Approved Motorcycle Scheme, some of the recent achievements and completed projects in Victoria have included:

- *Motorcycle Blackspot Program.* Over 120 motorcycle blackspot sites and popular riding routes have now been treated under the Motorcycle Blackspot Program. Evaluation of the program showed a 24 per cent reduction in motorcycle casualty crashes at 85 sites treated since the program's inception. At a more detailed level of analysis, the evaluation showed a 40 per cent reduction in motorcycle casualty crashes at 54 treated blacklength sites.
- *Role of speed and speeding in motorcycle crashes.* This project improved our understanding of the role speed plays in motorcycle crashes. The project examined the separate role of inappropriate and excessive motorcycle speed on fatal motorcycle crashes, and identified rider, vehicle and environmental factors associated with fatal crashes involving excessive and inappropriate speeding.
- *Involvement of scooters in crashes.* This project improved our understanding of the involvement of the motor scooters in crashes and identified the types of crashes scooter are commonly involved in. The findings indicated that scooter crashes are increasing at a faster rate than that for motorcycles or cars, and that this increase is likely to be due to a proportionate increase in scooter use.
- *Motorcycle exposure study.* Measures of exposure to risk such as number of licences on issue or kilometres travelled do not necessarily represent the most accurate estimate of exposure for motorcyclists. The study collected and examined information on some of the more commonly travelled roads in Victoria, trip purpose and time of day, and key characteristics of different rider groups to provide enhanced information on the current exposure of motorcyclists in Victoria.

- *Motorcycle Enhanced Crash Investigation*. This project involved in-depth investigations of 25 serious motorcycle injury crashes and was aimed at increasing the understanding among road safety stakeholders, riders and emergency services professionals of the causes and outcomes of motorcycle crashes, as well as to identify issues requiring further action.
- *Look, look, look again campaign*. This campaign involved the adaptation of a UK commercial aimed at promoting the importance of drivers looking out for motorcyclists at intersections. The television commercial was supported by radio, billboards and online media.

Victoria's Road Safety and Transport Strategic Action Plan for Powered Two Wheelers

The new strategic action plan was developed with input from government agencies including VicRoads, the Transport Accident Commission, Victoria Police, Department of Transport, Department of Justice and Environment Protection Authority as well as members of the Victorian Motorcycle Advisory Council.

The plan is aligned *with Victoria's Road Safety Strategy: arrive alive 2008-2017*. Like *arrive alive*, the plan takes a Safe System approach to road safety, recognising the need to focus on safer vehicles, roads and road users.

The plan is also aligned with the *Victorian Transport Plan* which provides a strategic approach to the management and development of the State's transport system. The PTW plan recognises the growth of motorcycle and scooter riders in Victoria and identifies initiatives and actions that will support greater consideration in transport policy and planning.

The plan will assist Victoria to meet the targets and objectives identified in both of these overarching strategies.

The plan focuses on four key areas: increasing knowledge and understanding, PTWs in the transport network, rider and pillion passenger safety, and safer PTWs and rider equipment. The plan identifies 49 actions, in addition to the 17 actions identified in *arrive alive Victoria's Road Safety Strategy: First Action Plan 2008-2010*.

This paper is structured under the same focus areas as the PTW plan, providing an outline of the key actions as well as some of the current projects addressing rider safety and mobility in Victoria.

1. Increasing knowledge and understanding

There continues to be a need to improve our knowledge and understanding of motorcycle crashes. Effective research and evaluation of initiatives is identified as a guiding principle for the plan. Research and evaluation underlies many of the actions identified throughout the plan. This knowledge is invaluable for planning and policy development as well as the development of safety and mobility countermeasures.

Actions in the plan include improving the quality of data, increasing information exchange, disseminating research findings and developing a coordinated program of research projects.

2. PTWs in the transport network

One of the major focuses of work over the past seven years in Victoria has been the Motorcycle Blackspot Program. Evaluations of the program have clearly demonstrated that improvements at motorcycle blackspots and popular riding routes can have a significant impact on rider safety at these sites.

Whilst there has been a significant focus on improving the roads for motorcyclists, limited consideration to date has been given to the role of powered two wheelers within an integrated transport network. The new plan identifies numerous actions that will be undertaken to address this.

One of these actions is research into the road safety and mobility impacts of road space management opportunities for motorcyclists. This includes the feasibility of initiatives such as allowing motorcycles in bus and transit lanes or to use advanced stop lines. These initiatives may provide benefits to an integrated transport system. However, the overall road safety impact of these potential initiatives needs to be better understood before any initiatives can be trialled. The research will involve reviewing current literature and consideration of their applicability to the Victorian environment as well as stakeholder engagement. It will result in the development of an assessment framework that will enable potential initiatives to be evaluated and compared.

VicRoads is also currently working with those involved in the maintenance, design and construction of the road environment to increase their awareness of the specific needs of motorcycle riders. Road authorities, utility providers, local governments and contractors all have responsibilities to ensure that their on-road work is undertaken in a way that takes into account the safety needs of motorcyclists. *Making Roads Motorcycle Friendly* is a package of training materials that has been developed and is currently being delivered to workers involved in road maintenance, design and construction to increase their awareness of the specific safety needs of motorcyclists.

3. Rider and pillion passenger safety

The safety of riders can be addressed through a range of measures focussed on both the rider and other road users. The plan addresses key issues such as rider responsibility, the responsibility of other road users, rider skills and knowledge, rider licensing, enforcement, and post-crash management.

Rider responsibility and the responsibility of other road users

The Transport Accident Commission continues to implement key initiatives targeting rider and driver behaviour. These include improving rider awareness of the risks associated with riding, educating riders of the importance of wearing protective clothing, and educating drivers of the need to look out for motorcyclists.

Under the PTW plan, motorcycle and protective clothing retailers will be engaged to develop and implement a code of conduct aimed at encouraging buyers to choose appropriate vehicles, and purchase protective clothing.

Rider skills and knowledge

Two key projects focussed on improving the skills and knowledge of novice and returning riders are currently being undertaken.

The assisted rides project involves the:

- development of an on-road program for novice riders based on best practice and adult learning theory
- delivery of the program to 2,000 novice riders
- evaluation of the impact of the program over a 12 month period.

The project is one of the first of its kind to evaluate the impact of an on-road rider assistance program conducted on such a large scale. It offers an exciting opportunity to better understand the impact of an on-road coaching program on novice rider safety.

The returning rider project involves the development of a training program targeted at those returning to riding after a break. The first stage of this project involves identification of the skill, knowledge and attitudes of returning riders that need to be addressed. This will then guide the development and piloting of a targeted training program.

Once complete, both of these projects are expected to have a significant impact on the future approach to rider training in Victoria.

Rider licensing

The licensing system plays an important role in the preparation of novice riders before they gain access to the road network, and as they gain experience riding on our roads. There is great potential to strengthen the graduated licensing system for motorcyclists and scooter riders and make it more consistent with the current system for novice drivers in Victoria.

Work conducted to date has included reviewing literature on graduated licensing for motorcyclists, analysis of crash data, and stakeholder workshops and focus groups to identify potential improvements to the licensing system. The next stages of this work will be the development and implementation of improvements to current motorcycle licensing policies and practices that are focussed on improving novice rider safety.

Enforcement

Enforcement activities play an important role in improving road safety for all road users. The Victoria Police continue to provide targeted enforcement for all road users.

One of the new enforcement initiatives that recently commenced is the Community Policing and Education Project. The project is unique in that it has a major educational focus to target all road users whose on-road behaviours put motorcyclists at risk. The project objectives are to reduce the incidence, severity and trauma of motorcycle crashes in Victoria through education of both riders and drivers combined with enforcement to act as a deterrent to those motorcyclists and drivers who exhibit high risk behaviours that jeopardise motorcyclist safety.

4. Safer PTWs and rider equipment

Safer PTWs

As motorcycle manufacturers develop and refine safety features such as antilock braking systems (ABS), integrated braking systems and traction control, consumers need to be kept well informed of the safety benefits of these technologies and the barriers to their uptake well understood. In addition, manufacturers need to be encouraged to increase the availability of these technologies in the Australian market and encourage consumers to purchase safer vehicles.

The actions identified within the plan are aimed at engaging riders and the motorcycle industry to increase the number of motorcycles sold and ridden in Victoria with features such as ABS. Engaging riders and the motorcycle industry to encourage these changes around the safety of motorcycles and scooters will form a critical component of the plan's implementation and its resulting success.

Safer rider and pillion passenger clothing

As initiatives such as airbags for riders built into riding jackets and motorcycles are developed and refined, and a wide range of protective clothing products become available on the market, consumers can find it difficult to know which products offer the highest level of protection in a crash. Promotion of the use of protective clothing has and will remain a key focus.

The concept of a star rating for motorcycle protective clothing shows promise. This would provide riders with an objective assessment of the protective qualities of different products that they may be considering buying. Discussions will continue with stakeholders including riders, industry and governments across Australia to further the development of a star rating system.

Summary

Victoria's Road Safety and Transport Strategic Action Plan for Powered Two Wheelers 2009-2013 provides a strategic and comprehensive approach to improving rider safety and mobility in Victoria. Some of the key actions and projects that are currently being delivered have been identified in this paper. A partnership between the agencies and departments involved in its delivery, the Victorian Motorcycle Advisory Council, motorcycle industry, rider clubs and associations as well as local government will be critical to the successful implementation of the plan.

Further information on the strategic action plan can be found at www.vicroads.vic.gov.au/ptwplan

Report on Moscow Road Safety Conference

By Lauchlan McIntosh, Chairman ANCAP Australasia Ltd, and President Australasian College of Road Safety

This is a summary of an address given by Mr McIntosh at a Seminar ***Crunch Time - National Road Safety Strategy towards 2020*** *held at the George Institute for International Health, Level 7, 341 George Street, Sydney on 9 December 2009, following his attendance at the First Global Ministerial Conference on Road Safety. 19-20 November 2009, Moscow, Russia. (Mr McIntosh attended the Moscow conference by invitation from the Russian Federation)*

Plenary session at the Moscow conference.

Proposal for a 'Decade of Action'

In November 2009, Ministers and senior officials from 160 countries met in Moscow and agreed to propose to the UN General Assembly that a Decade of Action for Road Safety be declared early next year.

The aim of the proposal is to save 5 million lives in the decade as well as save 50 million from being maimed or seriously injured in road crashes. This was a real target, and agreed as possible.

Ministers and Secretaries of State from countries such as the USA, UK, Sweden, Switzerland, Italy, Russia, Brazil, South Africa, Mexico, Chile, Malaysia, Vietnam, Indonesia, Cameroon, Morocco, Ghana and Uganda to name a few, as well as senior officials from the World Bank, OECD, the WHO, and companies such as Michelin, Shell, IRF and a range of NGO's attended.

Australia was thanked for providing financial support for the conference, but it was disappointing that the other mention of Australia was that our previous good ranking in the road safety performance tables had fallen in recent years.

Australia has a target to reduce our road crash fatality rate by 40% in this current decade (ending this year). Surprisingly Australian State and Federal Ministers a decade ago watered down a target from a recommended 50% to 40%. Given the current political demands for long term target setting over carbon emissions it is interesting that no one in the community and certainly none of their representatives in the State and Federal Parliaments appear to have noticed our failure to meet road safety targets this decade.

Since January 2001 over 14,000 people have lost their lives in Australia in road crashes; that is 1300 lives above the watered down target. This generated an additional cost to Australia of around $15bn or $1.5bn every year this decade. That is the additional cost! The dollars are terrible but of course the tragedy of this additional trauma is even worse.

The Conference in Moscow was something of a standard international "high level meeting". A plenary session with over 20 individual Ministerial presentations led by Russian President

Dmitry Medvedev and a series of panel sessions on partnerships, policy, health sector contributions, safe road users, safe road infrastructure, safe vehicles, improving data; where around 40 different speakers outlined solutions.

An International Tragedy

The overall picture drawn to the 1500 delegates from around the world (including three from Australia) was of the relatively unnoticed international tragedy with 1.3 million deaths and millions of injuries per annum from road crashes. Passionate ministers emphasised the tragedy is rapidly increasing; currently road crashes are the largest cause of premature death for young people and described by many as an epidemic. The costs to GDP were recognised at 2-4 % in many countries (equivalent or higher than the current Global Financial Crisis) and that 50% of trauma beds in hospitals are filled with road crash victims.

Many speakers said that unlike the climate change issue, road safety solutions are predictable. We understand and agree on the problems, and the antidotes and solutions are well known. The call for a Decade of International Action on Road Safety to reduce fatalities by 5 million began with identification of the seriousness of the problem over a decade ago and over that time many governments, agencies and specialists had worked to build workable solutions.

There were offers of financial support for improving road safety in developing countries; the Bloomberg Foundation has offered $US125m to help road safety programs in 10 countries. The Secretary of State for Transport in the USA said that the US House of Representatives had already agreed to support the call for the Decade of Action.

Australia has yet to decide what it will do. Australia has a tradition of taking positive steps internationally in a range of policy areas, and we have a history of political leaders offering policy leadership positions based on our own particular experiences.

The Moscow meeting was a watershed in bring together senior world leaders who not only recognised the need to reduce unnecessary road trauma in the developing world, but who could see that working together could help reduce road trauma in all countries.

The ACRS President, Lauchlan McIntosh with Mr. Hiroshi Goto from the National Association for Victims Aid in Tokyo (who run Japan NCAP) and Professor Claes Tingvale, the Chairman of EuroNCAP at the Moscow Conference

Australia will be asked to support the Moscow Declaration for a Decade of Action for Road Safety in March 2009. Our community should demand that our politicians become as passionate as some of the Ministers in Moscow. We need to encourage them to take the leadership role both in the developing world and in Australia. We need in Australia an independent review of why we have failed our road safety targets, we need to know why some States have better results than others, and we need to be committed to all working together to really make a difference. No one should die or be injured unnecessarily in road crashes.

Recent Progress in Implementing the Safe System Approach

By Blair Turner, Peter Cairney, Chris Jurewicz & David McTiernan ARRB

The Safe System Vision

The Safe System approach has now been adopted by each jurisdiction within Australia, and is likely to be at the core of the new national road safety strategy.

Based primarily on the Swedish ‘Vision Zero’, and the Dutch ‘Sustainable Safety’ approaches, the Safe System approach recognises that humans as road users are fallible and will make mistakes. There are also limits to the kinetic energy exchange which humans can tolerate (e.g. during the rapid deceleration associated with a crash) before serious injury or death occurs.

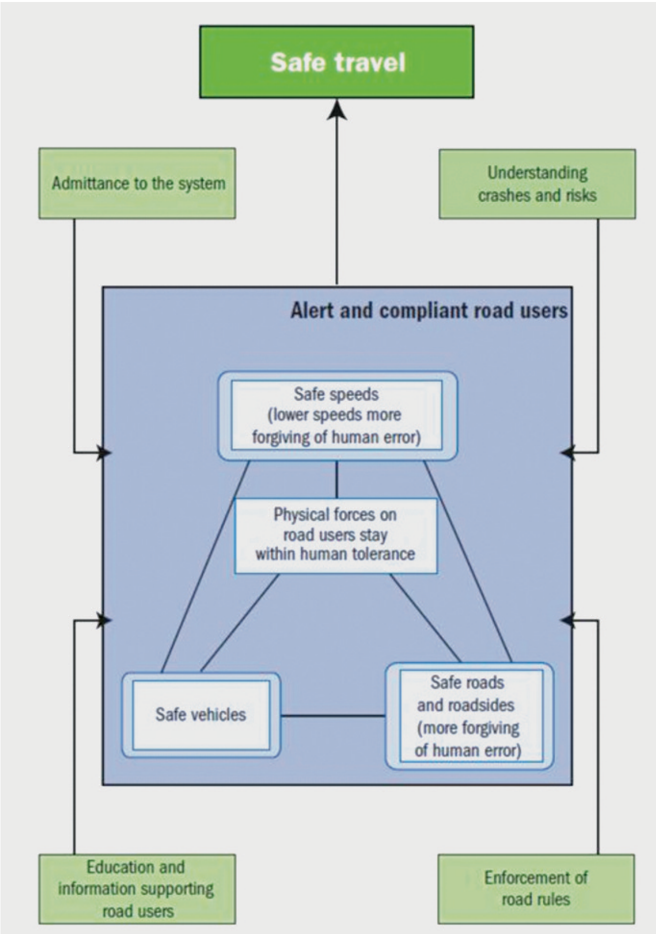
A key part of the Safe System approach requires that infrastructure be designed and managed to take account of these errors and vulnerabilities so that road users are able to avoid serious injury or death on the road.

Although the Safe System vision is clear within Australia, and there is general agreement about this, the approaches that might be taken to achieve this vision are less obvious. Advice is required regarding infrastructure options for achieving Safe System outcomes; on appropriate speed management strategies; and on ways to maximise the alertness and compliance of road users.

In order to help understand how jurisdictions can meet these objectives, ARRB has facilitated a series of national workshops to discuss these issues.

Infrastructure Options

A national forum was held to examine infrastructure options that might help achieve Safe System outcomes. The forum involved around 40 senior road managers from Australia and New Zealand. Discussion included current progress towards implementing Safe System principles, and options for future implementation. Some of the outcomes from the event are discussed below, while full details can be found in Turner et al (2009) [1].



It was recognised that the successful management of vehicle speeds is a critical element of the Safe System approach. Recognition of the human tolerances to impact forces at different speeds and in different road environments provides useful direction for future infrastructure improvement. As an example, it is recognised that above impact speeds of 50 km/h the chances of surviving a side impact collision at an intersection begin to reduce dramatically. This implies a need to reduce speeds to 50 km/h in situations where intersection conflicts are likely. This can be achieved through the installation of well designed roundabouts, or the use of platforms at intersections. For situations where higher speeds through intersections are required (i.e. on high speed major routes), consideration should be given to grade separation or the banning of specific turn movements and provision of acceleration and deceleration lanes.

A useful distinction was made between 'Primary' and 'Supportive' road safety treatments. Primary treatments are those that directly provide a Safe System outcome (i.e. minimise death and serious injury), for example by reducing impact forces to safe levels or by separating different road users. Supportive treatments assist in delivering safety improvements, but in an indirect manner (e.g. hazard warning signs may reduce the incidence of crash occurrence, but should a crash occur, would not have an influence on the severity outcome). Both are beneficial, but more use needs to be made of Primary treatments. In addition efforts are required to develop new Primary treatments. Continuing the intersection example provided above, there is a need to explore the use of raised platforms at signalised intersections, or ways to slow vehicles on the approach to intersections, perhaps through increased deflection and / or road narrowing. Work is currently underway in Australia and elsewhere to explore these sorts of possibilities.

Additional work is not only required to identify and implement Safe System infrastructure for intersections, but also for other situations where fatal and serious injuries are likely to occur. Of particular interest are measures to provide a forgiving roadside environment (for example through removal or relocation of roadside hazards, the use of crash friendly roadside features and barrier systems), measures that prevent head-on crashes (particularly barrier systems), and measures that protect vulnerable road users (including physical separation and slower speed environments).

It was identified that good progress is being made towards Safe System implementation in Australia, but there is a need to share good practice between jurisdictions more effectively. The report from the forum [1] is expected to form the basis for further discussions on the implementation of Safe System infrastructure, and to inform delivery strategies at local, state and national level.

Speed Management

A similar workshop was held to discuss speed management policy in light of the Safe System approach. This was held as part of an Austroads project on speed management. A key aim of this workshop was to reconcile the gap between Safe System outcomes (a 'must' have) and mobility (a 'should' have).

As a starting point this workshop considered the safe speeds that apply to different crash situations based on human biomechanical tolerances. These tolerances are derived from the impact speeds above which the chance of survival begins to rapidly decrease. For collisions involving pedestrians, this speed is 30 km/h; for collisions involving a side impact with a roadside object it is 40 km/h; for side impacts at intersections it is 50 km/h; and for head-on crashes it is 70 km/h (see Jurewicz & Turner in press [2] for a further discussion of these tolerances).

A key outcome from this workshop was the recognition that it is often the case that drivers are not able to brake prior to the occurrence of a crash because there is no warning. For instance, a pedestrian may step out from behind a parked vehicle and be struck by a vehicle before any braking can occur. In this case, the impact speed will be equal to the driving speed. Based on this assumption, the safe speeds presented above also represent the safe speed limits for these types of environments (e.g. 30 km/h where there are likely to be pedestrians).

Through this Austroads project a Safe System Analysis method was developed to match the speed limit to the level of road user protection offer by existing road infrastructure, or to recommend infrastructure improvements to retain a higher speed limit if this is the required function of the road. Further details of this process can be found in Jurewicz & Turner in press [2].

Road User Behaviour

A third workshop was held late in 2009, with the objective of discussing Safe System and how it applies to road user behaviour. Key points of discussion from this event included how we define an 'alert and compliant' road user. It was recognised that this is a complex issue, and that it is difficult to define these terms. Nevertheless, there was consensus that non-alert and non-compliant users should be catered for when designing a Safe System, although there is a limit to the extent that extreme driving behaviour can be accommodated through vehicle and infrastructure design.

There was agreement that education programs are not effective in reducing death and injury directly, but that these are necessary for building a climate of opinion where vigorous action to improve safety can be pursued. In this, the workshop participants identified that a gap currently exists in the marketing of road safety to the community and, as provided in the Safe System approach, the responsibilities of road users to be alert and compliant to operate within the parameters of the system. It is considered that achieving further gains in road safety will require a more effective engagement with the community both to secure appropriate behaviours on the road and to understand the reasons for infrastructure decisions such as the selection of speed limits that suit the prevailing road conditions and environment.

Other key issues discussed were the identification of performance indicators for measuring progress towards Safe System outcomes. Examples of existing measures included the proportion of motorists who were above the legal blood/alcohol level or who were not wearing seatbelts. New indicators included the need to measure consumer purchasing patterns when buying vehicles, and consumer demand for information about safety.

The results of this third workshop were still being assessed at the time this paper was being produced, but it is anticipated that a report will be released detailing the discussion in the near future.

The Challenge

The Safe System framework has been adopted as a way to make substantial future improvements to road safety in Australia. The vision appears clear, and appropriate steps to achieving Safe System outcomes are now being developed. The next challenge will be to ensure that the vision, as well as the steps required to achieve this are firmly embedded within policy at the national, state and local level. This is a substantial task and will involve extensive education programs and monitoring. It will also involve a large investment in infrastructure, vehicle improvements and the selling of road safety to the community over a sustained period. However, given the annual cost of crashes in Australia, the cost of not taking appropriate action is likely to be even greater.

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It's Crunch-Time for a New National Road Safety Strategy

Report on a Seminar by the Australasian College of Road Safety, NSW (Sydney) Chapter by Harry Camkin FACRS

Introduction

The current National Road Safety Strategy encompasses a vision of "Safe road use for the whole community", and a target *"to reduce the number of road fatalities per 100,000 population by 40%, from 9.3 in 1999 to no more than 5.6 in 2010".* (1)

The 2009-10 Action Plan (1) accepted the likelihood that the target will not be attained, and acknowledged that serious injuries, as the major component of the total financial cost of road trauma, should be targeted in future.

In response to an invitation by the Federal Minister for Transport (published in the August 2009 Special Edition of the College Journal "Preparing for the National Road Safety Strategic Plan 2011-2020", for members of the College to put forward their views on "key directions and priorities for Australian road safety over the coming decade", the NSW (Sydney) Chapter convened a seminar on the subject: "Crunch – Time for a new National Road Safety Strategy". This paper presents a summary of the proceedings of the seminar, which was held in Sydney on December 9th 2009

Seminar Objectives and Participants

The current strategy not having run its course, the seminar was constructed as an exploration of its progress to date and the issues likely to surround the development of a new strategy, and as an aid to preparation of possible input to the new strategy by the College, its members, and other major stakeholders. It took the form of a panel discussion by eminent road safety professionals, with further discussion from the floor. Initial presentations by the panellists covered:

- a brief review of the current strategy – its progress, successes and shortcomings,
- the context in which the new strategy will be prepared – other major domestic and international issues with which it must compete for community and government attention, and
- recent and emerging concepts and philosophies for planning at the strategic level.

The panel was selected for their experience and expertise at the strategic level of planning for road safety, this, rather than the relative merits of individual countermeasures, being the focus of the seminar. The panellists were:

- *Mr Lauchlan McIntosh AM, President, ACRS, Chairman ANCAP, and Director Asia Pacific IRAP,* whose presentation covered performance, responsibility and accountability, need for independent reviews of progress and economic analysis of the total costs of crashes, recent international developments, and a potential role for the College
- *Mr David Healy, Senior Manager, TAC and Co-Vice-President ACRS,* who discussed vision and target setting, making a "safe system", and State/Federal relations and their respective roles,
- *Professor Barry Watson, Director of CARRS-Q and Co-Vice-President, ACRS,* on the purpose and function of road safety strategies, the need for a guiding vision, ambitious targets including injury reduction, robust performance monitoring, leveraging support through linking to other agendas, and research-strategy interfaces, and
- *Professor Raphael Grzebieta, Chair of Road Safety, IMRC, UNSW, Immediate Past President, ACRS and current Chair, Sydney Chapter,* who discussed the relevance of traditional areas of focus, updating the Haddon-based approach, the USA's traffic efficiency approach to roads versus that of Europe's liveability and safety, and the influences of technology.

I was privileged to be invited to be the moderator of the seminar, perhaps with some deference to my participation in the development of the first national strategy, as well as New South Wales' Road Safety 2000. While this experience is perhaps of some relevance, both of these were formulated in somewhat less challenging times, and I have no envy whatsoever of those charged with the preparation of the strategy for the next ten years.

The presentations by the panellists as outlined above and subsequent discussion are summarised herein in terms of a review of the progress of the strategy, the international and domestic context in which its successor will be developed, and some major issues for consideration by those tasked with it.

There was consensus evident on many of the views presented, but it should not be inferred that they were universally subscribed to by each of the panellists. In particular the final summation is my own, as is the responsibility for any erroneous conclusions presented therein.

Progress with the Current Strategy

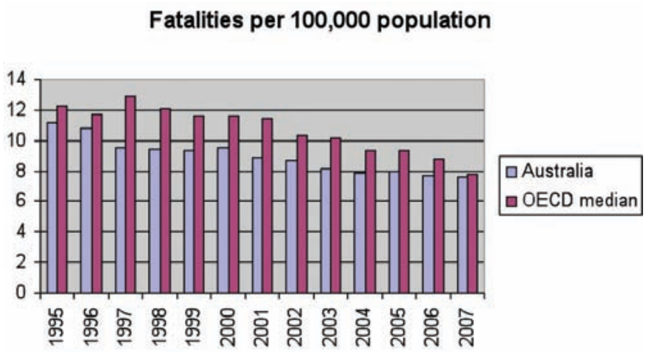
Any definitive appreciation of the effectiveness or otherwise of the 2001-2010 strategy must perforce await not only the passage of its full term, but also the assembly and analysis of much more data than is available at this time. Nevertheless there are some clear indications from the information already in the public domain that enable some worthwhile observations to be made. The principal issues noted relating to progress to date were:

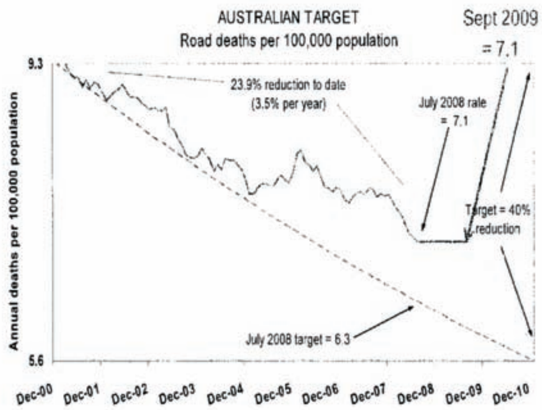
Targets

The absence of interim targets and performance indicators for implementation of the strategy has made it very difficult to evaluate the success of the strategy at any stage

"Benchmarking" was promised in the strategy as an adjunct to the transfer of "best practice", and was strongly recommended in the 2004 House of Representatives Inquiry report "Eyes on the Road Ahead" (3) for all road safety activities. But the only benchmark in general use in the current action plan is that of fatality rates in OECD countries. It is of some concern that against the measure of the fatality rate of the median OECD country, Australia's performance has slipped progressively from around 80% of that rate at the turn of the century to 97% in 2007.(4)

There is virtually no prospect of the target of 5.6 fatalities per 100,000 population being achieved. The strategy was aimed at saving 3600 lives over ten years, but fatalities up to September 2009 were some 1300 in excess of those that would have been experienced had the rate decreased linearly from 9.3 in 2009 towards the target. All 3600 lives can now only be saved by the avoidance of almost all fatalities in 2010. (10, McIntosh and Grzebieta)

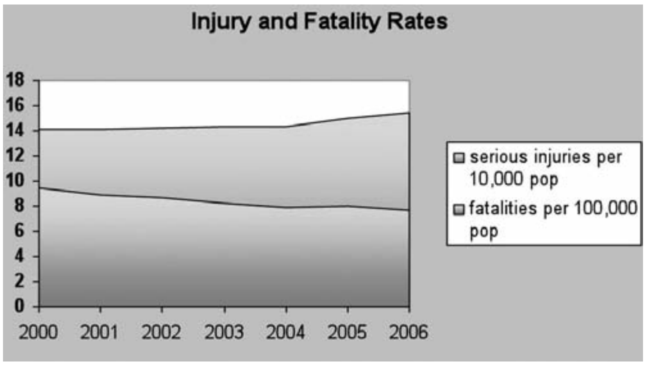




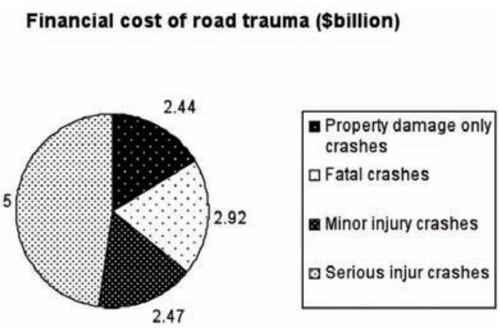
Injuries

The shortcomings of reliance on fatality rates for assessment of either the total cost or the relative significance of crashes involving different classes of road user, well recognised in, for example, "Eyes on the Road Ahead" remain as sources of possible misallocation of effort.

It is of particular concern that serious injuries actually increased each year from 2000 to 2006 – an indication that the total cost of road trauma is increasing rather than declining. (1,6)



Of the total financial cost of road trauma of $15 billion estimated in the National Road Safety Strategy, two thirds was associated with non-fatal injury crashes.(1)



Action Plans

The Strategy's provision for biannual action plans and its employment of a widely-representative Advisory Panel has been of value, the latter providing a forum for discussion across a wide range of professions, jurisdictions, and stakeholder groups prior to its disbandment in favour of a new National Road Safety Council. Limited leadership restricted the Panel's effectiveness in later years, for example in facilitating the initiation of the safe systems approach, but the development of which has been left largely to individual jurisdictions, albeit with some degree of national coordination.

More rapid implementation of "safe systems" is called for, but even so, the benefits of this approach will largely not be realised until after the present strategy has run its course. Some elements, eg the prospect of moving road design away from the traffic efficiency-oriented USA standards towards the more liveability/safety orientation being pursued in Europe will take some time to develop.

Similarly there needs to be greater support of efforts to promote the incorporation of the best of ITS technology into vehicle design and manufacture.

The 2009-10 action plan has acknowledged the need to include serious injury targets, and the decision by the Australian Transport Council to create a new National Road Safety Council has gone some way towards establishing an independent (if not really external) review process. The new Council's first formal meeting will not be until early 2010 however, and it remains to be seen to what extent the Council can improve on the input from the broader representation of the Advisory Panel, and especially to the commitment of the major players and stakeholders represented on the latter. The same plan concedes that there is still a pressing need for more effective performance monitoring and progress management.

Successive Action Plans have reported progress on a wide range of road safety activities, including priority actions from previous plans, but have been largely silent on lack of progress in other areas, including accountability and performance monitoring. They do not appear to have been very effective in accelerating the implementation of specific programs or countermeasures that they have promoted.

Issues of exposure and vulnerability arising from increased use of motorcycles and growth of road freight and countermeasures to address these have received little attention in recent Action Plans.

Technology

Emerging technology was heralded in 2000 in the current strategy as a significant means of reducing human error. Austroads e-transport, the National Strategy for Intelligent Transport Systems, was quoted as estimating that the total cost of crashes, congestion, and vehicle emissions could be reduced by at least 12% by 2012 from the use of ITS (1). While improvements in vehicles and traffic management have made, and will continue to make, substantial contributions to safety, progress seems to have been slower than anticipated, and it is difficult to see this result being attained. For example, the introduction of electronic stability control into all new light vehicles and trucks has not occurred, although one State, Victoria, is moving ahead of the Commonwealth to legislate for ESC in light passenger vehicles.

The time that such developments take to become fully effective is generally much longer than that of the innovations in entertainment and personal communication that tend to be more distractive than protective in the traffic environment. The current strategy and its action plans acknowledge this dilemma, but with a few exceptions have made little impact on accelerating penetration of "good" technology or diverting that of the "bad". Overall, there is little prospect of a "technology fix" making a major contribution in the short term.

Monitoring and Research

Recent experience of the impact of unforeseen external circumstances on exposure, behaviour, and the nature of traffic, and in consequence on even our "best-laid plans", has further demonstrated the importance of monitoring both the implementation and effectiveness of programs and countermeasures. The same is obviously true for the strategy itself.

While research has informed both establishment of the overall target and the various action plans in terms of monitoring progress towards it, and assisted in identifying emerging issues and appropriate countermeasures, there has been little progress (outside of Researchers' and College Conferences) in promoting the interface between health, medical, and road safety research, or in coordinating research data linking across the various sectors and jurisdictions. Evidence-based selection of activities calls for a more co-ordinated and strategic approach to research.

Accountability

Under the framework-collaboration concept of the current strategy, individual jurisdictions are accountable only for the selection and implementation of activities that they deem most appropriate for their circumstances. Given the constitutional independence of the States in the transport arena, it is difficult politically to avoid such sub-optimisation of the effectiveness of the overall resources utilised. It would be minimised however if all such major activities were attended by targets for both their implementation and outcome.

As pointed out in "Eyes on the Road Ahead", amongst others, there is an accountability vacuum in the strategy that calls out for clearer specification of the authority and responsibilities of the jurisdictional parties to it. While accountability for the strategy finally rests with the Australian Transport Council, the role of lead agency in future appears to be split between the relevant federal department and the incipient National Road Safety Council.

The 2009-10 Action Plan's reference to a new "Safety and Security Working Group" with "responsibility for progressing the National Road Safety Strategy and its action plans to ATC" further complicates the situation.

In the absence of a national accord or agreement perhaps similar to that establishing the new Council, it is difficult to see how the issue of accountability under the current "distributive" model of governance can be effectively addressed

Success or Failure?

In the absence of indicators for the implementation of specific activities promoted by the strategy and its action plans it is impossible to assess the success or otherwise of the strategy other than in relation to its single target. On this basis it can be deemed to date as only partially successful. More generally perhaps, it has been a useful stimulus of national activity and a focus for dissemination of new concepts such as the safe systems approach.

Pending formal analysis of final data it is only possible to surmise on the extent to which the shortfall on the fatality rate has been due to deficiencies in the strategy, the inertia or commitment of major players, the estimates of exposure (eg increasing motor cycle and freight vehicle use), countermeasure effectiveness, or external factors such as the economy. The effect of increased exposure has been acknowledged in the current Action Plan, but the point was missed that had the overall exposure in terms of vkm per head been kept at the year 2000 level instead of increasing at an average rate of approximately 2% p.a.(6), the fatality rate might have been very close to target for 2009.

Furthermore, while considerable attention has always been focussed on the funding of new initiatives, scarce consideration has been given to quantifying the resources required just to maintain the status quo in the face of increased exposure.

We should be wary of the counterfactual situation, and not be too hasty in declaring the strategic approach itself a failure, but the fact remains, that the application of considerable resources has not made a major impact on the total cost of traffic accidents. The Productivity Commission has undertaken inquiries into issues of far lesser economic import in recent years.

The Context in which a New Strategy will be Prepared

Government Priorities

The environment in 2010 will be very different from that in which the current strategy was prepared. Governments today are affording far greater priorities to international issues of climate change, national security, and the world economy, while domestically, health, transport and education will probably be the prime objectives of government attention over the next couple of years.

Given these distractions, the cost-effectiveness of road safety activity, not just as a determinant in prioritising safety initiatives, but also in terms of its potential to reduce health expenditure and improve occupational health and safety, should be utilised to garner political and inter-sectoral support for the strategy.

International Rapport

International developments in recent years have supported the concepts and substance of strategic planning for road safety, driven largely by European Community and World Health Organisation initiatives, but with a significant input of Australian expertise. This can be seen particularly in the 2009 "Moscow Declaration" (7) and the OECD/ITF 2008 report "Towards Zero: Ambitious Road Safety Targets and the Safe Systems Approach" (8), with the call for a UN Decade of Action on Road Safety, and confirmation of the need for strong lead agencies and commitment at the highest levels of government. There have been renewed calls also to leverage road safety through the seeking of allied priorities in health, transport, and the environment.

Foundations for a New Strategy

Vision, Goals, and Targets

"Vision Zero" has been held to be too aspirational for a national strategy, but similar concepts have been effective in occupational health and safety in many industrial areas, albeit in more "closed" environments, and there might well be a place for it at some level.

Nevertheless a guiding vision is sought that is more explicit than the current one. One that:

- avoids the perception of a stand-alone document that competes with other health, social, and environmental agendas,
- acknowledges the trade-offs that might need to be made between competing demands for safety, mobility, transport efficiency and environmental sustainability, and
- highlights the contribution that a more holistic approach can make to objectives in other arenas.

Bearing in mind the gestation periods of technological and infrastructure improvements, a vision needs to be sustainable beyond the 10-year horizon required to guide short-term improvement. Such a horizon might best be regarded as a staging-post with its own specific goals, and its own targets in terms of both implementing the strategy and defining its effectiveness.

The strategic vision also needs to provide a solid foundation for the principles underpinning the strategy and its action plans.

Australian expertise and Australian initiatives have met with frequent international applause, and given the necessary level of commitment by governments, a level of safety commensurate with that of the top quartile of OECD countries (current fatality rate about 5.2 fatalities per 100,000 population) would appear to be an achievable primary goal for the next decade.

The indications of a long-term rise in the serious injury rate, and the major contribution that serious injury crashes make to the financial cost of crashes make it imperative that the 2009-10 Action Plan proposal that injury targets be incorporated in the strategy be progressed and embraced by the strategic goals.

Effective monitoring of progress with the strategy and its goals demands the setting of interim targets in terms of both casualty outcomes and implementation of countermeasures and machinery processes. Research goals should include the early development of valid proxy measures to be used as indicators when there are significant lags in the availability of definitive measures.

The establishment of progressive targets should be associated with enhanced reporting of trends in circumstances likely to have a bearing on progress and analysis of their potential impact and implications for the strategy.

Accountability and Lead Agencies

There is now very strong insistence internationally on the establishment of effective lead agencies. In the absence of an identifiable alternative, the new National Road Safety Council's terms of reference appear to define its role as tantamount to that of a lead agency, but there is concern that the resources indicated will fall far short of those required to enable it to assert the necessary authority. Ultimately, accountability for the current strategy rests with the Australian Transport Council, but the diversity of responsibility under the collaborative mechanism with which ATC operates requires a parallel accountability schema.

A new strategy would benefit greatly from a lead agency that has both the capacity and the resources to identify and promote best practice and the authority to monitor, report, and recommend to ATC.

The statutory roles of individual jurisdictions are well established, but none is held accountable for its contribution to the strategy. The concept of the strategy as a framework, guiding individual jurisdictions but allowing them to proceed with activities that best address their particular problems and priorities, is probably inevitable. But at the very least, process targets should be established for the introduction of major road safety programs chosen by the individual jurisdictions.

Marketing

The contextual challenges and the likely perception of failure of the current strategy will demand the careful and persuasive marketing of the very concept of a national strategy, as well as and its principles, to governments and other major players, including the media as well as the community at large. This should focus not only on the human and total cost of road accidents in comparison with levels of social and financial cost in other areas of the national accounts, but also on the benefits to be derived from road safety activity that is synergistic to objectives in other sectors, as discussed elsewhere.

As envisaged in the COAG Agreement establishing the National Road Safety Council, and beyond marketing of the strategy itself, there is a major role to be played in promoting acceleration of safe system principles into the design and delivery of vehicles and highway infrastructure.

Principles

A set of principles underpinning the strategy and directing the application of resources and countermeasures should be clearly articulated and agreed at the highest levels of government. Many such principles have been advocated in the current action plan and in reports such as *Eyes on the Road, Towards Zero*, and the *Moscow Declaration*. In short, they should include cost-effectiveness, safe systems, best practice, and accountability.

In amplification:

- Evidence-based cost-effectiveness as the principal determinant in the selection of programs and countermeasures.
- A focus on safety programs as a highly cost-effective contribution to objectives in other sectors, particularly health, and those industries where profitability is challenged by deficiencies in the safe transport of goods and personnel.
- A strong lead agency with adequate resources for both monitoring and advocacy, and with the prestige and authority to influence governments and major stakeholders.
- A strong alliance between the many professions, academics and practitioners already involved in road safety work, perhaps through the College, to ensure improved data collection, reduce duplication of effort, and enhance the dissemination of best practice.
- Clarity in accountabilities, and commitment at the highest levels of Federal, State, and Territory Government.
- Importation, and translation where necessary to local conditions, of best practice from overseas and domestic sources.
- Promotion of the *Safe Systems Approach* as an appropriate balance between the concepts of *Vision Zero* and the realities of competition between mobility, efficiency and safety on Australian roads.
- Quantifying the externalities and taking their impacts into account whenever major decisions are made in the transport and land use sectors so as to mitigate the sub-optimisation of social costs otherwise derived from conflicting objectives for efficiency, mobility and safety.
- Likewise so far as the relationships between transport, land use, the environment, energy and health are concerned.
- Continued, strategic research into the design, cost-effectiveness and promotion of programs and countermeasures.
- Support for non-government programs that conform to the safe-systems approach, such as ANCAP, AusRAP, and Local Government-oriented programs in the various States.

These principles align closely with the key recommendations of the 2008 OECD report *Towards Zero : Ambitious Road Safety Targets and the Safe Systems Approach* as adopted in the College's 2009 declaration "A highly ambitious vision needed for the next decade in road safety".

Summation

The total cost of road accidents appears to have increased, hindsight has illuminated many shortcomings in the current strategy, and the action plans and occasional reviews that have been attempted since its inception have not prompted much in the way of urgent change.

Does this mean that the strategy has failed? After all, the fat lady is yet to sing! Have we made any progress towards attaining "safe road use for the whole community"?

Like the proverbial "curate's egg", the strategy has been good in parts, and the fatality rate, if not the total cost of road trauma, is currently running about 25% below that of 1999. There are many measures in the pipeline that will undoubtedly bring benefits in future years, and perhaps some of the shortfall can be explained by an over-optimistic expectation of the timing of the stream of benefits from the strategy. But short of an unforeseeable and unprecedented dip in fatalities in 2010, it will certainly fail to meet its one and only target.

Notwithstanding our inevitable ignorance of what economists allude to as the "counterfactual situation" – where we might have been without it, the strategy can hardly be hailed as a success.

Has it failed by way of design or has its execution been flawed? The jury will be out for a long while waiting for analysis to cast some light on this question, a dilemma arising largely from the absence of indicators designed to measure progress and effectiveness of implementation of the strategy and its action plans.

In particular, the Strategy's expectation of "little growth" in per capita vehicle use, and "moderation" of the growth of road freight by the use of larger vehicles has proven to be erroneous. The annual growth of 2% in total vehicle travel is in fact almost synonymous with the target shortfall.

Reviews have suggested change, but there seems to have been no imperative and no effective lead agency to accelerate the process or drive the changes indicated. Execution is to a large degree a product of the design of the strategy, and there is clearly a major flaw in the strategy itself in this regard.

The community will be looking to better performance from a new strategy, and "more of the same" is most probably not an option, even if it can address the major deficiencies in the current strategy.

Has the framework/distributive-responsibility model of the last two strategies seen its day and do we need a completely different approach for the future?

Footnote

A New Policy?

Perhaps the overarching document should be a national policy, endorsed by COAG, establishing a long-term vision, mid-term goals, short term targets, and the principles underpinning a strategic approach to improving road safety nationally. It might charge federal, state, and territory governments with pursuing their own strategic plans that reflect those principles, but focus on their particular domestic issues and priorities while contributing to the national goals.

Each jurisdiction could be accountable under the policy for the execution of its own plan, and an independent lead agency to ATC for such coordination as is necessary and the monitoring and review of the overall process.

Given the recent agreement by COAG to establish the National Road Safety Council, is it overly optimistic to expect that given an appropriate briefing on the total social cost of road accidents and its impact on other sectors, particularly health, a similar agreement at the highest level of governments can be reached?

A Role for the College?

The recent special edition of the College's journal reflects some of the concern at the present situation and the considered response of many of its members to the Minister's invitation to provide input to the new strategy.

Should the College marshal the technical and administrative skills amongst its membership and submit its own recommendations for a new national strategy?

Should the College demand change, and should it go so far as calling for perhaps a Productivity Commission inquiry into the national cost of traffic crashes and the strategy for addressing it?

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Simulation Forgives – Reality Does Not; Driver Training in the Next 10 Years

By Max R. Pallavicini, Rheinmetall Defence, tel: 02-6259 6359[1]

Introduction

In spite of modern trends in driver training, which encourage the learner driver to experience a wide range of driving environments before getting their licence, there are many potential hazards for which the learner driver cannot be prepared through on-road training. Examples are:

- A kangaroo jumping into one's path on the highways;
- Blinding rain or fog;
- Sudden sharp bends on our country roads framed by tall trees;
- Other traffic participants who don't know, or even want to know, how to handle a roundabout;
- Impatient drivers overtaking on narrow and dangerous country roads;
- A fast motor cycle passing a car and then turning sharp left;
- Driving in snow and hailstorms, on iced-up roads often called "black ice";
- Overtaking long vehicles such as B-Doubles, particularly when the truck driver decides to speed up;
- Falling asleep behind the wheel;
- Driver distraction by the mobile telephone, text message or an interesting sight in the traffic lane next to you, etc;
- Interacting appropriately to the passage of emergency vehicles.

A driving simulator can produce any, all and more of these situations. Any damage occurring as a result of a hazard materializing in the simulator is "virtual", i.e. confected illusion. The learner drive leaving the simulator might shake and tremble, but ***"Simulation forgives – the reality does not"***. A driver beset by these hazards in an on-road situation might not survive or become a real risk.

Hazard Perception

Realistic Hazard Perception involving a fast moving piece of equipment (e.g. a passenger vehicle, truck, police high speed pursuit vehicle, fire engine, airplane etc.) in this day and age cannot be properly conveyed to a trainee by theory. Major industries frequently train their staff on simulators for the control of their hazards. This is particularly true of the airline industry. Why then should a young inexperienced driver in charge of a complex, fast moving appliance such as a motor vehicle on a narrow road, perhaps in rain in the dark, be left unprepared on how he/she should control a suddenly occurring hazard?

Simulation – the Answer to Hazard Training

A Driver Training Simulator (DTS) provides an objective tool to establish, educate, and finally test Hazard Perception in a totally safe and controlled environment. The author suggests that universal and realistic driver instruction and education by means of high-fidelity driver training simulators can be achieved, placed in a number of strategic State and Territory locations.

A high quality simulator system provides a realistic presentation of normal traffic flow and specific traffic events. It thereby enables drivers to train in standard and various difficult situations without any risk whatsoever.

How Driver Training Simulators are operated

The trainee sits in an actual car seat, which replicates the movements and noise of a motor vehicle. The degree of difficulty of the relevant training exercise can be controlled by the instructor who can choose among numerous possibilities the creation of different exercise scenarios.

A database comprising a large variety of road layouts, crossings and other features of individual characteristics is provided with the simulator. City as well as country roads and motorway sections in good and inclement weather appearance are incorporated as training areas.

Such simulator traffic scenarios provide great realism. The density of simulated animated road users and their traffic behaviour can be specified as well as selected mistakes individual road users make, provoking special training situations. In simulated training, road users are interacting with regard to the behaviour of the learner driver.

New driving exercises can be modified, named differently and added to the exercise library, which is stored in the simulator computer software. Additional exercises with different scenarios or varying degrees of difficulty can therefore be created with little effort. The prepared exercises can be checked by means of the simulation preview function.

With the assistance of the integrated monitoring functions the instructor is able to evaluate the trainee's behaviour and monitor his training progress. The instructor then retrieves the next training exercise out of the exercise library based on his/her assessment of the evaluation criteria.

1. Max Pallavicini is a retired graduate electrical engineer from the TU Karlsruhe (Germany). He is also a professional fire engineer, member of the German Institution of Engineers VDI, Senior Associate and Honorary Member of the Australian & NZ Institute of Insurance & Finance ANZII, and a Certified Insurance Professional (CIP). He is the Australian representative of Rheinmetall Defence AG for land vehicle and power station simulation.

The simulator system permits both uniform and individual training for each learner driver. Briefing as well as interactive monitoring of ongoing training sessions can be carried out at the instructor session.

An optional Training Management System (TMS) is available for keeping long-term records of the learner driver's training performance. This can also be used in cases where repeat training of "at-fault" drivers becomes necessary.

An optional separate replay station can be used for the debriefing of simulator training without the need to access the actual simulator.

Currently available high-quality simulators can be software programmed for Australian Standards and road furniture and, if required, for the most popular passenger vehicles (manual and automatic) used in Australia. Alternatively a relatively simple generic motor vehicle simulator can be programmed for Learner and P-Plate driver training sessions. The trainee is always in communication with the instructor and possibly a virtual co-driver or other student. A high-quality simulator can prepare the trainee to handle a wide variety of "what if" situations.

To handle emergency assignments, the simulator simulates the approach of emergency vehicles with flashing lights and siren switched on. During an assignment, the simulated road users do not comply with the modified general traffic regulations, but also with a number of additional rules of conduct specifically developed for such emergency missions.

Advantages of Simulator Driver Training

- Vast range of training possibilities with risk-less training of dangerous situations;
- Training situations available at any time independent of weather and environment;
- Recorded assessment and training analysis from replay ability of trainee skills;
- Analysis of accident and dangerous situations;
- Objective assessment and examinations;
- Drivers gain individual experience to cope with difficult situations prior to encountering them in real life;
- Increase of the quality and efficiency of driver training by standardization;
- Speed-up of individual driver training;
- Cost reduction by resulting in reduced damage to instructor and trainee's vehicles;
- Overall cost reduction to insurance industry resulting from improved learner driver and P-Plate driver performance;
- Reduction of community social impact from road fatalities, injuries, time-off work, reduced CO_2 emissions, etc.

European Trends

Driver instruction simulators are being introduced in Europe and the USA. For example, the Allgemeiner Deutscher Automobil Club ADAC (largest European 16.5 Million. member motoring club) advises that later this year it will carry out, possibly with academic support, a feasibility study on whether to equip some or all of its 56 driver training schools with driving simulators.

Also the European Commission in its Directive No.2003/59/EG has advised that professional drivers training on a "high-quality" simulator may obtain a discount of 30 training hours on the road.

The Next Ten Years

Australia could become a leader in our area in driver education for all stakeholders concerned, such as driving schools, drivers, insurers, health authorities, licensing authorities, etc. This would require entirely new ways of thinking. Pertinent legislation would have to be amended. Organisations such as the Australasian College of Road Safety and universities would have to pick up the baton and motivate the authorities concerned.

Motorcycle Route Safety Review

By Wendy Taylor

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This paper was originally presented at the November 2009 Road Safety Research, Policing and Education Conference and won the NRMA Practitioners Award.

Abstract

The Victorian *"arrive alive!" Motorcycle Safety* Strategy (2002-07) acknowledged the growth in motorcycling and aimed to reduced motorcycle crashes, and motorcycle rider and pillion passenger deaths and injuries.

Crash data analysis identified an issue with road safety for motorcyclists, with implications for infrastructure, within the RoadSafe Inner Melbourne Community Road Safety Council (RSIM CRSC) boundaries, which encompass the Cities of Melbourne, Port Phillip and Yarra.

In response, RSIM CRSC instigated a series of audits to address the infrastructure aspects of this problem. Rather than focus on intersection black spot issues, the audits sought to identify hazards that had the potential to cause motorcycle crashes for the ten routes with the highest rider and pillion serious injury incidents and deaths.

The routes audited encompassed significant lengths of arterial roads.

Funding was obtained through the Victorian "SafeRoads Make Motorcycling Safer" initiative, plus equivalent funding from the three municipal councils.

The project was managed by the RIMCRSC motorcycle safety sub-committee, which is convened by a community representative who is an experienced motorcyclist, with representation from the three involved Councils, VicRoads and Victoria Police.

The motorcycle route safety review was conducted by an experienced motorcyclist, on a motorcycle. The audit included video footage, photos, crash data, and identified key issues and hazards for motorcyclists. The audit recommended remedial treatments and changes to maintenance programs. Many of these treatments are now underway with funding from VicRoads or, where appropriate, the Cities of Melbourne, Port Phillip and Yarra

Keywords

Motorcycle, Safety, Audit, Review

Introduction

RoadSafe Inner Melbourne (RSIM) Community Road Safety Council (CRSC) encompasses the Cities of Melbourne, Port Phillip and Yarra. It is one of 24 CRSC that cover Victoria and deliver programs to address road safety issues in their local area. Membership of RSIM CRSC comprises engineers from each of the three Councils and community engagement staff, police from Melbourne, Port Phillip and Yarra traffic management units, a VicRoads person, and community members volunteering their time and energy representing residents, local business or particular road safety stakeholders (such as motorcyclists).

The RSIM motorcycle safety subcommittee reviewed crash data along routes with the highest crash injury and fatality rates for motorcyclists, with a particular interest in routes that crossed between the boundaries of the Cities of Melbourne, Port Phillip and Yarra.

Crash data analysis identified that between September 2000 and August 2004 within these three Council areas there were:

- 17 rider fatal crashes
- 361 rider serious injury crashes
- 19 pillion serious injury crashes
- 10 -13 November 2009, Sydney, New South Wales

Rather than a focus only on "black spots" or intersections, the RSIM motorcycle safety subcommittee agreed that a motorcycle route safety review would be undertaken.

Funding for the review was sought from the "SafeRoads Make Motorcycling Safer" initiative. This was supplemented with contributions from the three Councils.

Methods

Crash data analysis and consultation with the three Councils identified the following routes to be included in the motorcycle safety review:

- Elizabeth Street (Bourke to Victoria Streets)
- Queensberry Street (Swanston to Curzon Streets)
- Victoria Street/Victoria Parade (Peel to Hoddle Streets)
- Swan Street (Hoddle to Burnley Streets)
- Johnston/Elgin Street (Yarra River – Swanston Street)
- Wellington Street (Victoria Parade to Johnston Street)
- Hoddle St/Punt Rd (Dandenong Rd to Eastern Freeway)
- St Kilda Rd/Brighton Road (Commercial Road to Glen Huntly Road)
- Dandenong Road (Westbury Street to Upton Road – westbound only)

- Montague Street (West Gate Fwy to Normanby Rd – southbound only)

Analysis of motorcycle casualty crash data for the agreed routes identified:

Jan 2000 to Dec 2004 – 244 casualty crashes

Type	No.	%
Vehicles – same direction	68	28
Vehicles opposing direction	62	25
Off path on straight	37	15
Vehicles adjacent direction	29	12
Manoeuvring	23	9
Pedestrian	13	5
On path	6	3
Off path on curve	3	1
Overtaking	2	.8
Passenger and miscellaneous	1	.4

The audit for each route was undertaken by an experienced motorcyclist, on a motorcycle. The auditor rode each route in each lane. The audits were undertaken between 10 am and 2 pm on various days. The audits included video footage and at a later stage, photos of hazards and issues.

Results

The Motorcycle Route Safety Review [1] identified the main hazards as:

- No lane delineation
- Poor / uneven pavement on road surfaces
- Crack sealing along centre of lanes
- Two lanes merging into one over a short distance and without sufficient warning
- Sunken pit lids in lanes
- Slippery pit lids in lanes
- Oil build up on road surfaces on the approach to signalised intersections
- Faded line marking

Recommendations included :

- Right turn issues – implementing fully controlled right turns at signalised intersections/closing medians
- Elimination or better management of pit lids – cooperation with other authorities and understanding of responsibilities – new products need to be identified
- Oil – cleaning protocols and re-sheeting, car and truck vehicle maintenance improvement
- Rider visibility – education for riders and drivers

Conclusion

The RSIM CRSC Motorcycle Route Safety Review report was tabled with VicRoads, and the City of Melbourne, the City of Port Phillip and the City of Yarra. The Review was also tabled at the Victorian Motorcycle Advisory Council.

Most of the routes identified are declared roads, and are the responsibility of VicRoads to manage and to maintain.

The three Councils have accepted some of the recommendations from the review as they affect roads under their management. VicRoads have also accepted some of the recommendations, and many of these have been actioned and are completed, or are underway. Some recommendations were channelled through the Victorian Motorcycle Advisory Council, and have also been actioned. VicRoads is continuing to schedule actions in 2009/10.

Another project, RoadSafe Inner Melbourne Motorcycle Route Safety Audits – follow-up [2], is underway. This includes:

- A progress report of the works undertaken to date based on the recommendations in the original review
- A review of the motorcyclist fatalities and serious injuries to determine changes and trends with a starting point of the statistics used from the original review
- Identifying the next ten routes with the highest risk for motorcyclists within RSIM boundaries

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RSIM CRSC members involved in the Motorcycle Route Safety Review:

Colin Bates – City of Yarra

Sam Donato – City of Melbourne

Paul Smith – City of Port Phillip

Senior Sergeant Mick Downes, Victoria Police, Melbourne Traffic Management Unit

Sharon Wishart – VicRoads

Kerry McConnell – VicRoads

Maria Falzone - VicRoads

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Peer Reviewed Papers

Lay Perceptions of Responsibility and Accountability for Fatigue-Related Road Crashes

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Abstract

Small groups of participants acting as mock juries heard an audiotape of the summing up arguments in a fatigue-related truck-crash court case. When asked to decide if they thought that the defendant was guilty, participants found the defendant not guilty significantly more often than guilty. Furthermore, their decision of guilt was not affected by whether the defendant was an individual or a corporation. Issues that participants thought important when coming to their decision were the awareness of sleepiness by the defendant and communication that the driver had with others earlier in the day prior to the crash. On average, when asked to allocate penalties, participants gave an average of half the maximum penalty to the defendant. Coupled with the low conviction rate, and the content of the discussions captured when the groups were coming to their decisions, this study suggests that the seriousness of driver fatigue is under-recognised by the general public.

Introduction

Fatigue is a serious problem in the road transport industry, with a 2007 estimate that in the Australian State of New South Wales, 20% of fatal crashes were fatigue-related [1]. Considerable progress is being made in understanding the biological underpinnings of fatigue, and this information is slowly being incorporated into legal and regulatory structures in many jurisdictions. In addition to legislative requirements to manage fatigue, regulators are also using education and training campaigns directed at the general public (see for example the "Think!" campaign in the United Kingdom). Nevertheless, the knowledge base of the general public and how this information is used to make day-to-day decisions about driving and working in relation to fatigue are unknown.

This paper considers how people perceive the issue of fatigue and make decisions in relation to it in the context of commercial driving operations. For the purposes of this article, fatigue is defined as a subjective desire to rest and an aversion to continue with the task at hand coupled with an objective decrease in performance as time without sleep increases, moderated by circadian factors [2]. The term was used in this study in preference to drowsiness or tiredness because the majority of road safety campaigns to date have used the term fatigue.

Following a fatigue-related motor vehicle crash, authorities have a number of potential legal remedies. If the crash is particularly severe, involving death, authorities can lay formal criminal charges against either the driver, and/or the (usually corporate) employer of the driver [3]. One of the elements of this process involves the court making an assessment about what a defendant knew or should have known about what they did. The use of a mock jury provides a framework for the investigation of how members of the general public in Australia understand and assesses what ought be known about fatigue when driving.

As with other workplace safety topics, the question of fatigue involves the interaction of overlapping duties by different parties, in particular between the (usually corporate) employer and the employee. The question of corporate criminality has been the subject of considerable debate in the legal literature [4], in particular whether corporations should be subject to the criminal law in the same way as natural persons. Nevertheless, at the present time in Australia, corporations can be charged with criminal offences under certain circumstances and this paper will utilize a mock jury process to investigate attitudes towards corporate criminal responsibility for fatigue.

Psychological research has been used to explain and predict the ways in which a random selection of citizens come together to make a decision in the jury setting. Currently, there is no directly relevant research into the question of jury decision making in fatigue-related scenarios (see [5] for a review of jury research). In the context of corporate legal responsibility, research has been conducted into whether the populace has a general anti-corporate defendant bias [e.g. 6- 9], although to date such research is inconclusive. Nevertheless, the research does suggest that people evaluate the acceptability of corporate action in the context of social responsibility, rather than a traditional economic analysis which proposes that corporate responsibility primarily is based on a duty to maximize return to shareholders [10]. The research indicates that people expect that corporations will behave ethically [11] and a failure of ethical behaviour can have a range of adverse consequences. In particular, corporations will be disapproved of when they are involved in a crisis that was preventable [12].

The present study three main aims. First, as corporations have an ethical and legal responsibility to manage fatigue in their operations, and as a large section of the road transport industry is controlled by corporations, we sought to test the prediction that participants from the general public would expect corporations to effectively manage fatigue such that fatigue-related crashes are avoided or minimised. Therefore, we expected that if a fatigue-related crash does occur, it is more likely that a defendant corporation will be held responsible, and held to a higher degree of responsibility, than when one of their employees is a defendant, because the employee has relatively less control over fatigue management practices of the organisation.

A further aim of this study was to explore the decision making process that participants from the general public use when coming to conclusions about fatigue-related crashes. Finally, this study explored the extent to which driving while fatigued is considered a serious safety risk by members of the general public.

Participants

Sixty seven participants (29 males, 38 females, mean age 25 years, range 18 – 70 years) took part in the study. They were recruited by placing advertisements on a local university student employment website, and by recruiting from a retired persons social club, to capture a range of age groups. The only criteria for inclusion was that the individual was over 18 years old and an Australian citizen and thus eligible for jury service in South Australia. No participants had participated in a jury before, and none had worked as a long distance truck driver.

Method

Participants were divided into groups of 3-7 individuals (14 groups in total), and presented with a short audio tape of the summing up arguments of the prosecution and the defence in a fatigue-related truck crash case, in which fatalities and serious injury occurred. The groups were randomly assigned to one of two defendant identity conditions: (1) where a truck driver was the defendant, and (2) where the driver's corporate employer was the defendant. Each presentation lasted approximately 20 minutes in total.

After listening to the arguments, but before discussing the scenario and without others in the group, participants were asked to complete a questionnaire stating their opinion as to the guilt of the defendant (guilty/not guilty), as well as to assign a percentage of responsibility that they believed each party bore in relation to the crash. They were instructed that the percentage responsibility that they assigned each party did not need to have any relationship to the decision of guilt. Thus, theoretically a party could be not-guilty, but still be assigned 100% responsibility. They were then asked to nominate the maximum penalty that should be applied in a fatigue-related fatality situation, and what penalty that they would apply to the defendant in the scenario they with which they were presented.

Participants were also asked to complete a questionnaire on their perceptions of the strength and reasonableness of various arguments that the prosecution and defence raised on a 7 point Likert-type scale. After doing this, participants were asked to discuss and come to a conclusion in their groups as to the guilt of the defendant. They were instructed to reach a unanimous verdict if possible. This discussion was videotaped for transcription and later analysis.

The study was approved by the Human Research Ethics Committee of the University of South Australia, and participants were remunerated AU$50 for inconvenience and their time.

Materials

The general scenario presented to the participants was that a driver of a truck was involved in a crash in which two people died when his truck failed to negotiate a bend. On the night before the crash, the driver had obtained about five hours of sleep, and he had worked for 32 hours in the prior three days. When the driver came into the depot where he was to collect the truck on the morning of the crash, he commented to his employer that he felt exhausted. For the defendant identity condition manipulation, the text was altered so that the name of the defendant was either that of the driver or of the company. It could be inferred from the facts presented that the driver fell asleep. The defendant was charged with culpable driving causing death, although the section of the act (s. 318(2)(b) of the Crimes Act, 1958 (Vic)) was not specifically identified

Analytic Methodology

Quantitative and qualitative data were collected in the study. The quantitative (questionnaire-derived) data, consisting of the assessment of guilt (guilty / not guilty) and percentage of responsibility, were analysed by Chi Squared test and independent samples t-test, respectively. The questionnaire data were also analysed using linear and binomial regression techniques, where the responsibility percentage and guilt responses were considered as dependant variables. The quantitative analyses were conducted using the Statistical Package for the Social Sciences (SPSS) Version 12 for Windows program (SPSS Inc.,

Chicago, Illinois, USA).

The analysis of the qualitative data transcribed from video tapes had two purposes - to identify any differences in arguments raised in the two defendant identity conditions, and to assess the discussions in an exploratory fashion to identify arguments that participants used in coming to their conclusions. The analysis was conducted using a modified approach to grounded theory method [13]. This involved scrutinizing the conversations to identify categories of arguments made by the participants, and describing how the categories interacted with one another. An independent rater also coded a sample of the transcripts based on the category matrix established. The inter-rater reliability ($\kappa = .7$) was at the level traditionally considered to be sufficient [14].

Results

Sixty six of the sixty seven participants recorded a guilty or not guilty decision. Of the 32 participants with a corporate defendant, 8 found it guilty. With an individual defendant, 14 of 34 participants found him guilty. Although there were significantly more participants that recorded a not-guilty decision ($\chi 2= 7.1$, $p <0.01$, effect size $\varphi = .328$), there were no significant difference between defendant identity conditions on the finding of guilt (defendant type: $\chi 2 = 2.5$, $p>0.05$, effect size $\varphi = .195$).

The level of responsibility assigned to the different parties followed a similarly non-significant pattern of differences. The corporation was assigned a mean responsibility level of 43% (SD 19.7%) and the mean responsibility level assigned to the individual was 57% (SD 19.8%). This difference was not significant ($t = .35$, $p>0.05$, effect size $d = .7$).

Participants responded that they would have assigned average maximum financial penalty of $330, 000 (Range $0 - $2M; SD $400,000) and average imprisonment period of 96 months (range 0 months – 300 months; SD 92 months) for a crime of this type. In the scenario presented, the participants would have fined the defendant 55% (SD 31%) of the maximum financial penalty that they nominated and 46% (SD 30%) of the maximum imprisonment time.

As there were no effects of defendant identity condition, the groups were combined for the subsequent analyses. Binary logistic regression performed on responses to the questionnaire items indicated that three items were significantly associated with a guilty decision. When these three items were inspected, it became apparent that two of them were associated with the topic of the self awareness of sleepiness that the driver possessed. The other significant item was related to the topic of the quality of the communication between the employer and the driver . Table 1 lists the items that were found to be significantly associated with the guilt decision, as well as the general topic with which they were associated.

Stepwise multiple regression analysis performed on the same items against the assigned percentage of responsibility indicated that six were significantly associated with the decision. When these items were inspected, it was apparent that four of the six could be assigned into the "self awareness of sleepiness" and "communication" topics. In addition, two items concerned with the topic of sleep emerged as also having a significant association with the attribution of responsibility (See Table 2).

Qualitative analyses from the transcripts of the discussions revealed no evidence of an anti-corporation bias, although there was discussion of concern over perceived poor industry-wide work practices.

Examples of statements made that illustrate this line of argument are:

- The driver in the scenario worked too many hours
- The driver was not getting enough time off or enough sleep, e.g. "And his previous work roster for the past three days, thirty hours in three days, he was working 60 hours a week … So if that's an indication, his previous rosters, then he's working a 12 hour day or something, and to me he's not getting enough sleep."
- There is a dangerous culture of excessive working hours in the industry e.g. "Um, well experience I suppose. In industry, bosses do work their drivers very hard and long hours…"
- This culture can generate sleep debt and doesn't consider drivers' family and social lives, e.g. "So he had worked something similar in the past few days… I would expect that it would build up a certain sort of sleep debt with that lifestyle" and "That's a very [pause], kind of neglecting the fact that people have social lives and you don't just go home sleep and sleep after work. That's not what happens and [the company] should be aware of that."

In addition, some participants expressed the view that fatigue was a special threat to the road transport industry which put the employer on notice. They proposed that this should lead to the

Table 1. Items found to be significantly associated with the guilt decision

Question	Topic	Wald value	Sig
How important did you consider the awareness that the driver had of his tiredness or the possibility that he might fall asleep?	Self Awareness	4.3	<.05
How important did you consider that the conversation was that the driver had with his employer on the morning of the crash?	Self Awareness	9.1	<.01
How reasonable did you think the argument that the driver communicated his level of tiredness with his employer was?	Communi-cation	4.3	< .05

1 The experiment was conducted before the amendment to the *Crimes Act* that makes driving while fatigued a manner by which negligence can be established.

Table 2. Items found to be significantly associated with the attribution of responsibility.

Question	Topic	ß	t	Sig.
How reasonable did you think the argument that the driver communicated his level of tiredness with his employer was?	Communi-cation	.348	3.9	< .01
How reasonable did you think that the argument was that the employer thought that the driver had an opportunity to get enough sleep on the night before the crash?	Sleep	-.337	-4.0	< .01
How reasonable did you think that the argument was the employer thought that the driver was only saying that he was tired because he had just got up?	Communi-cation	-.235	-2.68	.01
How important did you think how much sleep the driver managed to get on the night before the crash was ?	Sleep	-.262	-3.08	<.01
How important did you think the employer's conversation with the driver on the morning of the crash was?	Communi-cation	.269	2.90	<.01
How important did you consider the awareness that the driver had of his tiredness or the possibility that he might fall asleep?	Self Awareness	-.179	-2.12	<.05

employer having a responsibility to be vigilant to the possibility of fatigue. For example, one participant said:

"… but in a trucking industry, I mean, the most common cause of an accident is fatigue. So if your employee comes in and says, 'Oh, I'm completely bumbling today mate', I think the company has a responsibility to take that seriously. I mean fatigue is a serious issue in the industry so why wouldn't you take it seriously? So yeah, I blame it on the company"

Thus, any negative attitudes were expressed in terms of specific practices, not against the institution or the corporate body.

Exploratory analysis was undertaken to determine if further patterns of responses could be deduced from the discussions. There were 58 participants in 13 groups that provided the material for the analysis of the qualitative data generated by the group discussions. For a verdict to be reached from the material presented, participants had to draw inferences from the facts presented based on their understanding of the nature of fatigue and its impact in the workplace. The complexity of the subject area was reflected in the discussions, as 10 of the 13 groups (77%) raised the point that they thought that the responsibility did not lie exclusively with either the driver or the employer (i.e. they both ought to share some of the blame).

For most of the groups, a single argument per debate emerged as pivotal. The most frequent pivotal argument (nine of the 13 groups) was that the driver knew, or due to his experience should have known, that he was tired, and therefore had a responsibility to pull over. However, this was not universally supported, as there were some arguments in opposition to this point, mainly that the driver did not intend deliberately to crash (and wouldn't have continued to drive if he thought that he might). Some participants made the argument that shift work always makes people feel tired, and that would make the driver unable to make an assessment of how he would perform.

In total, 82 different arguments were identified in the discussions which could be classified into three themes. These were:

1. The responsibility that the driver had to assess his capacity to begin driving. eg "The driver is a professional driver, that is what he does, and he had enough time to get sleep. And he knew what he was doing the next day …"
2. The introspective capacity of the driver to gauge his own fatigue during the trip (and the related sub-theme of his responsibility to pull over when a threshold of fatigue had been reached) e.g. "…I think that the [driver] has the responsibility to pull over and stop, and that he could assess how tired he was."
3. The working arrangements that the company had in place in general, including the responsibility that it held towards its drivers.

In addition, there was a distinction made about whether the driver should have started driving at the start of the day because he knew, or ought to have known that he was unfit to drive, and whether the driver should have stopped driving at some point later due to his inability to continue driving safely. The relevance of this distinction appeared to be that the driver was assessed as having responsibility at both of those points in time, but the employer was only assessed as having a responsibility towards the driver at the start of the day.

When the penalties that each participant were compared, there were no differences between the groups. To counter for the range of potential penalties, the comparisons were made between the percentage of the potential maximum that each participant allocated in this instance. The overall average financial penalty recommended was 54.5% of the maximum, and the average custodial sentence was 45% of the nominated maximum.

[2] In the scenario, the driver and a manager had a brief discussion, including an exchange in which the manager asked how the driver was, to which the driver replied that he was exhausted.

Discussion

Although there was an overall tendency for participants to find the defendant not guilty on the facts given, one third of participants found them guilty. Indeed, during the discussions none of the groups assigned 100% responsibility to either party, suggesting that participants considered the responsibility for managing fatigue in the long haul road transport industry to be shared between drivers and management. This result occurred notwithstanding the fact the instruction to the participants that there was not necessarily any association between their guilty/not guilty decision and their assignation of percentage responsibility. Unfortunately, the literature does not contain any direct comparisons of acquittal rates and responsibility for other road traffic safety offences (e.g. drink driving or drug driving).

Analysis of the questionnaire material indicated that there were nine questions that were significantly related to either the guilt or percentage responsibility (see Tables 1 and 2). Upon inspection it became apparent that they could be assigned into three broad thematic categories: self-awareness of fatigue, communication with the employer and sleep history. These three categories can largely be aligned with the categories that emerged from the qualitative thematic analysis of the discussions. The self awareness category maps directly on to the self awareness theme, and the communication category is tied into the policy theme. The final category, sleep history, is related to the working arrangements that the company had in place, although there was not a lot of discussion directly about what length of sleep would be acceptable.

Both the questionnaire and qualitative analyses indicated that the most important issue to consider when making decisions about fatigue-related crashes is the ability for the parties involved to determine the extent to which the driver was able to self-assess his level of fatigue and therefore his competency to drive safely. Participants tended to assume introspection was a suitable and accurate technique for self-assessing fatigue. Thus, participants argued that the driver would be aware of how much sleep he needed, how tired he was and when he should engage in an appropriate countermeasure. One could argue that this is a reasonable proposition, as repeated exposure to a situation and its outcome is the basis for classical learning theory [15]. However, scientific research is unclear about whether expert drivers are better (than non-experts) at assessing their own performance [16- 17]. Moreover, research has indicated that although people can assess their fatigue level in general terms, these assessments are not necessarily accurate the self-assessments are not strongly associated with levels of performance decrement [18-19].

On the other hand, as the employer did not have direct access to the subjective experience of the driver, the employer had to rely on other methods to assess fitness for duty. In this study, the primary method was asking the driver how he felt when he reported for duty. Other issues were implicitly considered during the discussions, such as long working hours and inadequate time off-duty, as well as the ability of the driver to raise concerns without fear of retribution. In this context, it is interesting to note that the participants considered that the driver's work history was excessive, as research has indicated that an average of 60 hours for a working week is not unusual in the long haul road transport industry in Australia [20].

Some issues that were not related to the facts of the present case (and therefore not relevant to come to a conclusion) were raised by participants in their discussions. These included the use of stimulant drugs and the concept of motive of the parties. These issues warrant further investigation.

Participants' knowledge and perceptions of fatigue were evident from their discussions. In some cases these appear to have been influenced by media reports:

"Some guy in Britain got [a jail penalty], even more. He fell asleep at the wheel, went off the motorway, went, he was unlucky, went on to a railway line, a passenger train hit him. Yeah, really unlucky, and a coal train came the other way and killed... [Interruption] You're joking!? [Continues] No. It killed a lot of people, and he got a lot of time [in jail]").

The participant appears to be referring to the Selby rail crash in the UK where a car, a coal trail and a high speed commuter train crash was attributed to the fatigue of the driver of the car [21].

More frequently, personal experience informed the perceptions and knowledge of participants:

"I don't think that they should be driving for 10 hours a day. Even if they got home for 10 hours, it's still, you can't go the next day and drive. I mean I drove to Melbourne in the holidays... After driving like two hours and I was like falling asleep. I was really tired, so I don't even see how they can drive long hours."

The reference to personal experience in the reasoning process may have influenced the perceived culpability of the offence. The scenario was designed to represent a crash with very serious consequences, involving fatalities, and one which might be expected to draw significant punishment. If an individual has personal experience with driver fatigue, they may come to see it as less serious, not wanting to see themselves in the category of someone who has committed a serious criminal offence. This reasoning process might explain the relatively low penalties that participants applied to the defendant (approximately half of their self determined maximum).

That the cause of this serious incident appeared to be downgraded in culpability by the participants is interesting, and indeed in the decision of a recent Victorian non-heavy vehicle fatigue related case [22] on appeal, the court appears to be unwilling to categorize the circumstance that it was faced with as grossly negligent or culpable,

"the sentence which is imposed for dangerous driving which causes death or serious injury must take account of variations in the moral culpability of those who commit the offence .., the facts in this case do not suggest any deliberate act, gross negligence or recklessness that endangered others. The cause of this accident was probably only

***a momentary sleep or a moment of inattention,** and that it is the 'dangerousness of the driving' rather than the fatigue per se that justifies the higher culpability. This is an exceptional case of low level moral culpability, constituted of momentary inattention, …"*
(Emphasis added)

Conclusion

This study did not find any evidence that supports the argument that there is a general view that a corporation should be held more responsible for fatigue-related truck crashes than an individual driver. The discussions indicated that the way these questions were presented to participants may have over-simplified the matter, and that responsibility was a complex issue that could rarely be resolved down to a responsibility of a driver or of a corporate employer. This "mutual responsibility" approach reflects to some extent the approach underlying Occupational Health and Safety legislation in Australia, and the intent behind the extended (chain of responsibility) offences in the Heavy Vehicle Driver Fatigue reforms that have been recently introduced . In view of the potential weaknesses associated with individuals taking responsibility to self-monitor their level of fatigue, an important question for future research is whether models of shared responsibility for fatigue management are indeed effective in reducing the incidence of fatigue-related crashes and occupational injuries. These models should be compared directly with those that place the responsibility exclusively with the employer.

Three main themes emerged from the questionnaire material and from the discussions. The self-awareness of the driver (coupled with his responsibility to pull over when he was too tired) was a major theme, as were the communication between the driver and his corporate employer, and opportunity to sleep between or during shifts. Although we found no difference between the defendant identity conditions (corporate employer vs individual driver) in the guilt and responsibility variables, participants tended to scrutize the actions of employers, in particular in relation to their decisions about the employee's fitness to drive. Adoption of policies that clearly specify how such decisions are to be made, and evidence that this has been communicated to drivers would appear to be important steps for employers to take.

Nearly all of the participants agreed that fatigued driving was a serious matter, although the content of the discussions indicates an ambivalence towards the culpability associated with the offence of driving while fatigued. Comments during the discussions such as the ones cited above also indicate that educational campaigns serve an important function in raising awareness about this significant road safety issue. Beyond that, it appears there is a need for more education about management of fatigue, as one of the main points considered by participants was that individuals should be able to accurately assess their level of fatigue and engage in an appropriate response. This assumption is not well supported by scientific evidence and disproportionate reliance upon it may hamper efforts to effectively address fatigue management in the work place.

[3] This study was conducted in Adelaide. The distance between Adelaide and Melbourne is approximately 800km.

[4] National Transport Commission (Model Legislation – Heavy Vehicle Driver Fatigue) Regulations, 2007

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The Relative Age Related Crashworthiness of the Registered South Australian Passenger Vehicle Fleet

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Abstract

In this paper, the crashworthiness of passenger vehicles in South Australia is characterised. For this purpose, crashworthiness is defined as the rate of serious and fatal crashes per crash of any severity. The relationship between this rate and the ages of passenger vehicles is used to characterise and compare the crashworthiness of the South Australian registered passenger vehicle fleet and the fleets of other Australian jurisdictions. The mean age of passenger vehicles registered in South Australia is around 11.2 years compared with 9.9 years for the entire Australian registered passenger vehicle fleet and 9.3 years for registered passenger vehicles of New South Wales. Based on these mean vehicle ages, tow-away crashes in South Australia have a 3% over-representation of seriously injured or killed drivers compared with the national average (assuming a crashworthiness decline of 2.53% per year of vehicle age).

Analysis of only those vehicles that crash, confirm these estimates and suggest an over-representation of 3.5%. Young drivers appear to be doubly disadvantaged in that they have a higher rate of serious and fatal crashes for a given vehicle age, and they tend to crash vehicles that are much older than the vehicles crashed by drivers over 25 years of age. Despite this, the benefits of fleet renewal on average age-related crashworthiness are relatively modest and it may be more fruitful to encourage the safest new car fleet now so that road safety benefits can be realised in 10-15 years time. In the mean time, removal of impediments to younger drivers who would otherwise drive newer and safer cars could be considered.

Keywords

Vehicle Crashworthiness, Registered Fleet, Vehicle Age, South Australia, Modelling

Introduction

The concept of vehicle crashworthiness has had currency for more than 50 years. The term "crashworthiness" itself was coined in 1949 by John Lane of the Australian Department of Civil Aviation in relation to aircraft safety "when he said that it was time we stopped considering only whether an airplane was airworthy; [but also] whether it is crashworthy" [1]. It has since entered into the vehicle safety vernacular to refer to the ability of a vehicle to manage the energy of an impact to minimise the risk of injury to its occupants.

More formal definitions of crashworthiness exist. For example, a useful definition may be derived from considering the number of serious injury or fatal crashes as a product of an exposure based risk of a serious crash and the exposure to that risk; i.e:

Number of serious crashes (N) =
risk of a serious crash x exposure

Furthermore, the risk of a serious crash may be thought of as the product of the risk of having a crash and the risk that any given crash is serious in nature, so:

N = risk of having a crash x risk that
a given crash is serious x exposure.

To reduce N, the three components on the right hand side of this equation provide broadly distinct opportunities for intervention. Factors determining the risk of having a crash are often described as *primary* safety factors and they include, for example, driver behaviours and vehicle active safety (crash avoidance) technologies plus a host of road environmental factors. The risk that a given crash is serious primarily is related to the energy of the crash and the management of the vehicle and occupants' energy in the crash. It also encompasses some aspects of road and road user safety (lower speeds reduce the energy of the impact). It is in this risk, that a given crash is serious, that a vehicle's crashworthiness plays its role in determining the severity of the outcome of the crash. The crashworthiness of the vehicle is often described by its *secondary* safety features.

Considering crashworthiness as the risk that a given crash is serious

Newstead et al. [2] operationalised the concept of crashworthiness as an adjusted rate of serious and fatal driver fatalities per tow-away crash, with a lower number indicating better crashworthiness. Newstead et al. [2] reserve the term "crashworthiness" to the self-protection of the driver, and use the term "aggressivity" to characterise the risk that a vehicle poses to the drivers of other vehicles (or pedestrians) in a crash involving more than one crash unit. The overall measure of risk to any driver or vulnerable road user in a crash is called "total secondary safety" [2].

The crashworthiness of vehicles related to vehicle year of manufacture

It seems intuitive that a newer vehicle fleet is a safer vehicle fleet. And prior research results appear to support this idea. For the present purpose, it will be assumed that age-related crashworthiness relates to improving design with successive

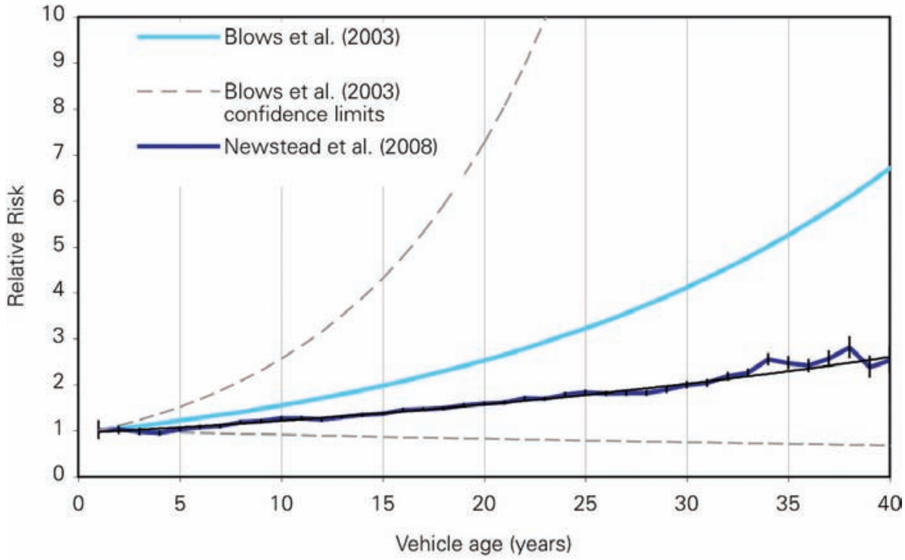

Figure 1: The relationship between average crashworthiness and vehicle age, relative to vehicles that are one year old, based on Newstead et al. [2] and Blows et al [3]

vehicle model releases, rather than age-related vehicle condition. Vehicle age therefore represents improving built-in crashworthiness, not roadworthiness.

Newstead et al. [2] found that the average crashworthiness of vehicles in each particular age cohort improves with year of manufacture, implying that drivers of newer cars are less likely to be killed or admitted to hospital after a crash. The average crashworthiness value for all vehicles in their sample was 3.8%, the best average crashworthiness was for vehicles manufactured in 2003 at 2.17% and the worst for vehicles manufactured in 1969 at 6.42%. On average, injury risk also decreased as the year of manufacture increased, similarly to injury severity. Similar trends were observed when the vehicle fleet was divided into market groups - e.g. small cars, four wheel drives, etc.

If an exponential function is fitted to the measured relationship between average crashworthiness and age measured by Newstead et al. [2], the decrease in average crashworthiness of passenger vehicles is 2.53% per year of age (Figure 1).

In a case control study conducted in the Auckland region, Blows et al. [3] also found that there were crashworthiness benefits from newer vehicles. The focus of the study was light vehicles driving on nonlocal public roads between April 1998 and July 1999. In the study, 615 drivers who had been involved in a crash where an occupant had been hospitalised or killed were identified, of which 571 were interviewed. Controls were selected by stopping all vehicles at a randomly assigned location and time on a non-public local road to achieve a representative sample of 746 control cars, of which 588 drivers where interviewed. The analysis of the effect of vehicle age on crash outcome included numerous adjustments. Covariates that were found to be significant were drivers age, sex, education level, ethnicity, time of day, acute sleepiness score, marijuana and alcohol use before the crash, seatbelt use, driving exposure in hours per week, licence type, current vehicle safety inspection certificate, insurance status of the vehicle, number of passengers, travelling speed and engine size.

After the model was adjusted for all these covariates it was found that there was, on average, a 5% increase of the risk of being involved in a serious injury crash with each additional year of vehicle age, but with confidence intervals of -1% to 11%. When vehicle ages where grouped by vehicle year: pre-1984, 1984-1989, 1989-1994 and post-1994 it was found that the risk was 2.88 times higher for pre-1984 vehicles than post 1994 vehicles, but was only 1.38 times higher for 1989-1993 vehicles and 1.02 times higher for 1984-1989 vehicles.

Vaughan [4] looked at the relationship between vehicle age and safety, based on vehicle occupant deaths in New South Wales. The author found that the occupant death rate per kilometre travelled was consistently higher for older vehicles. In 1991, occupants of vehicles that were at least 13 years old had twice the death rate per kilometre travelled compared with occupants of vehicles that were less than 4 years old.

The relationships between average crashworthiness and vehicle age from Newstead et al. [2] and Blows et al. [3] are shown in Figure 1.

Objectives

In this Paper, the vehicle age-related crashworthiness of the South Australian fleet will be examined. The Paper is organised as follows:

- the composition of the South Australian registered fleet is described;
- the distribution of vehicle ages in the South Australian fleet is calculated;
- a comparison is made between the distribution of the ages of the registered passenger vehicle fleet in various Australian jurisdictions, at which point an estimate is made of the relative crashworthiness of the South Australian registered passenger fleet;

- adjustments are made for crash exposure; and finally
- some observations of the ages of vehicles crashed by younger and older drivers are made.

Methods

Data sources

Two data sources were used in the analysis of the registered fleet:

- Data from the registration and licensing database held by the South Australian Department for Transport, Energy and Infrastructure describe the current composition of the South Australian registered fleet. The Safety and Regulation Division produces a regular report of current registrations from "TRUMPS". Vehicles are categorised in the TRUMPS report by vehicle type, body type, configuration and insurance class.
- The Australian Bureau of Statistics (ABS) produces a regular report "Motor Vehicle Census" (9309.0) and associated data tables. At the time of writing, the most recent data from the ABS on vehicle registrations was a census taken on the 31st of March 2007.

For the distribution of ages of the South Australian crashed car fleet, data from the South Australian Traffic Accident Reporting System was used.

Determining vehicle ages

In this study, vehicle age will be defined in accordance with the definition used by the ABS in the regular censuses of motor vehicle registrations [5]. For vehicles manufactured in the year current with the census or query, vehicle age is defined as

Vehicle age = Reference month/24

where the reference month is the number of whole months at the end of which the query or census is performed. For vehicles manufactured in previous years, vehicle age is defined as

Vehicle age = Current year - Year of manufacture + (Reference month - 6)/12

These definitions assume a constant rate of manufacture throughout the year, and provide the average age of each cohort of vehicles.

Fitting a statistical distribution to vehicle ages

The Wiebull distribution [6] (often used in survival analysis) was fitted to the vehicle age data. Note that the normal interpretation of Weibull parameters in survival analysis may not apply, as the distribution of vehicle ages is not a distribution of survival times. The justification of the use of the Weibull distribution is its goodness-of-fit.

The Weibull cumulative distribution is given by

$$F(t) = 1 - e^{-(t/\eta)^{\beta}} \quad (1)$$

Rearranging and taking the natural logarithms of both sides of the distribution gives

$$\ln(-\ln(1-F(t))) = \beta\ln(t) + \beta\ln(\eta) \quad (2)$$

which is in the form

$$y = ax + b$$

Hence, a test for the suitability of the Weibull distribution can be made by plotting the function on the left hand side of (2) against the logarithm of time. The goodness-of-fit can then be assessed by the linearity of the resulting function.

Transforming the distribution of vehicle ages to a distribution of average crashworthiness

Both Newstead et al, [2] and Blows et al. [3] identified improvements in average relative crashworthiness that could be expressed as a constant rate from one year to the next; that is:

$$c_{rel} = (1+r)^t \quad (3)$$

where c_{rel} is the relative crashworthiness of a vehicle compared to a newly manufactured vehicle (age t = 0), r is the rate of increase in the crashworthiness number per time, t (recalling that a higher crashworthiness number indicates a higher rate of serious and fatal crashes). Taking logs of the both sides of this expression and rearranging gives:

$$\ln(t) = \ln\left(\frac{\ln(c_{rel})}{\ln(1+r)}\right) \quad (4)$$

Note that because the relationship given by Equation 2 is linear with respect to the natural logarithm of time, it is also linear with respect to the right-hand side of Equation 4. As such, Equation 4 provides a means of transforming a distribution of vehicle ages to a distribution of average age-related relative crashworthiness. A graph of the cumulative distribution of vehicle ages, plotted according to Equation 2, will also represent the cumulative distribution of the average age related crashworthiness of those vehicles when the x-axis is rescaled according to Equation 4.

It is important to note, that in applying this transformation to any given population of vehicles, that there is an implicit assumption that the makeup of the fleet is otherwise uniform across age cohorts in terms of crashworthiness and also across fleets where comparisons are made between those fleets.

Results

Age distribution of the South Australian registered fleet

The TRUMPS database records, amongst other items, the year of manufacture of each registered vehicle. The DTEI TRUMPS report provides this data by vehicle type.

Figure 2 shows the age distribution of passenger vehicles, utilities and vans registered in South Australia. The mean age of the vehicles in this data is 10.9 years and the median age is 8.9 years. The mean age varies between vehicle types. For 'Cars' the mean age is 11.2 years, 'Station wagons' – 9.7 years,

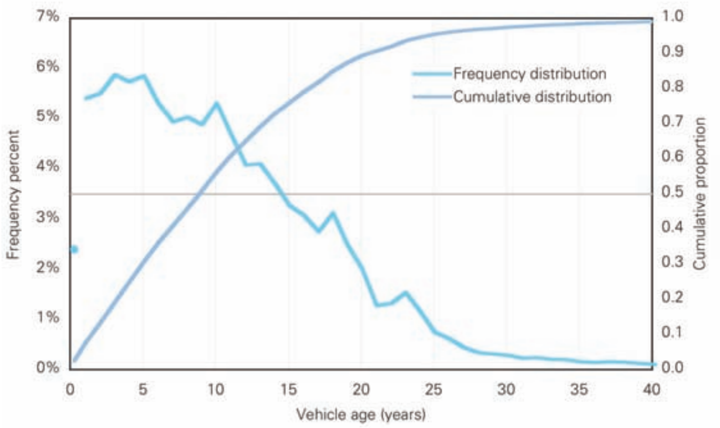

Figure 2: Age distribution of registered passenger vehicles, utilities and vans in South Australia as at 31/7/08. For the density distribution, vehicle age corresponds with the average age of vehicles in each particular bin. The first frequency bin covers a smaller cohort of vehicle ages than the subsequent age bins. (Source: DTEI TRUMPS report 31/7/08)

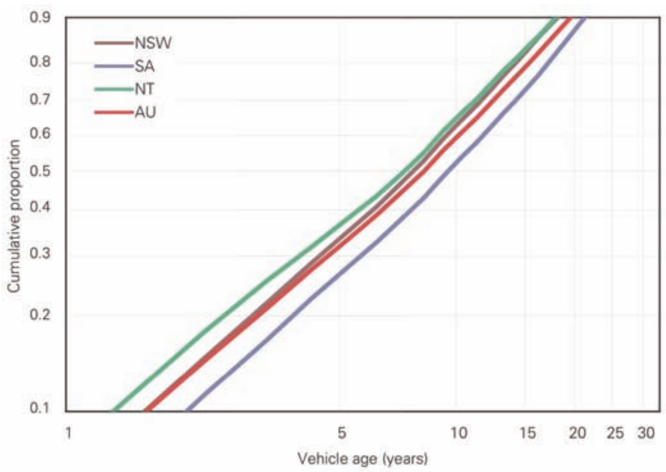

Figure 3: Cumulative distributions of registered passenger vehicles of some Australian jurisdictions. Axes are linear in the Weibull transformation (Weibull – log) [5]

'Panel vans' – 12.7 years and 'Utilities' – 10.5 years. The mean age of 'cars' plus 'station wagons', which broadly fits the ABS definition of 'Passenger vehicle' is 10.9 years, and the median age is 9.0 years.

The average age of the entire registered fleet, minus trailers and caravans, was also computed for the TRUMPS report. The average age of this segment was 11.36 years, compared with the ABS estimate of 11.1 years for South Australia [5].

A comparison with other States of Australia

Because of inconsistencies of vehicle body type definitions between States, the ABS perform their own categorisation of vehicle types based on make and model data, matched via the VIN code [5]. Hence some subtle differences between TRUMPS categorisations and ABS categorisations may exist. Inspection of the various definitions suggests that a combination of the TRUMPS categories of 'Cars' and 'Station wagons' would largely be equivalent to the ABS's category 'Passenger vehicles'. Utilities and forward control vans would be part of the ABS category 'Light commercial vehicles', which also includes vehicles up to 3.5 t GVM. For this reason, this Section examines differences between States in the ABS category 'Passenger vehicle'.

Figure 3 shows cumulative density functions of the ages of the registered passenger vehicle fleet of four Australian jurisdictions on a Weibull-log scale (representing the linear relationship expressed in Equation 2). Other States have not been included for clarity, but they are similarly linear on these axes.

The Northern Territory has the newest fleet of any Australian jurisdiction and Tasmania the oldest (not shown).

Least-squares regression suggests Weibull distributions as detailed in Table 1 for registered passenger vehicles in South Australia, New South Wales and Australia. Note that the mean and median vehicle ages of the fitted SA distribution are slightly higher than the equivalent numerical values, but are within 3%.

The probability density functions of the fitted Weibull distributions for Australia, NSW and SA are shown in Figure 4. Figure 4 also shows the age profile of the South Australian fleet given in Figure 2. The adequacy of the fitted distribution is apparent.

Figure 5 shows the age-distribution of the passenger fleets with the x-axis appropriately transformed to

show the relative age-related average crashworthiness of the registered passenger fleets for various Australian jurisdictions, assuming r = 2.53% decline in relative average crashworthiness with each preceding year of manufacture (after Newstead et al. [2]). Note that a rate of 2.53% appears to match the crude crashworthiness of vehicles in South Australia.

Table 1: Parameters of Weibull distributions (Equ. 1) fitted to the distribution of the vehicle ages of the registered passenger vehicle fleets of South Australia, New South Wales and Australia

State	Equation	R^2	beta	eta	Weibull median (years)	Weibull mean (years)
SA	ln(-ln(1-F(t))) = 1.2914 ln(t) – 3.2252	0.998	1.298	12.2	9.2	11.2
NSW	ln(-ln(1-F(t))) = 1.2486 ln(t) – 2.8852	0.999	1.248	10.0	7.4	9.3
Australia	ln(-ln(1-F(t))) = 1.2212 ln(t) – 2.8946	0.999	1.225	10.6	7.9	9.9

Note: R2 values refer to the correlation between ln(t) and ln(-ln(1-f(t)))

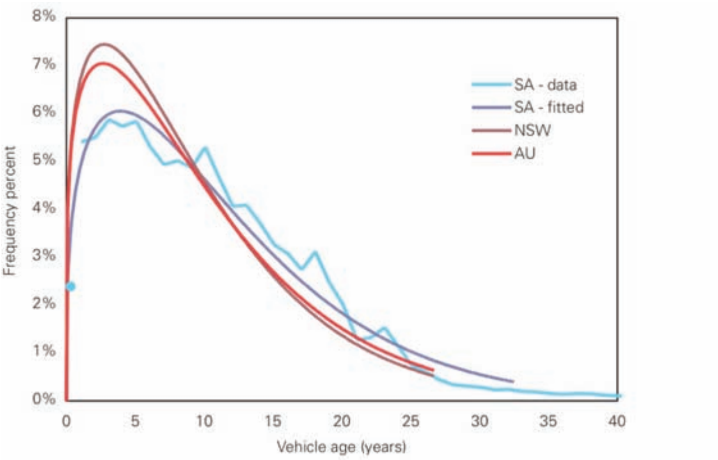

Figure 4: Fitted age distributions of registered passenger vehicles in SA, NSW and Australia as at 31/3/07. Actual data for South Australia is shown also

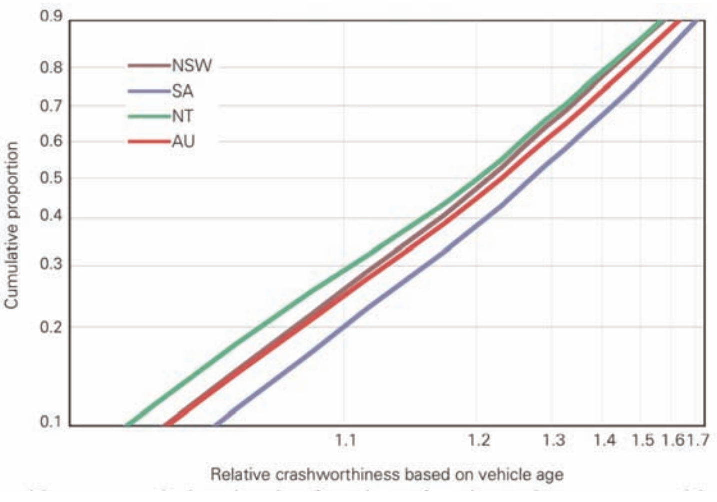

Figure 5: Crashworthiness cumulative density function of registered passenger vehicles in SA , NSW, NT and Australia as at 31/3/07 [5], based on a 2.53% p.a. decrease in average relative crashworthiness (i.e. an increase in the crashworthiness number).

As with the age distribution of each fleet, a linear function can be fitted to the relative age-related average crashworthiness distributions in Figure 5. Having done so, the mean and median relative age-related average crashworthiness of each fleet can be calculated. The results of these calculations are given in Table 2.

It may be noted that, assuming a 2.53% decline in relative age-related average crashworthiness with each preceding year of manufacture, the relative average crashworthiness (driver serious injury and deaths per tow away crash) of the national and NSW fleets are 3% and 4% lower than the average passenger vehicle in South Australia. If passenger vehicles involved in crashes were a random sample of vehicles from the registered passenger vehicle fleet, these numbers would imply that tow-away crashes in South Australia have a 3% over-representation of seriously injured or killed drivers compared with the national average.

Assuming that the age distribution of the passenger fleet is stable over time, the overall crashworthiness of the fleet will improve with the passage of time. Therefore the difference between the relative average crashworthiness of the South Australian registered passenger vehicle fleet and those of other fleets, can also be expressed as a time constant. For example, a certain time constant corresponds to the time that elapses

Table 2: Median and mean relative average crashworthiness of the registered passenger vehicle fleets of SA, NSW and Australia, assuming a crashworthiness improvement of 2.53% p.a. (after Newstead et al. [2])

State	Relative average crashworthiness (based on the ages of vehicles only)	
	Median of the fitted distribution (drivers seriously injured or killed/tow away crash relative to the new car rate)	Mean of the fitted distribution (drivers seriously injured or killed/tow away crash relative to the new car rate)
SA	1.26	1.32
NSW	1.20	1.27
Australia	1.22	1.28

before the future South Australian registered passenger fleet has an equivalent average crashworthiness to that of the current New South Wales or Australian registered passenger vehicle fleets.

Given that

$$\ln(c_{rel}) = t\ln(1+r)$$

it follows that the lag between the average crashworthiness of two fleets may be expressed as:

$$t_1 - t_2 = \frac{\ln c_1 - \ln c_2}{\ln(1+r)}$$

where c_1 and c_2 are the mean average relative crashworthiness of each fleet. As such, the time lag between the mean crashworthiness of the South Australian and New South Wales passenger fleets is 19 months and between the South Australian and Australian passenger vehicle fleets, it is 14 months.

Adjustments for crash exposure

An alternative to examining the distribution of crashworthiness of registered vehicles, is to consider the distribution of crashworthiness among vehicles that actually crash – it is for this subpopulation of vehicles that crashworthiness is most relevant. Rather than applying an adjustment by weighting each vehicle age by a crash rate, the following analysis examines the distribution of the ages of crashed cars directly.

The number of vehicles involved in serious and fatal crashes in each vehicle age cohort will not be independent of the vehicle age (as the rate of such crashes per tow away crash is believed to increase with vehicle age) so, it is appropriate to examine the vehicle age distribution of the entire crashed car fleet.

The South Australian Traffic Accident Reporting System (TARS) was queried to extract data on crashed vehicles from the 5 year period 2003-2007, where the severity of the crash was either $3,000 damage (the minimum report processing limit) or worse. Vehicle types included were: “Car”, “Station wagon”, “Panel van”, “Utility”, “Taxi cab”, “Motor vehicle – type unknown”, “Forward control passenger van”, and “4WD” (separately coded for fatal crashes only). It should be noted that the vehicles examined were all vehicles of the types mentioned above, involved in each crash, and the severity of the crash relates to the highest injury severity of any person involved.

The ages of vehicles at the time of the crash were calculated. Some averaging was required to do this. The year of the vehicle’s manufacture is recorded in the TARS database, and also the date of the crash. In this sense, the date of the crash may be considered analogous to the census date the ABS census of motor vehicle registrations. So while the exact age is not ascertainable from the TARS record, the average of all possible ages can be determined from the following equations:

Vehicle age = Month of crash/24

for vehicles which crash in the same year as the year of manufacture, and

Vehicle age = Year of crash - Year of manufacture + (Month of crash - 6)/12

for vehicles that were manufactured in any year prior to the year of the crash.

The distribution of vehicle ages of the crashed vehicles is shown in Figure 6. The cumulative distribution of the vehicles’ ages is shown on transformed axes (Weibull – log axes) with the age distribution of the registered passenger vehicle fleet in Figure 7.

At this point, it is pertinent to use the TARS data to calculate the crude relationship between vehicle age and crashworthiness in this set of crash records. To do this, the TARS query was altered to extract only those crashes that resulted in at least one person being admitted to hospital, or killed (i.e. serious or fatal crashes). For each age cohort of vehicles, the number of serious or fatal crashes was expressed as a rate, per crash of any severity (>$3,000 damage). The results of this are shown in Figure 8. An exponential line was fitted to the data, which indicates an increase in the rate of serious and fatal crashes of 2.8% per year of vehicle age, an increase almost identical to that adjusted rate of driver serious injuries and fatalities per tow away crash estimated by Newstead et al. [2].

Possible changes to the number of serious and fatal crashes arising from altering the vehicle age distribution of the crashed car fleet

In the previous Section, it was noted that the distribution of the age of the crashed passenger vehicle fleet was somewhat represented by the distribution of ages of the passenger fleet in general. It will therefore be assumed that changes to the distribution of vehicle ages in the registered passenger vehicle

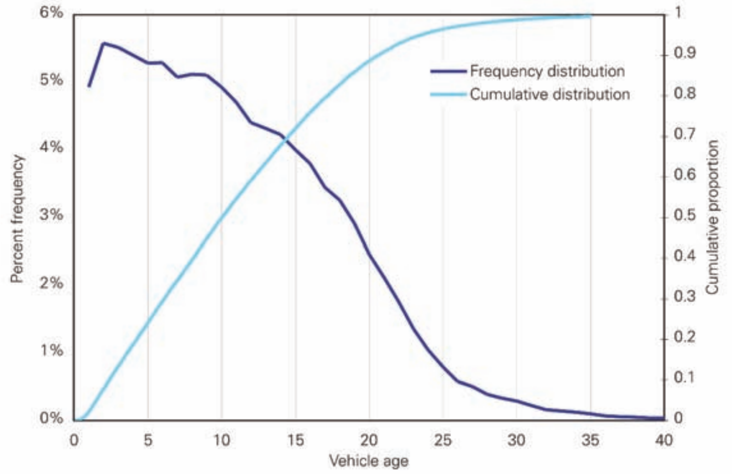

Figure 6: Age distribution of crashed passenger vehicles, utilities and vans in South Australia between 2003-2007 (Severity >= $3,000 damage). For the frequency distribution, vehicle age corresponds with the average age of vehicles in each particular bin.(Source: TARS)

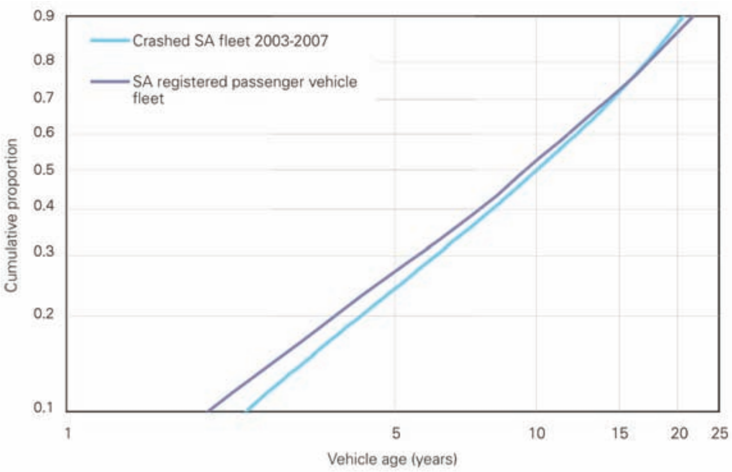

Figure 7: A comparison between the cumulative distributions of the crashed vehicles (shown in Figure 6) and the registered passenger fleet.

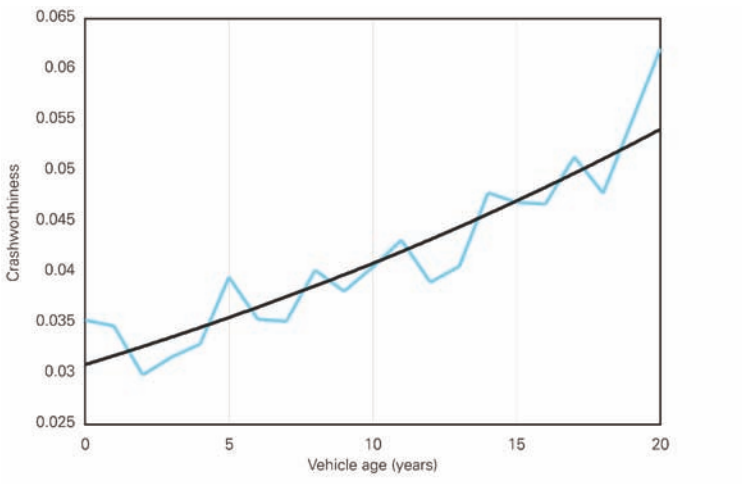

Figure 8: Unadjusted crashworthiness calculated from raw South Australian crash data 2003-2007. Crashworthiness is calculated as the number of serious and fatal crashes per crash where the damage cost was at least $3,000. The average increase in the serious injury/fatal rate is 2.8% per year of vehicle age.

fleet would also be reflected in the distribution of vehicle ages in the crashed car fleet.

To confirm the earlier estimate of a 3% benefit of bringing the distribution of the general fleet into line with the overall Australian fleet, a simulation of crash severity was undertaken using all crashes that occurred from 2003-2007.

In this simulation it was assumed that the total number of crashes is constant. So the effect of altering the distribution of vehicle ages (and the related crashworthiness) would be to alter the distribution of severity within the sample of crashes.

Two simulations were performed:

- the first was to apply the age distribution of the Australian average fleet to the total number of crashed vehicles to estimate the effect of bringing the ages of crashed vehicles into line with the Australian average. That is, the proportion of the total number of crashed vehicles in each vehicle age group reflected that age group's representation in the entire Australian Fleet;

- the second simulation determined the required change in the vehicle distribution to effect a 10% reduction in the number of serious and fatal crashes in the State.

Applying the distribution of vehicle ages of the Australian average fleet

The actual distribution of vehicle ages of crashes reported to police in South Australia between 2003 and 2007 is given in Figure 6. The simulation will assume that this distribution is changed to reflect the Australian registered passenger vehicle fleet as shown in Figure 4 and given mathematically in Table 2.

The normalised frequency distribution of the vehicle ages of the Australian passenger vehicle fleet was multiplied by the total number of crashed vehicles in the 2003-2007 period (162,703 crashed vehicles) to arrive at hypothetical numbers of crashed vehicles in each age group. From Figure 7, crashes involving the newest vehicles include 3% that are serious or fatal. This number was applied to crashes involving vehicles in the first age group (age = 0, with an average age of 0.5 years) to arrive at a hypothetical number of serious and fatal crashes involving brand new passenger vehicles equal to 114.7.

The process was then repeated for every other vehicle age group (from 1 to 65 inclusive) but compounding the rate of serious and fatal crashes by 2.53% per year of vehicle age. Finally the total number of hypothetical serious and fatal injury crashes was calculated.

To validate the procedure (and for comparison purposes), the procedure was repeated using the Weibull distribution fitted to the actual South Australian registered passenger vehicle fleet: this produced an estimate of an average of 1325 serious and fatal crashes per year over the period (compared to the actual value of 1360 crashes per year).

The simulation predicted that, if the distribution of vehicle ages of passenger vehicles crashed in South Australia were representative of the average Australian registered passenger vehicle fleet, there would be 47 fewer serious and fatal crashes per year, or 3.5%. This number is close to the estimate made earlier.

Producing a 10% reduction in serious and fatal crashes

The Weibull distribution fitted to vehicle ages in the Australian registered passenger vehicle fleet is described in Table 2. Recalling that the Weibull distribution is given by:

$$F(t) = 1 - e^{-(t/\eta)^{\beta}} \quad (1)$$

the values for beta and eta for the Australian fleet are 1.225 and 10.6. Comparing the values of beta amongst Australian jurisdictions reveals it to be relatively constant.

The simulation used in the previous Section was altered to reframe the question from, what effect on the serious and fatal crashes would a change in beta and eta have (i.e. making the SA fleet similar to Australia's fleet), to what change in eta (holding beta constant) would effect a 10% reduction in the number of serious and fatal crashes in South Australia. The "goal seek" function in Microsoft Excel was used to determine the appropriate value of eta.

The resulting value of eta was 8.03 (beta = 1.225), giving a fleet with an average vehicle age of 7.5 years and median of 6 years. The resulting distribution is shown alongside the distributions of current vehicle ages of various Australian jurisdictions in Figure 9. It may be noted that the relative numbers of vehicles 5 years or younger would need to increase by approximately 50%. The resulting fleet would be the youngest of any Australian jurisdiction.

Observations related to driver age

A subject of repeated observation is the over-representation of young drivers in crashes. In the years 2003-2007, drivers under 25 years of age were involved in around 24% of all reported crashes (at least $3,000 damage) and in around 29% of all serious and fatal crashes (Source: TARS). They therefore also have a higher serious/fatal crash rate in general.

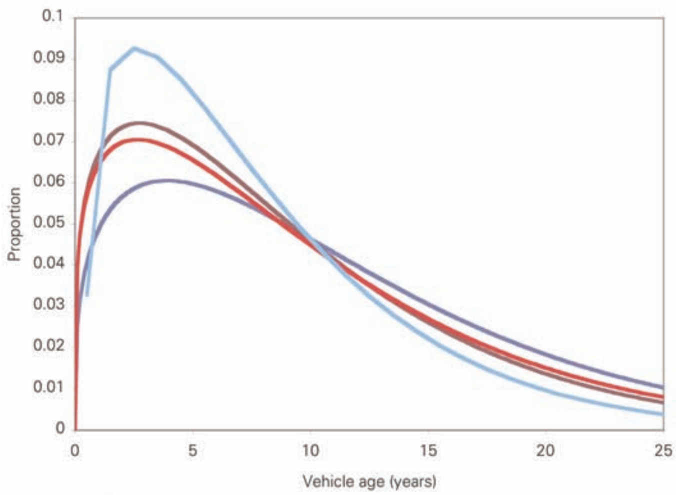

Figure 9: An estimate of the distribution of vehicle ages in South Australia required to effect a 10% reduction in the number of serious and fatal crashes.

Figure 10 shows that there is a correlation between the age of the driver and the age of their vehicle in crashes in South Australia. The graph in this Figure shows that the modal vehicle age for vehicles involved in crashes and driven by teenage drivers is around 11 years, whereas for drivers over 30 who crash, the modal (most common) vehicle age is around 2 years.

These differences are emphasised further in Figures 11 to 13. These Figures show the distribution of vehicle ages in crashes for drivers 25 years and older, the same distribution but for drivers younger than 25 years and finally, the cumulative age distributions shown on transformed axes that show the cumulative proportions of vehicles in crashes driven by the two age groups, plotted against the relative age-related average crashworthiness of the vehicles.

Figure 14 shows the crude crashworthiness of vehicles showing the dependence of the apparent rate of serious and fatal crashes on the age of the driver. In effect, vehicles appear less crashworthy when crashed by a younger driver.

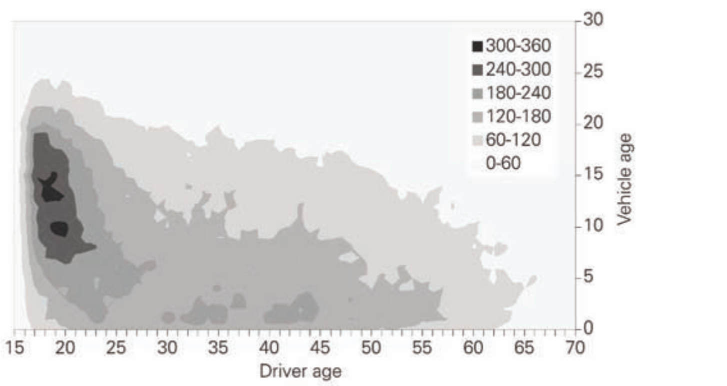

Figure 10: The number of crashes in the 5 years 2003-2007, disaggregated by vehicle age and driver age

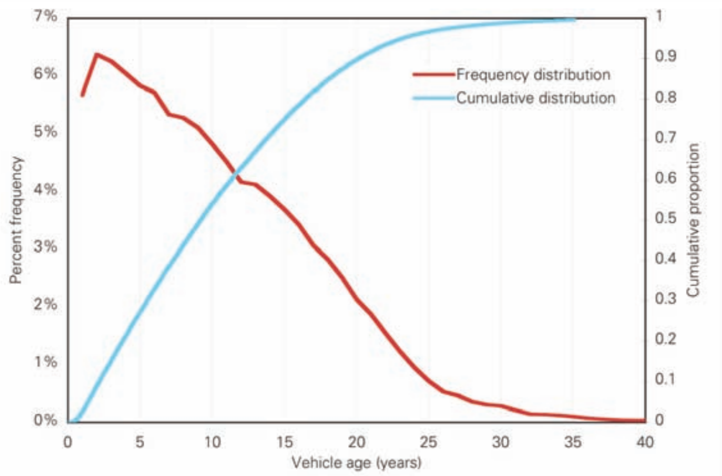

Figure 11: Age distribution of crashed passenger vehicles, utilities and vans in South Australia between 2003-2007 (Severity >= $3,000 damage) for drivers aged >= 25 years. For the frequency distribution, vehicle age corresponds with the average age of vehicles in each particular bin.(Source: TARS)

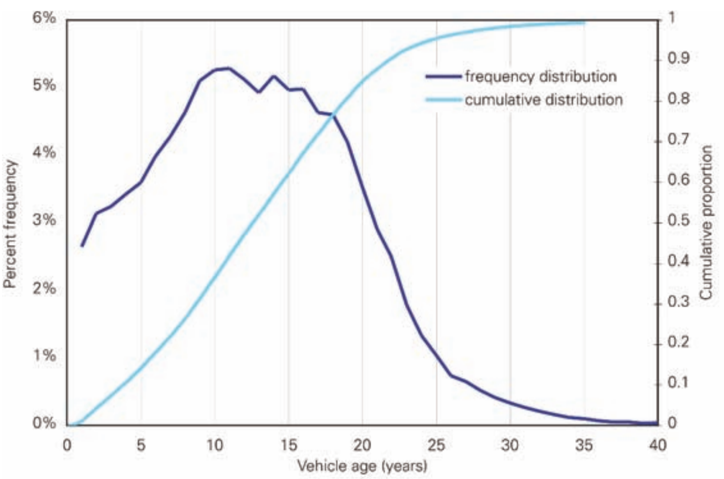

Figure 12: Age distribution of crashed passenger vehicles, utilities and vans in South Australia between 2003-2007 (Severity >= $3,000 damage) for drivers aged < 25. For the frequency distribution, vehicle age corresponds with the average age of vehicles in each particular bin.(Source: TARS)

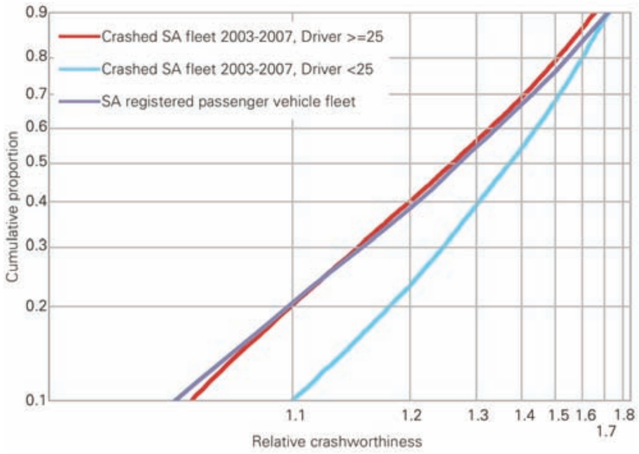

Figure 13: Cumulative distributions of registered passenger vehicles in South Australia and the crashed vehicle fleet for younger and older drivers. Axes are linear in the Weibull transformation (Source: TARS)

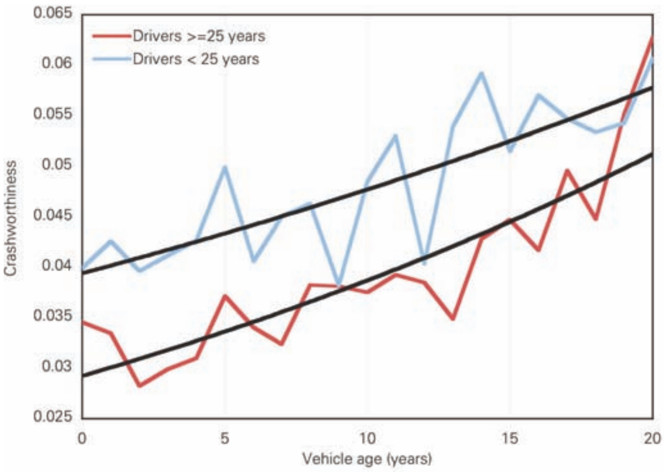

Figure 14: Unadjusted crashworthiness calculated from raw South Australian crash data 2003-2007. Crashworthiness is calculated as the number of serious and fatal crashes per crash where the damage cost was at least $3,000.

Discussion

There appears to be a modest but measurable road safety benefit associated with reduction of the vehicle fleet age. Vehicle age has been correlated with increased crash risk and crash severity (Newstead et al, [2]; Blows et al, [3]) and accordingly, there is probably more serious and fatal crashes in South Australia due to the State's generally older vehicle ages. If the distribution of vehicle ages in South Australia was representative of the current distribution of vehicle ages in Australia, then, all other factors being equal, there would be 3.5% fewer serious and fatal crashes in the State. This is equivalent to the natural changes in the fleet that occur over 14 months.

However, to effect a 10% reduction in the number would require radically altering the distribution of vehicle ages, including increasing the number of cars under 5 years old by around 50%.

For analysis purposes, crashed cars appear to be represented by the registered fleet. This is somewhat surprising given that vehicle kilometres travelled declines with vehicle age [7]. It may be that crash involvement per kilometre travelled is not independent of the distance travelled by a vehicle. Certainly there is some evidence that drivers who drive less have a higher per kilometre crash involvement [8, p. 83]. The bias in the age of drivers of older vehicles may also be a confounder.

Cars appear less crashworthy in South Australia when a young driver (<25) is behind the wheel, as younger drivers have a higher rate of serious and fatal crashes per crash of any severity. This effect exacerbates the poorer average crashworthiness of vehicles crashed by this age group: the modal age of vehicles crashed by drivers under 25 years of age is the vicinity of 10-15 years, whereas the modal age of vehicles crashed by drivers aged 25 years and older is around 2 or 3 years of age. The differences between the ages of vehicles driven by younger drivers and the general registered fleet may be of more practical significance than the fact that the South Australian fleet is older than the Australian average or than other Australian jurisdictions.

Similarly, it is instructive to place the results of this study in the context of the differences in crashworthiness between market groups. On the measure of the rate of seriously and fatally injured drivers per tow away crash, based on the average age of vehicles in the registered fleet, South Australia exceeds the national average by 3%. Compare this with the crashworthiness of the average new model light passenger vehicle which is around 4%, twice that of the average new model large vehicle (Newstead et al., [2], p87). The mix of models in the fleet is likely to be far more influential on crashworthiness than small movements in the average age of vehicles.

This points to a limitation of the analysis in this study: when computing and comparing the age-related crashworthiness of the different fleets, the assumption has been that in all other respects (fleet mix, driver characteristics, crash configurations) fleets are equivalent across jurisdictions.

While this study has examined the crashworthiness of the South Australian registered passenger vehicle fleet, it has not investigated any factors that influence the composition of the fleet. It was noted that the South Australian fleet is older than the fleets of several of the other States of Australia and data not published in this paper indicate that, in South Australia, the number of vehicles built in a given year tends to increase for up to a decade after the build year, suggesting significant importation of second-hand vehicles from interstate. Similar data from New South Wales indicated an immediate decline in the number of vehicles of given build year in subsequent years.

The influence of new-car safety on the fleet's average safety is not immediate. Of course, if all vehicles were replaced instantaneously with new vehicles, there would be a significant benefit, but the reality is that a benefit of that sort of magnitude takes many years to realise. The young drivers that will crash the new cars being built today are currently young children and it is only once these children grow old enough to drive, that the benefits of today's new car technology will be fully realised. In the shorter term, there may be merit in understanding the impediments to young drivers driving newer (and safer) vehicles; for example, there may be restrictions/surcharges on vehicle insurance that discourages the use of newer cars to members of households that are young drivers.

With this in mind, rather than be concerned about the ages of vehicles in the fleet, it may be more fruitful to instead focus on trends in vehicle safety technology and other safety related characteristics of the fleet, particularly with vehicles entering the registered fleet for the first time (either as new cars or as imported second-had cars). It is probable that positively influencing the level of safety in vehicles entering the registered fleet will have road safety benefits many years into the future.

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Simulation of Rural Travel Times to Quantify the Impact of Lower Speed Limits

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Abstract

The number and severity of rural road crashes has been shown to decrease with reduced travelling speed. One method of reducing the travelling speed on rural roads is to reduce the speed limit of those roads. Despite the considerable road safety benefits resulting from reduced speed limits, public opposition to the change exists. One of the main concerns of the public is the perceived increase in travel times associated with a reduction in speed limit.

This study quantifies this increase in travel time on a rural road if the sign posted speed limit of 110 km/h was replaced with the default speed limit of 100 km/h. A Markov simulation model of travel time on an undivided rural road was developed. The model includes factors such as vehicle speed distributions, vehicles travelling in the opposite direction and the ability for vehicles to perform an overtaking manoeuvre. Real data collected on rural roads in South Australia that have had a similar reduction in speed limit are used to define the distribution of speeds of vehicles before and after the change in speed limit.

The model shows that the increase in travel time is less than is first predicted by considering only the allowed speed limit. The model also shows that a driver who desires to maintain a constant travel speed must overtake more often when the speed limit is higher than when it is lower.

Keywords

Speed Limit, Rural Road, Travel Time, Simulation Model, Overtaking

Introduction

It is clear that reducing the speed of all vehicles on a road network has a positive safety benefit [1,2]. The safety benefits of reduced travel speed include a reduction in the number and severity of crashes that occur on the road. There are several ways of reducing speeds on the road network, the most common of which include lowering speed limits and enforcement combined with mass media activity. This paper focuses on the modelling of travel times brought about by lower speed limits.

In South Australia, speed limits were reduced on 1060 km of rural roads from 110km/h to 100km/h, resulting in a reduction in casualty crashes of 12% and crash savings of $9.5 million per year [1]. An opportunity existed to use the data from these changes to explore the issue of travel times.

Despite the road safety benefits of reduced speed limits, a reduction in speed limit is often perceived by the public as a change that severely increases the time taken to complete a journey. This perception was shown in a metropolitan setting when considering a reduction in speed limit from 60 km/h to 50km/h [3]. A simple analysis, using equation (1) indicates that the travel time will indeed increase after a reduction in speed limit. For a speed limit change from 110 km/h to 100 km/h, an increase in time of 10% is expected.

$$Time = \frac{Distance}{Speed} \quad (1)$$

However, other parameters also affect the time taken to travel a road. These other parameters include the influence of other traffic on the road and the length of road which can actually be traversed at the speed limit, as restrictions may be placed on the driver due to geometrical constraints. In order to accurately calculate the increase in time taken due to a reduction in speed limit, these other parameters should also be taken into account.

The first of these additional parameters, the influence of other vehicles on travel time is investigated in this study. At present the influence of road geometry independent of overtaking constraints is not modelled. Other vehicles on the road network have two immediate qualitative effects. Firstly, when a slower vehicle is encountered by a faster vehicle, the faster vehicle must slow to the speed of the slower vehicle to avoid a collision. The number and distribution of slower vehicles on the road network therefore influence the travel time on a rural route. Secondly, overtaking can only be performed when either a dedicated overtaking lane is present, or there is no oncoming traffic and there is sufficient sight distance for the faster vehicle to overtake.

However, the change of speeds of each individual vehicle is not equal to the change in speed limit. This has been observed in both a metropolitan setting [4] and also a rural setting [1]. Furthermore, the reduction in speed is not uniform for all vehicles in the speed distribution [4].

To investigate the effect of the variable slowing of traffic after a speed limit change, a simple mathematical model of travel time was developed using several Markov chains. The mathematical model was developed to provide a tool which would be useful for engaging the public in the debate over a reduction in speed limits. As a tool, the model provides additional information for the public relating to the journey in addition to the increase in travel time that results from a decrease in speed limit. As a simple mathematical model, the absolute values that are reported need to be validated, but the relative values provide insight for the public. Markov chains are frequently used to describe systems where queues are involved, such as calls arriving at a call centre, and customers waiting in a line to be served at a shopping centre. In traffic theory they have been used to describe the level of congestion on links of a highway [5] and for an analysis of travel time on a unidirectional highway [6]. However, to the authors' knowledge, Markov chains have not been used to describe the discrete states of travel which are determined by following of slower vehicles until an overtaking opportunity presents itself on a single lane rural road.

Computational software is available to determine various aspects of travel on rural roads in an Australasian context [7], but typically a detailed input of the distribution of speeds of vehicles on the road is not possible [8,9]. Generally, the computational software that is available are micro-simulations [7] where various vehicles are placed on a length of highway and their interactions with each other are simulated. The model developed in this paper considers only the vehicles which interact with the modelled vehicle: slower vehicles that are in front of the modelled vehicle and all vehicles travelling in the opposite direction to the modelled vehicle.

The Markov chain used in this study allows a driver to maintain a steady speed unless he or she is restricted by a driver in front who has a slower desired speed. The model also allows for passing only when sufficient sight distance is available and there are no opposing vehicles, or when a passing lane is available. After a large number of simulations, the distribution in travel times for a particular road was obtained.

Methods

Data

The travelling speeds of cars on rural roads was taken from the raw data used to compute the summary statistics of average speed presented in Long et al [1]. Data in this study was obtained for sites where a speed limit reduction from 110 km/h to 100 km/h occurred on July 1 2003. One week of speed data was used to derive the speed distribution at each site. For simplicity, two sites at which data were available were used in this study: one near Pt Clinton, and one between Murray Bridge and Jervois. They were chosen because they represented sites with the most traffic, and each had a high proportion of vehicles travelling at a free speed. A free speed for the purpose of this study was defined as a vehicle with headway, or time gap between itself and the previous vehicle, of not less than four seconds. Free speeds are commonly used to represent the chosen speed of a driver independent of other vehicles on the road. Details of the two sites chosen are presented in Table 1.

Table 1: Details of the sites selected for use in this study.

Site	Speed limit	Date range of speed observations extracted	Number of vehicles during observation period	Vehicles at free speed	Average free speed (km/h)
Port Clinton	110	29 Jan – 4 Feb 2003	12 730	84.7%	101.1
	100	29 Oct – 4 Nov 2003	12 459	85.7%	99.3
Murray Bridge	110	4 Dec – 10 Dec 2002	8 797	90.3%	96.8
- Jervois	100	10 Sep – 16 Sep 2003	7 882	90.8%	96.2

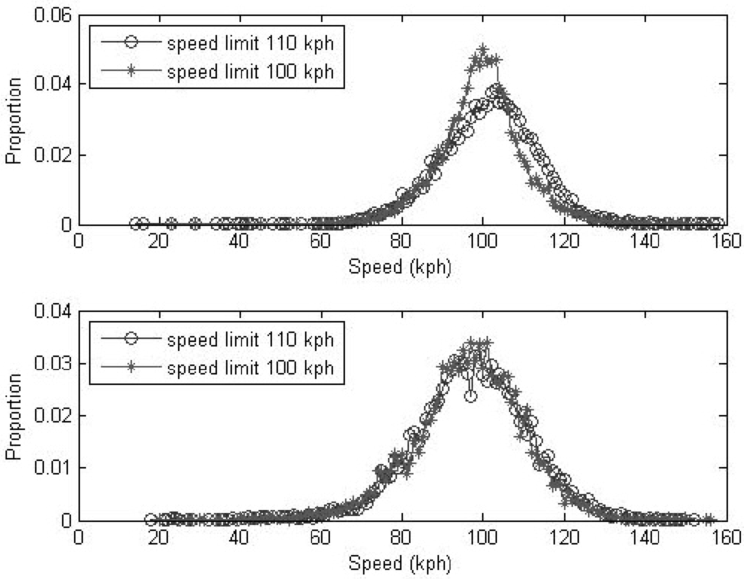

Figure 1: Speed distributions before and after the change in limit for each site: Pt Clinton (above) and Murray Bridge - Jervois (below)

The distributions of free speed for each site are shown in Figure 1. This demonstrates that the magnitude of speed reduction following the speed limit change does not simply match the difference in speed limit.

Model

The model uses three variables in order to determine the travelling time and average speed of a vehicle on a rural road. These three variables are:

1. The speed of the modelled vehicle,
2. The status of the lane that is being driven in (explained later)
3. The presence of an opposing vehicle that would restrict an overtaking manoeuvre.

The first variable is used to determine the travel time for each journey. The remaining two variables are used to determine if an overtaking manoeuvre can be performed. Each variable is modelled using a Markov model and are briefly described in the following sections. A more thorough description of the model is included in the Appendix.

A Markov model

Briefly, a Markov model is a memory-less stochastic process. If *X(t)* is a continuous time Markov chain then a notation to indicate that the Markov chain is in state *j* at time is *t* given by equation (2).

$$X(t) = j \qquad (2)$$

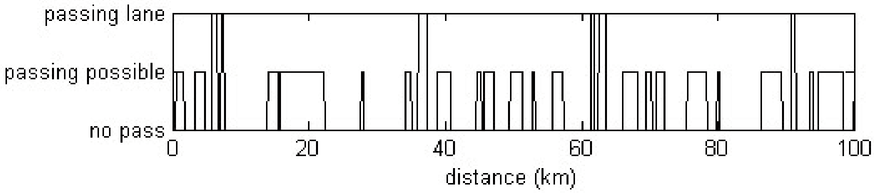

Figure 2: The model with constant overtaking opportunities

If we assume that the Markov chain has a finite number of possible states, I , and that the notation $P\{p|q\}$ is the probability of p given q; then the definition of a continuous time markov chain is given in equation (2)

$$P\{X(t+\Delta t)=j|X(t)=i, X(u)=x(u), 0\leq u\leq t\} =$$

$$P\{X(t+\Delta t)=j|X(t)=i\} \quad (3).$$

For all $t, \Delta t \geq 0$ and $i, j, x(u) \in I$.

Or, more simply; the probability of making a transition from a state $X=i$ to state $X=j$ is dependant only on the state i and not on the complete time history of X. That is, a Markov chain is memoryless.

The particular Markov model used is built from three continuous time Markov models:

$$X(t) = \{S(t), L(t), H(t)\} \quad (4)$$

Where

S(t): speed at time t (km/h)

L(t): lane state at time t)

H(t): state of the safe distance at time t.

Speed model

The modelled vehicle has a maximum speed and a desired speed equal to the speed limit. The speed of the modelled vehicle may be slower than the desired speed because the modelled vehicle will encounter other vehicles travelling at a speed less than the speed limit. Each time the modelled vehicle encounters a slower moving vehicle, the modelled vehicle duplicates the speed of the slower vehicle until an overtaking opportunity arises. If further successive slower vehicles are encountered while the modelled vehicle is already following a slower vehicle, the modelled vehicle duplicates the speed of the slowest vehicle. This speed is maintained until an overtaking opportunity arises and the modelled vehicle overtakes all vehicles in front of it.

Slower (and faster) vehicles are distributed in front of the modelled vehicle using a Poisson distribution.

The Poisson distribution is used in order to keep the model simple. It is the simplest distribution possible for a Markov model and does not model platooning of vehicles and consequently requires the number of overtaking opportunities to be high and the density of traffic low.

Lane model

Each lane model has three different types of lane:

$$L(t) = \begin{cases} 1 & \text{where no overtaking is allowed, eg. on bends} \\ 2 & \text{where overtaking is allowed if safe} \\ 3 & \text{where an overtaking lane exists} \end{cases}$$

Modelling was conducted in two phases. The first phase assumed a fixed length of 100km of road with each of the three lane states distributed as shown in Figure 2. The fixed overtaking opportunity road was generated using a single run of this Markov model for 100 km using the parameters detailed in the appendix. This lane will be referred to as the model with constant overtaking opportunities.

The lane with constant overtaking opportunities is distinct from the lanes used in the second phase which was conducted to explore the influence that variations in overtaking opportunities have on travel times. The state of the lane with the varying overtaking opportunities was determined during each simulation using a Markov model that is described in detail in the appendix.

Safe overtaking distance model

The safe overtaking distance is the distance from the modelled car to the furthest car that is travelling in the opposite direction that would impede an overtaking manoeuvre from occurring if it was going to be attempted. An overtaking manoeuvre would only be attempted if it were in a lane where overtaking was possible. Cars travelling in the opposite direction to the modelled vehicle enter this safe overtaking distance with a Poisson distribution. Cars will sequentially leave this safe overtaking distance at a rate which uses the distribution of speeds used in each simulation. The safe distance considered is a function of the speed difference between the vehicle being followed and the desired speed of the modelled vehicle. A shorter overtaking length is required if the modelled vehicle is travelling much slower than its target speed.

Overtaking

Overtaking is possible in the model when either the modelled vehicle is in a passing lane or in a lane where passing is possible if safe. When an overtaking opportunity arises, and the modelled vehicle is travelling at less than its desired speed the modelled vehicle overtakes and resumes its desired speed. If the modelled vehicle is following two or more slower vehicles, the modelled vehicle overtakes all slower vehicles when an overtaking opportunity arises.

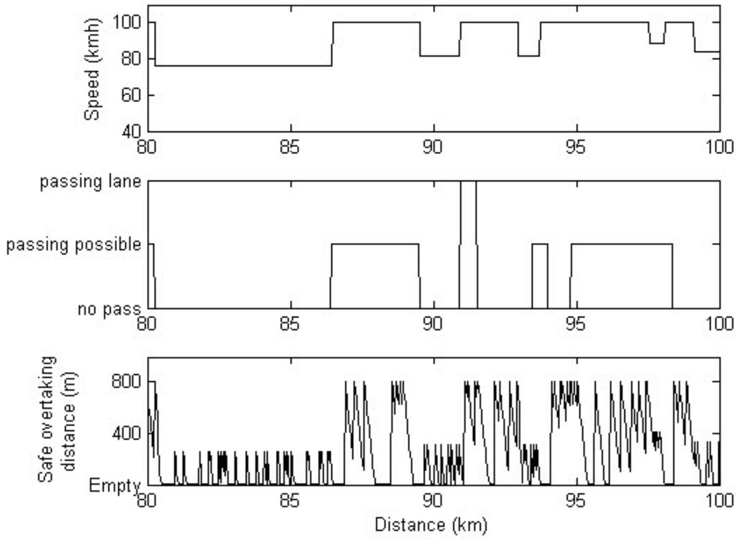

Figure 3: Typical simulation of the defined lane. Only the final 20 km of simulation is shown for clarity. High density traffic. Murray Bridge to Jervois speed distribution. 100 km/h desired speed.

For simplicity the distance required to move in front of the vehicle is set to be 40 metres in the model. This value is constant in the model, and hence the model considers all slower moving vehicles to be equally difficult to pass.

Simulations

Simulation was performed using Matlab (version 2009a) and processed using a desktop PC. A total of 1000 simulations were completed for each site for volumes of 1000, 3000 and 6000 vehicles per day averaged equally throughout the day for a single direction of travel. These volumes were selected arbitrarily to provide a range of situations for the modelling, referred to as low, medium and high traffic density in this paper. As an example, the traffic volumes of the roads from which the speed distributions were obtained had flows in the region of 1100-1800 vehicles per day, or 550 to 900 vehicles in one direction.

Results

Results of a single simulation

The results of a single typical simulation of the lane with constant overtaking opportunities described in Figure 2 are shown in Figure 3. For clarity, only the final 20 km of the simulation is shown. This figure shows how the model simulates travelling speed over the distance of the road. Slower vehicles are encountered, and an overtaking manoeuvre is only performed when the lane is an 'overtaking possible' lane and a clear safe overtaking distance is available (for example at 87 km) or the lane is an overtaking lane (for example at 92 km). The safe overtaking distance required to be empty is much less when trying to overtake a slow moving vehicle than a faster moving vehicle, as a result the safe overtaking distance maximum is smaller when following a slower moving vehicle than behind a faster moving vehicle. This is shown in the figure with lower peak values of safe overtaking distance when the vehicle is travelling slower than when the vehicle is travelling faster.

Results of simulations performed with fixed overtaking opportunities (as defined by lane state)

After completion of the simulations, the variation in travel times is shown in Figure 4. This demonstrates that nearly all percentiles of journeys will see an increase in travel time. However, the increase in travel time will be less than the increase in travel time that would be expected if the modelled vehicle could travel at its desired speed for the entire journey. Using Equation (1), the theoretical increase in travel time due to the speed limit change from 110 km/h to 100 km/h is 10%. All of the simulated results suggest that the increase in travel time, while considering other traffic on the road, is less than this theoretical value.

Percentage increases in travel time of between 0%, say when much of the journey is spent following a slow moving caravan, and 10%, when no slower moving vehicles are encountered, are possible using the model. 50% of all trips would expect an increase in travel time of between 6% and 10% depending on the density of traffic after a decrease in speed limit from 110 km/h to 100 km/h, provided the driver drives at the applicable speed limit as often as possible.

Furthermore, the number of overtaking manoeuvres performed can also be measured using the model. The number of overtaking manoeuvres performed by a vehicle is shown in Table 2. More overtaking is required at the higher speed limit than the lower speed limit.

The proportion of time spent travelling less than the desired speed and the proportion of time spent travelling more than 10 km/h less than the desired speed is presented for the sum of all journeys simulated is presented in Table 3. Higher proportions of time spent travelling at slower than desired speeds are observed when the speed limit is higher. Typically, the proportion of time spent travelling behind slower moving traffic approximately halves after the speed limit is dropped from 110 km/h to 100 km/h.

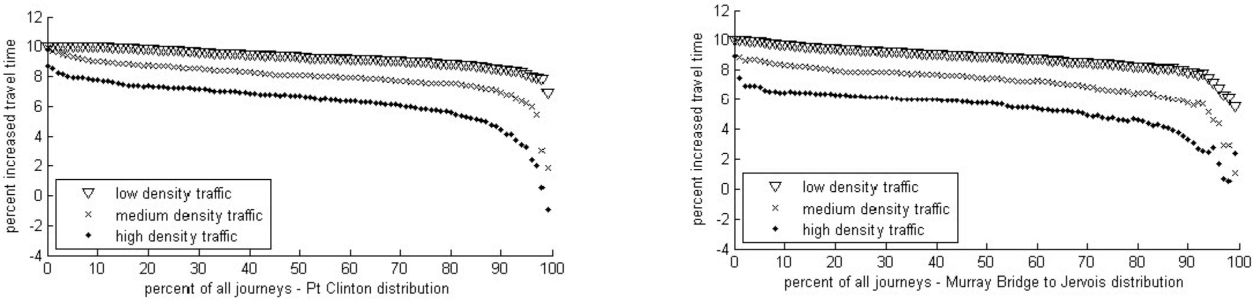

Figure 4: Percent increase in travel time for percentile of all journeys using the constant lane for percentile of all journeys completed before speed limit change for various traffic densities, Pt Clinton (above), Murray Bridge to Jervois (below).

Table 2: Number of overtaking manoeuvres performed to maintain travel speed for various percentiles of journeys using the constant overtaking opportunity lane.

Site		Low density traffic			Medium density traffic			High density traffic		
	Percentile	*15%*	*50%*	*85%*	*15%*	*50%*	*85%*	*15%*	*50%*	*85%*
Pt Clinton	110 km/h limit	0	1	2	4	5	6	9	11	13
	100 km/h limit	0	0	1	1	2	3	4	6	7
Murray Bridge - Jervois	110 km/h limit	1	2	3	6	7	9	13	15	16
	100 km/h limit	0	1	2	3	4	5	8	10	11

Table 3: Percent of time spent travelling at a speed less than desired speed, S_O, and more than 10 km/h slower than desired speed using the constant overtaking opportunity lane.

Site		Low density traffic		Medium density traffic		High density traffic	
	Speed difference	$< s_0$	$< s_0 - 10$	$< s_0$	$< s_0 - 10$	$< s_0$	$< s_0 - 10$
Pt Clinton	110 km/h limit	5.1	4.2	13.7	11.8	25.6	21.7
	100 km/h limit	2.2	1.6	6.6	4.2	14.1	9.0
Murray Bridge - Jervois	110 km/h limit	7.7	7.1	20.2	18.9	33.8	31.5
	100 km/h limit	4.3	3.5	12.7	10.6	23.1	19.1

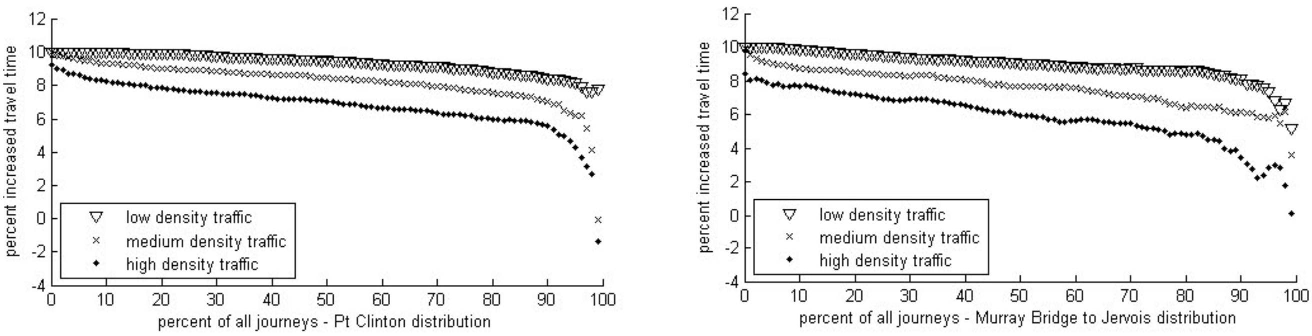

Figure 5: Percentage increase in travel time after speed limit change using the variable lanes for percentile of all journeys completed before speed limit change for various traffic densities, Pt Clinton (above), Murray Bridge to Jervois (below).

Table 4: Number of overtaking manoeuvres performed to maintain travel speed for various percentiles of journeys using the variable overtaking opportunity lanes.

Site		Low density traffic			Medium density traffic			High density traffic		
	Percentile	*15%*	*50%*	*85%*	*15%*	*50%*	*85%*	*15%*	*50%*	*85%*
Pt Clinton	110 km/h limit	0	1	2	3	5	6	9	11	12
	100 km/h limit	0	0	1	1	2	3	4	5	7
Murray Bridge - Jervois	110 km/h limit	1	2	3	5	7	8	12	14	16
	100 km/h limit	0	1	1	3	4	5	7	9	10

Table 5: Percent of time spent travelling at a speed less than desired speed, S_O, and more than 10 km/h slower than desired speed using the variable overtaking opportunity lanes.

Site		Low density traffic			Medium density traffic			High density traffic		
	Percentile	*15%*	*50%*	*85%*	*15%*	*50%*	*85%*	*15%*	*50%*	*85%*
Pt Clinton	110 km/h limit	0	1	2	3	5	6	9	11	12
	100 km/h limit	0	0	1	1	2	3	4	5	7
Murray Bridge - Jervois	110 km/h limit	1	2	3	5	7	8	12	14	16
	100 km/h limit	0	1	1	3	4	5	7	9	10

Results of simulations performed with varying overtaking opportunities (as defined by lane state)

The outcomes of simulations performed on roads with varying overtaking opportunities are shown in Figure 5, Table 4 and Table 5. Only slight differences are observed between the two sets of results. In the second case where the lane has varying overtaking pportunities, less overtaking manoeuvres are required for some journeys than for the fixed overtaking opportunities case. In the fixed overtaking opportunities case approximately 1% to 2% more time travelling behind slower moving vehicles is observed. These results are specific to the particular fixed overtaking opportunity lane that was selected.

Discussion

A simple Markov model has been developed to simulate the effect of other vehicles on the road network and their influence on travel time. The Markov model described includes provision to include real world speed distribution data that had been collected before and after a change in speed limit. Real world data that had been collected when a speed limit was changed in South Australia from 110 km/h to 100 km/h was applied to the model and results were simulated. The travel times, number of overtaking manoeuvres and proportion of time spent travelling at a speed less than the desired speed of the fastest law abiding driver were retrieved from the model. Three key points are found after evaluating the model for the fastest legal driver driving on the roads described in this paper with the distributions of vehicle speeds also described in the paper. The three key points relate to the increase in travel time, the number of overtaking manoeuvres required to maintain the drivers desired speed and the percentage of time spent behind vehicles travelling at a slower speed than the desired speed. Each key point is discussed in the following paragraphs.

Increases in travel time of between 2% and 8% are noted for high density traffic of 6000 vehicles per day on a road with fixed overtaking opportunities and a road with varying overtaking opportunities after a decrease in the speed limit. Increases in travel time of between 4% and 10% are noted for low density traffic of 1000 vehicles per day on both of these types of road. This compares with a theoretical increase in travel time of 10% if the speed limit is the sole consideration. Clearly, a decrease in the speed limit will see an increase in travel time if the road travelled is similar to the road modelled in this study, however, the increase in travel time is not as large as is suggested by the decrease in speed limit alone. Interestingly, this result is applicable to drivers who take every opportunity to overtake as is described in the model. For real drivers, however, the percentage increase in travel time will be less than is predicted in this model. This is due to the real driver possibly choosing not to overtake a vehicle that is going at a slightly slower speed than the desired speed.

The second key point is that the number of overtaking manoeuvres that were performed in order for the modelled driver to maintain their desired speed was greater when the desired speed was higher. This was true for both the road with the fixed amount of overtaking opportunities and the road with varying amounts of overtaking opportunities.

The third key point regards the percentage of time spent travelling below the desired speed of the vehicle.

The amount of time that is spent travelling behind a slower moving vehicle is reduced when the lower speed limit is used.

An explanation as to why the number of overtaking manoeuvres and percentage of time spent travelling behind a slower moving vehicle is higher at higher speed limits can be found after analysis of the distribution of vehicle speeds shown in Figure 1. As is shown well at the Pt Clinton site, vehicles travelling at greater than 100 km/h tend to slow down toward a speed of 100 km/h after the speed limit change, while vehicles travelling less than 100 km/h tend maintain their speed. Vehicles travelling near the desired speed of the modelled vehicle are rarely caught by the modelled vehicle because their difference in speed is small. Thus, with a greater proportion of vehicles with a speed near the desired speed of the modelled vehicle the time spent following these vehicles is lower. In order to pass a vehicle, the modelled vehicle must firstly be following a slower vehicle. Because the incidence of following a slower moving vehicle is less, the need for an opportunity to overtake is also reduced. Clearly, the time spent following another vehicle, and the number of overtaking manoeuvres performed is related to the distribution of speeds.

This paper is aimed at addressing the concerns of a driver who claims that he or she never travels at a speed higher than the speed limit, nor does he or she travel below the speed limit unless following a slower vehicle. Such a driver might claim that travel time will increase 10% as a result of a speed limit change from 110 km/h to 100 km/h. This study has shown that this theoretical value is the upper bound of the increase in travel time for such a driver. A more realistic estimation of increase in travel time of between 4% and 10% is appropriate for such a driver when the influence of other traffic on the road is also considered. Additionally, this driver will spend less time following a slower vehicle, and be required to overtake less often if the speed limit is lowered as described. An increase of travel time of between 4% and 10% equates to an increase of between 2.2 minutes and 5.5 minutes over a 100 km journey. This increase in travel time is balanced against approximately a 50% reduction in time spent following a slower vehicle and a lowering in the number of overtaking manoeuvres that are performed. The claim of the descried driver can be engaged and discussed using the results of this study.

The difference between the fixed overtaking opportunities case and the varying overtaking opportunities case is small. The lane used for the fixed overtaking opportunities case was generated using the Markov model described in the appendix. The negligible change in results indicates that a specific road may be modelled by a general road with the same average properties.

The model, like all models, has limitations. An assumption in the model is the Poisson distribution of vehicles on the road network. Platoons of cars are not modelled using a Poisson distribution and are hence neglected in the model. Dramatic changes in speed are modelled rather than a more steady acceleration or deceleration when a speed change occurs. Vehicles with difference characteristics for overtaking are not considered; such as the difference between overtaking a heavy articulated truck and a small passenger vehicle. Furthermore, overtaking of only one vehicle is considered equally difficult as passing a platoon of vehicles. Increases in travel time due to the speed reductions caused by geometrical constraints of the road are also not modelled. Each of the assumptions were made to simplify the model; in order to make the mathematics easier to apply.

Further improvements of the model include a more appropriate spatial distribution of vehicles on the road. Other cars, while for short periods of time can be considered to leave their origin with a Poisson distribution, over time these cars interact with each other. A lack of platooning of traffic is an acknowledged deficiency in this model, and as such, the results of the model can only be considered sensible for low volumes of traffic. Often, however, roads for which a speed reduction could potentially be considered are low traffic volume roads, for which a model like this becomes appropriate.

An interesting extension of the model would be to describe a distribution of travel times for the vehicles on the road that have a desired travelling speed given by the distribution of free speeds on the road. This value could then be used in economic evaluations of costs associated with a decreased speed limit, because the 50th percentile travel time of the average journey could be calculated. This will be included in future work with this model.

There are other future tasks for the model. The model needs to be tested in a real world situation. The model has been designed to take an input of an actual road lane state, ie. overtaking is possible if safe, overtaking not possible, and overtaking lanes if such measurements are available. The lane states of a real road will be measured and used in the simulation. The results of the simulation with real lane states will be compared travel times, with traffic volume counts being done simultaneously. The results of this real world testing can then be compared to the output of the model. Ultimately, it would be ideal to link the results of this study with the expected change in crash statistics.

Conclusions

The model presented in this paper is a simple tool for simulating the change in travel time after a change in speed limit is introduced. The simulation includes real data of distributions of travel speed. The results of the simulation can be used to engage the public during a debate on the lowering of speed limits including a less than expected reduction in travel time, a lowering of the number of overtaking manoeuvres that are required and reduction time spent travelling behind vehicles travelling at a slower speed than the speed limit. The model can be further refined to include additional parameters that will be important in the evaluation of total increase in travel time due to a speed limit reduction.

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Appendix

Markov models were used to simulate the vehicles on the road, and also the state of the lane when a lane with varying overtaking opportunities was used. This appendix describes a Markov model, and each of the models.

Model of vehicle speed

At each time step the modelled vehicle is assumed to have a speed given by a whole number of kilometres per hour. The set of speeds that include all speeds that are possible in the model are given by the following.

Let S(t) be the speed of the modelled vehicle at time step t. Then:

$$S(t) = s \,, s \in \{0\,, 1\,, 2, \ldots, \text{max speed}\} \qquad \text{(A1)}$$

The maximum speed is the fastest speed encountered in the model. Typically this speed is the fastest speed found in the distribution of other vehicles. However, this speed must be at least the desired speed of the modelled vehicle, s_O.

Transition from one state to another is only possible if the modelled vehicle encounters a vehicle that is travelling slower than the modelled vehicle, or, an overtaking manoeuvre is performed.

Overtaking can only be performed on a rural road in South Australia that does not have overtaking lanes if the lane markings indicate that overtaking is possible, given by a dashed centre line, and there is sufficient clear space in the oncoming lane for an overtaking manoeuvre to be safely performed. The traffic in the opposing lane was modelled using a Markov model, which modelled the distance to the furthest car that could be considered to impede an overtaking manoeuvre.

Let H be the distance, in metres, to the furthest car that would be considered before making a decision to overtake.

$$H(S(t), t) = h \in \{0\,, 10, 20, \ldots \max(H)\} \qquad \text{(A3)}$$

The maximum value of H, while theoretically unbounded, is chosen for computational simplicity. A distance of 800 m was used in all simulations in this study. A schematic for this value is shown in Figure A1.

We define some other parameters necessary for this model.

Let

s_0: Desired speed of modelled vehicle
S_i: Value of speed - i km/h
Δt: Time step
V_i: Proportion of vehicles at speed S_i
$\overline{V}$: Average speed of other vehicles
C_W: Concentration of vehicles travelling in same direction as modelled vehicle (vehicles / km)

Then:

$$P\{S(t+\Delta t) = j | S(t) = i\} = \begin{cases} (S_i - S_j) \cdot \Delta t \cdot C_W \cdot V_j & \text{where } s_0 \geq S_i > S_j \\ 1 - \sum\limits_{S_i > S_k} (S_i - S_k) \cdot \Delta t \cdot C_W \cdot V_k & \text{where } s_0 \geq S_i = S_j \\ 0 & \text{otherwise} \end{cases} \qquad \text{(A2)}$$

For instance, for the modelled vehicle, travelling at speed to catch another vehicle travelling at speed , the modelled vehicle must be travelling faster than the vehicle it catches. The probability that it catches the slower vehicle is equal to the difference in speeds multiplied by the time step multiplied by the probability that a vehicle travelling at that particular speed is next one that is caught by the modelled vehicle. Overtaking is not considered at this stage of the model as it is dependent on both the state of the lane being traversed and the vehicles travelling in the opposite direction to the modelled direction.

Reaching a platoon of traffic was not considered in the model. The model assumes that there are sufficiently low number of cars, and sufficiently high amounts of overtaking opportunities that the effect of platoons of traffic can be neglected.

Modelling of cars in immediate safe overtaking zone travelling the opposite direction

We also define some other parameters necessary for the formulation of this model.

Let

OTD: Overtaking distance: distance required to move ahead of vehicle in front to perform an overtaking manoeuvre

C_A: Concentration of vehicles travelling in opposite direction as modelled vehicle (vehicles / km)

B: Additional speed that the modelled car is willing to travel over S_0 to perform an overtake

In a real world scenario, when a vehicle is travelling behind a slower vehicle, an overtaking manoeuvre will not be considered if there exists a vehicle travelling in the lane carrying traffic in the opposite direction if within some distance: H_{max}.
A schematic for this distance is shown in Figure A1 and this distance is calculated in the following way:

$$\mathrm{H}_{\max}(S(t),t) = \frac{\mathrm{OTD}}{\mathrm{S}_0 - \mathrm{S}(t) + \mathrm{B}}(\mathrm{S}_0 + \mathrm{B} + \overline{\mathrm{V}}) \qquad \text{(A4)}$$

We assume that the cars travelling in the opposite direction that arrive in the zone bounded by H = 0 and H = H_{max} can be modelled by a Poisson arrival process. Therefore the probability of a car coming within the considered safe overtaking zone is independent of any other car entering the safe overtaking zone. An assumption is made that the effect of a platoon of traffic arriving from the other direction can be neglected.

distance is set to the nearest state in h to overcome this problem.

Therefore, in order for the safe overtaking zone to un-fill:

$$P\{H(S(t),t+\Delta t) = j | H(S(t),t) = i\} = \begin{cases} \sum\limits_{G_k \in h = i-j} V_k & i > j, j > 0 \\ \sum\limits_{G_k \in h > i-j} V_k & i > j, j \leq 0 \\ 0 & otherwise \end{cases}$$

(A6)

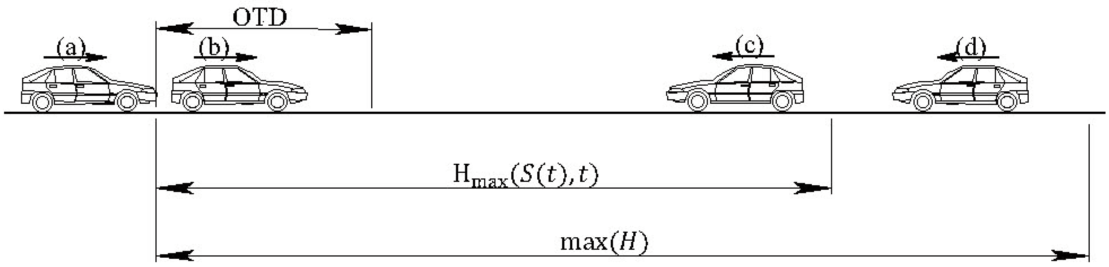

Figure A1: Schematic of overtaking zone parameters. Vehicle (a) is the modelled vehicle, following a slower moving vehicle (b), both at speed $S(t) < S_O$. The oncoming vehicle (c) is modelled as an oncoming vehicle as it is inside the distance $H_{max}(S(t),t)$. Vehicle (d) is not modelled until it is inside H_{max} .H_{max} is a function of travelling speed of vehicle (a) and is constrained to have a maximum value of max*(H)*.

The probability of a car entering the safe overtaking zone space for each travelling speed, and hence of the safe overtaking zone becoming in time Δt is:

$$\{H((S(t),t+\Delta t) = \mathrm{H}_{\max} | H(S(t),t) = i\} = (\mathrm{S}(t) + \overline{\mathrm{V}}) \cdot \Delta t \cdot C_A$$

(A5)

This probability holds regardless of the amount of the safe overtaking zone already consumed. This allows more than one vehicle to occupy the safe overtaking zone while only considering the vehicle which will affect an overtaking manoeuvre for the longest time period which is the one furthest from the modelled vehicle, but still in the safe overtaking zone.

Once a vehicle is in the safe overtaking zone it proceeds out of the zone. At each time step, Δt, the vehicle will have moved a distance equal to the sum of the speed that the car in the safe overtaking zone is travelling and the modelled vehicle multiplied by the time step. For instance, if the modelled car is travelling at 100 km/h and a car in the safe overtaking zone is travelling at 60 km/h, for a time step of 1 second, the car in the safe overtaking zone will move 44.4 m toward the end of the safe overtaking zone. 44.4 m is not within the set of states that can be occupied by $H(s(t),t)$, however, so the value is rounded to the nearest value in the set h, ie. 40 m. The vehicles in the safe overtaking zone have a distribution of speeds given by the distribution of speeds, HU, allocated to the model. Therefore the distance moved by any car out of the safe overtaking zone is distributed according to the distribution of speeds at each time step. The change in safe overtaking zone distance will not generally be equivalent to one of the states available in the safe overtaking zone model, Z. The change in safe overtaking zone

Where

$$\mathrm{G}_k = (S(t) + S_k) \cdot \Delta t, G_k \in h \qquad \text{(A7)}$$

Lane model

The state of the lane for the phase where varying overtaking opportunities arise is also described using a Markov model. The distribution of these states could be directly modelled from a real road without the need for Markov transition probabilities. However, in the absence of detailed measurements of the lane state on a long stretch of road, the state of the lane modelled using a stochastic process. The fixed overtaking opportunity road was generated using a single run of this Markov model for 100 km.

Let the states be described by L:

$$L(S(t),t) = l \in \{1, 2, 3\} \qquad \text{(A8)}$$

Where the passing lane states are:

$$L(S(t),t) = \begin{cases} 1 & \text{where no overtaking is allowed, eg. on bends} \\ 2 & \text{where overtaking is allowed if safe} \\ 3 & \text{where an overtaking lane exists} \end{cases}$$

(A9)

The following parameters are needed to fully describe the transition matrix.

Let

D_i: Average Length of Lane in state *j*

$Le_{i,j}$: Probability of moving to state *j* if the previous state was i, $i \neq j$

The average length of each of the lane states D_i can be estimated. The values of these D_i can be used to determine the probability that the current lane ends within Δt and therefore if it will continue for another time step:

$$P\{L(S(t), t + \Delta t) = i | L(S(t), t) = i\} = 1 - \frac{S(t) \cdot \Delta t}{D_i}$$

(A10)

The probability of transitioning to a state that is different in a single time step is given by the following equation:

$$P\{L(S(t), t + \Delta t) = i | L(S(t), t) = j\} = \frac{S(t) \cdot \Delta t}{D_i} \cdot Le_{i,j}$$

(A11)

In particular, some values needed to be set for this paper. The average distances for each lane type used in the lane state model were:

$$D_1 = 2\ km$$
$$D_2 = 2\ km$$
$$D_3 = 1\ km$$

And the transitions between each state in the lane type model were:

$$Le_{1,2} = 0.8, \quad Le_{1,3} = 0.2$$
$$Le_{2,1} = 1.0, \quad Le_{2,3} = 0.0$$
$$Le_{3,1} = 1.0, \quad Le_{3,2} = 0.0$$

Using these transitions, the lane will only transition to a passing lane from a 'no overtaking' lane and not from a 'overtaking possible' lane and the only state that can follow either a 'passing lane' or a 'passing possible' lane is a 'no passing possible' state.

Using these known transitions between states, it is possible to determine the average time spent in each state. The average distance spent in the lane where no passing is allowed is 52.63%, the average distance in a passing is possible lane is 42.11% and the average distance in a passing lane is 5.26%. The transitions, $Le_{i,j}$ and D_i, could be changed to adjust these average lane states if desired.

Overtaking

Overtaking is allowed by considering all three models together. Overtaking will occur if one of the following two conditions are met in conjunction with $S(t) < S_O$:

1. The modelled vehicle is in a passing lane
2. The modelled vehicle is in a passing-possible lane and the safe overtaking zone of the modelled vehicle is clear.

If either of these conditions is satisfied then the modelled car resumes its desired speed, S_O and maintains its current lane state and safe overtaking zone state until such time as they change. No time is considered for the acceleration required to reach maximum speed. A safety margin for overtaking can be built into the safe overtaking zone model, through the distance, *OTD*, required to pass around a slower moving vehicle.

Time step

The time step chosen for the model needs to be sufficiently small such that two events have a negligible opportunity to occur in one time step. Examples of two events occurring simultaneously include two vehicles filling the safe overtaking zone in one time step, or the lane state changing from passing possible, to passing not possible to a passing lane.

Parameters used in the simulations

Particular parameters were used throughout this paper during the simulations. These are itemised here:

$$\Delta t = 1\ second$$
$$OTD = 0.04\ km$$
$$B = 10\ kph$$

Databases for Road Traffic Injury Surveillance in New South Wales

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Abstract

Road traffic injuries are a significant public health problem around the world. Efforts to prevent road traffic injuries are likely to benefit from the collection of consistent and comparable injury information. This study evaluated data item availability across different road traffic injury surveillance data collections in New South Wales in relation to the World Health Organization's recommended core minimum, optimal and supplementary data sets that outline the necessary data items for injury surveillance. The data collections reviewed are suitable for road traffic injury surveillance in different contexts. However, none of the data collections examined sufficiently categorized two common data items required in road safety research: occupant protection devices and injury outcomes. Further improvement of current routine road traffic crash data

collections is warranted to build the required data infrastructure to overcome challenges for etiologically based analyses.

Keywords

Road Traffic Injury, Surveillance

Introduction

Road traffic injuries represent one of the leading causes of injury-related death worldwide [1]. In Australia, road crashes result in around 1,600 deaths [2] and 31,200 serious hospitalised injuries [3] each year, at a conservative annual cost of $18 billion to the community [2]. Importantly, road traffic injuries result from preventable events that have many causes [1]. Injury surveillance data, which describe crashes and their causal factors, are crucial to road traffic injury prevention efforts, such as problem identification and the evaluation of interventions at the broad population level [4].

In New South Wales (NSW), as in other Australian states and territories, different agencies collect a range of data items that are potentially useful for road traffic injury surveillance. However, because the data items are collected for each agency's particular purposes, which do not often include injury surveillance, the recorded data items generally differ across agencies and may not be well suited to answer every road traffic-related research question. In addition, the data collections have varying case inclusion criteria. This means that the individual data collections are neither necessarily comparable nor complementary. For example, routinely collected hospital separation records describe the nature of injuries well (e.g., fractures and abrasions), but are limited in terms of the information they contain about circumstances or factors associated with the cause of the injury (e.g. information regarding restraint use for injured motor vehicle occupants is not recorded) [5]. In contrast, police collected crash records provide detailed information about the circumstances of the crash and its causal factors, but they do not include injury details (e.g., nature of injuries such as fractures) [5].

The aims of this paper are to summarise a number of characteristics of data collections in NSW that are relevant to unintentional road traffic injuries and indicate differences among the data collections in the recording of injury outcome data items. In addition, because of the multifactoral nature (i.e., involving factors related to the environment, vehicles, drivers, and occupants) of road traffic injuries, the paper also aims to report on data item availability within each data collection, including whether information about occupant protection devices is recorded as an active injury countermeasure. This is used to highlight the availability of data items in different data collections in NSW to answer research questions regarding road traffic injuries.

Method

Eight large-scale routinely-collected data collections that are used frequently by various government agencies or research institutions to direct and evaluate road safety prevention efforts in NSW were reviewed. These data collections consisted of: the Australian Bureau of Statistics (ABS) mortality data file (MDF), the National Coronial Information System (NCIS), the Fatal Road Crash Database (FRCD), the NSW Admitted Patient Data Collection (APDC), the NSW Hospital Emergency Department Surveillance System (HEDSS), the Traffic Accident Database System (TADS), the Motor Accidents Authority Claims Register (MAACR), and the NSW WorkCover Data Collection (WCDC). Sample survey data collections and ad-hoc road traffic injury investigations were not examined. Information on the reviewed data collections was obtained from the coding manuals and from the data custodian of each collection.

Results

Characteristics of study data collections

A description of each data collection, collected injury outcomes, case inclusion criteria, type of classification system and timeframe of data collection are presented in Table 1. (See page 58)

Availability of core data items for injury surveillance

Core data item availability was evaluated against both the Minimum Data Set (MDS) and Optional Data Set (ODS) recommendations in the World Health Organization (WHO) injury surveillance guidelines [6], using a three-level scale (definite inclusion, possible inclusion, definite exclusion). Because this study focused on unintentional road traffic injuries, the WHO recommended item, "intent" was not recorded. Other WHO recommended items, "mechanism" and "external cause", were not considered as either the mechanism or external cause were the means of case identification (i.e. road traffic injury).

Table 2 shows the WHO recommended data item availability for each data collection. None of the data collections comprised a complete list of WHO recommended MDS and ODS data items, except for the NCIS. (See page 59)

Availability of supplementary data items for injury surveillance

There are many casual factors leading to road traffic injuries and these are usually attributed to various aspects of the crash scene (e.g., where and when), traffic units involved (e.g., vehicle type and impact point), traffic unit controllers (e.g., on road driving experience) and/or causalities (e.g., use of vehicle restraints). Therefore, the availability of supplementary road traffic injury data items describing exposures to various risk factors across these four categories was also assessed. These supplementary road traffic injury data items were also suggested in the WHO's guidelines for injury surveillance [6]. In addition, the availability of a "medical cause of death" data item was examined for relevant data collections because it can be used to identify injury-specific fatal cases in which a specific injury is the underlying cause of death, so as to calculate injury-specific fatality rates (e.g., rates of death attributable to fractured skulls versus multiple injuries).

Table 1 Data collections relevant to road traffic injury data collections in New South Wales, Australia

Data collection	Administrative agency	Injury outcome	Case criteria	Type of classification system used	Time frame
ABS Mortality Data File (MDF)	Australian Bureau of Statistics www.abs.gov.au	Fatal	Information on fatalities obtained from the NSW Registry of Births Deaths and Marriages. Includes all road traffic deaths of NSW residents.	Structured coding system, such as application of International Classification of Disease	1964 onwards
National Coronial Information System (NCIS)	Victorian Institute of Forensic Medicine www.ncis.org.au	Fatal	Information on fatalities obtained from police investigation reports, autopsy and toxicology reports, other relevant reports, and coroners' findings. Includes all road traffic deaths of NSW residents including those injured in other jurisdictions.	A mixture of structured coding and narrative description of crash scenes	1 July 2000 onwards
Fatal Road Crash Database (FRCD)	Australian Transport Safety Bureau www.atsb.gov.au	Fatal	Information on fatalities obtained from an aggregation of datasets supplied by the relevant State or Territory road authority, eg NSW data is a subset of the TADS data from the RTA (web-based and open to public access).	Structured coding using agency-developed system	1989 onwards
Admitted Patient Data Collection (APDC)	NSW Health Department www.health.nsw.gov.au	Fatal and nonfatal	Information on NSW residents admitted to all public, private, repatriation hospitals, private day procedure centres, public psychiatric hospitals and public nursing homes in NSW or interstate. Includes all road traffic-related hospitalisations of NSW residents in Australia.	Structured coding system, such as application of International Classification of Disease	1993 onwards
Hospital Emergency Department Surveillance System (HEDSS)	NSW Health Department www.health.nsw.gov.au	Fatal and nonfatal	Information on NSW residents presenting to an Emergency Department from 50 selected major hospitals across NSW. Includes all road traffic-related Emergency Department Presentations of NSW residents to selected hospitals.	A mixture of structured coding and narrative description	1996 onwards
Traffic Accident Database System (TADS)	NSW Road Traffic Authority www.rta.nsw.gov.au	Fatal and nonfatal	Information on unintentional road crashes that occurred on a public roadway in NSW and were reported to NSW police. Includes road crashes resulting in death or injury or where a vehicle was towed away. May or may not be a NSW resident.	Structured coding using agency developed system and applying National Traffic Crash Guidelines	1986 onwards
Motor Accidents Authority Claims Register (MAACR)	NSW Motor Accident Authority www.maa.nsw.gov.au	Fatal and nonfatal	Information on persons either fatally or non-fatally injured in an vehicle crash as a driver, passenger, pedestrian, pedal cyclist, or motor cyclist, where the driver of the other motor vehicle was considered partially or completely at fault and the vehicle at fault was registered in NSW. From October 2006, includes all road traffic-related injuries of children, regardless of fault.	Structured coding using agency-developed system	1989 onwards
WorkCover Data Collection (WCDC)	NSW WorkCover www.workcover.nsw.gov.au	Fatal and nonfatal	Information on work-related deaths, injury and disease (excluding dust diseases) claims of workers employed in NSW.	Structured coding system, such as Type of Occurrence Classification System (TOOCS)	1991 onwards

Table 2 Availability[a] of WHO-recommended data items[b] included in the road traffic injury surveillance data collections in NSW[b]

Data items	Categorisation examples	MDF	NCIS	FRCD	APDC	HEDSS	TADS	MAACR	WCDC
WHO Minimum Data Set components									
identifier	a unique identifier for each injury case;	+	+	N/A	-	-	+	+	+
Age-group	0-4, 5-9, etc (in years);	+	+	+	+	+	+	+	+
sex	male, female, unknown;	+	+	+	+	+	+	+	+
place	home, street, sports area, etc;	+	+	-	+	-	+	+	+
activity [c]	working, boarding vehicles, etc;	-	+	-	+	-	-	-	?
nature	fracture, burns, bruise, etc;	+	+	-	+	+	-	+	+
WHO Optional Data Set components									
ethnicity	an indication of race or country of birth;	+	+	-	+	+	-	-	+
injury date	date an injury event occurred ;	-	+	+	-	-	+	+	+
injury time	time an injury event occurred (in 24 hour);	-	+	+	-	-	+	-	+
Residence [d]	usual place of residence;	+	+	-	+	-	+	+	+
alcohol use [d]	yes, no, unknown, etc;	-	+	-	-	-	+	-	-
other substance (e.g., marijuana)	yes, no, unknown, etc;	-	+	-	-	-	-	-	-
Severity of injury [e]	no, minor or superficial, moderate, severe;	N/A	N/A	N/A	-	-	-	+	?
disposition [f]	discharged, admitted, died, etc;	N/A	N/A	N/A	+	+	-	+	?
narrative incident summary	a description of injury-event circumstances;	-	+	-	-	+	?	-	?

[a] A "+" sign indicates a definite inclusion; A "?" sign indicates an inclusion with uncertainty, for example, the access to a data item is restricted, or information could be extracted from texts but not guaranteed; A "-" sign indicates a definite exclusion; "N/A" refers to not applicable, such as a fatality itself of "fatal" severity.

[b] All selected datasets were exempted from present consideration for examination on WHO recommended items, "intent" (e.g., intentional, unintentional), "activity" (e.g., sport, travelling), "mechanism"/"external cause" (e.g., traffic, poisoning), because of the focus on road traffic injuries that were defined as unintentional in this study.

c WCDC collects activity information that only 'at work' or 'commuting' incidents can be determined.

[d] These items were recorded in TADS datasets only for traffic unit controllers.

[e] Datasets (APDC, HEDSS, TADS) collect information from both fatalities and non fatal injuries. However, the APDC only records deaths that occurred in hospital. WCDC datasets may not have identical levels of categories as described in the Categorisation examples.

[f] TADS datasets have not recorded disposition information since 1997.

Discrepancy in data item availability (especially with respect to crash information) was observed between the data collections [Table 3]. The TADS included the highest number of data items relating to supplementary road traffic data items. Because the NCIS contained narrative data of a crash event, it also offers the possibility (although not the guarantee) of identifying these supplementary road traffic injury data items.

Information on occupant protection devices

As widely-accepted injury countermeasures, occupant protection devices are designed to mitigate injury risks in a crash and proper use or deployment of these devices have saved lives and prevented injuries worldwide [1]. Nonetheless, data collections seldom include adequate information about occupant protection devices. To examine the ability of each reviewed data collection to record information on occupant protection devices, two common devices were selected: occupant restraints (i.e. seat belts) and airbags. For both of these devices, the categorisation available in each collection to accurately record the use of these devices was identified.

Table 4 (See page 64) demonstrates that no data collection recorded comprehensive information regarding the use or deployment of the two occupant protection devices examined, and several recorded no information at all. Data coding practices [see Table 1] for each data collection may also have an impact on the level of detail recorded. For example, structured coding schemes are easy to use and allow for the recording of pre-defined coding categories. However, the pre-defined categories may not reflect important information about use of these protection devices, such as the correctness of use of restraint. In contrast, narrative text, as used in the NCIS, could allow possible identification of different forms of safety device-use [7]. A limitation of this is that searching the narrative text for these details, or indeed for data items of interest, requires increased resource investment (e.g., software and time).

Information on injury outcomes

The capacity of each collection to record injury severity, nature of injury, multiple injury counts, and injured body region(s) was also examined. The MDF and the NSW APDC recorded multiple injury outcomes based on the structured International Classification of Disease (ICD) codes [8], whereas the other data collections examined did not provide complete information of selected measurable dimensions to describe potential injury outcomes [Table 4].

Discussion

Roles for epidemiological analyses

Descriptive analyses of the data items present in each of the data collections examined are appropriate to assess the prevalence of protective/hazardous exposures or the incidence of injury outcomes. The TADS and NCIS are the only two data collections that collect both crash and injury information, which highlights their applicability in etiological analyses.

Because each data collection captures casualties from a different but potentially overlapping injured population (except for the MDF and the NCIS which represent the same population – i.e., all road traffic fatalities of NSW residents), these data collections are suitable for road traffic injury analyses in different contexts [see Table 1]. For example, the APDC is suitable for profiling serious road traffic injuries that require hospitalisation, while the TADS additionally incorporates road traffic injuries of a less serious nature. Discrepant findings may result from different case inclusion criteria for different agencies [see Table 1]. For example, using police collected crash data to estimate crash fatality and non-fatality burden may produce different findings from using hospitalisation data. For example, in July 2007-June2008, TADS comprised 435 fatalities and 25,845 non-fatalities, whereas APDC comprised 119 fatalities and 10,711 non-fatalities..

Further, the relevance of a particular data collection to a given research question depends on the availability of the data items specific to that question [see Tables 2- 4]. The different datasets address important variables somewhat differently, with implications for usability, interpretation, and matching. For example, the APDC addresses crash location in terms of general place of occurrence (such as "street and highway" without further information), whereas the TADS addresses crash location with more detailed information (such as GPS co-ordinates).

Privacy and confidentiality issues may limit the accessibility or usability of data for researchers. In the U.S. the National Highway Traffic Safety Administration makes available to the public two major crash datasets with de-identifiable information: the Fatality Analysis Reporting System and National Automotive Sampling System. These datasets are widely used in road traffic injury epidemiological studies. Whether or not the U.S. experience is translatable in Australia requires further investigation

Opportunities for road traffic injury surveillance in NSW

All of the data collections in this study have different case inclusion criteria, use different classification systems for recording data items, and collect different combinations of data items from the WHO's MDS, ODS and supplementary recommended data items. In addition, the majority of data collections insufficiently categorise data items related to safety devices to reflect complex crash-injury situations, if they collect information on these devices at all. Because of the multifactorial nature of road traffic injuries, it is important to shift the focus of injury epidemiology from descriptively-based to etiologically-based research, emphasised by Haddon [9].

A systematic overhaul of current road traffic injury data collections would be required to ensure that the WHO recommended minimum, optional and supplementary road traffic injury data items are recorded in each data collection.

Table 3 Availability[a] of supplementary data items at various exposure levels in the road traffic injury surveillance data collections in NSW

Data items	Categorisation examples	MDF	NCIS	FRCD	APDC	HEDSS	TADS	MAACR	WCDC
Casualty level									
road user type	pedestrian, driver, passenger, etc;	+	+	+	+	?	+	+	?
restraint use	unrestrained, seat belt, child restraint, etc;	-	?	-	-	?	+	-	-
seating position	front left, centre, third row left, etc;	-	?	-	-	?	+	-	-
airbag [b]	deployed, not deployed, not fitted, unknown;	-	?	-	-	-	+	-	-
Driver level									
licence compliance	learner, standard, expired;	-	?	-	-	-	+	-	-
alcohol	a quantitative blood alcohol concentration;	-	?	-	-	-	+	-	-
restraint use	unrestrained, seat belt, unknown;	-	?	-	-	?	+	-	-
airbag	deployed, not deployed, not fitted, unknown;	-	?	-	-	-	+	-	-
Vehicle level									
vehicle type	car, utility, motorcycle, bicycle, etc;	+	+	?	?	?	+	?	?
travelling speed	a quantitative description of the travelling speed;	-	?	-	-	-	+	-	-
impact direction	an indication of 12-hour clockwise direction	-	?	-	-	-	+	-	-
counterpart colliding with	fixed object, motorised vehicle, etc;	?	+	-	?	-	+	?	?
Environmental level									
road condition	wet, dry, snow, ice, unknown;	-	?	-	-	-	+	-	-
natural light	dawn, dusk, daylight, darkness, unknown;	-	?	-	-	-	+	-	-
weather condition	fine, rain, fog, etc;	-	?	-	-	-	+	-	-
Other exposure factors [c]		-	?	?	-	-	+	?	?
Specific data item									
medical cause of death	underlying and contributing causes (e.g., brain damage)	+	+	-	-	-	-	-	-

[a] A "+" sign indicates a definite inclusion; A "?" sign indicates an inclusion with uncertainty; A"-" sign indicates a definite exclusion.

[b] The "air bag" data item on casualty level was available since 2000, however this item was recoded on vehicle level and may not be specific to each casualty in the vehicle.

[c] "Other exposure factors" referred to data items that reflected other exposures on casualty, driver, vehicle, or environmental level, such as casualty ejection, driver fatigue, vehicle weight, speed limit, and etc.

Table 4 Coding practices[a] for occupant protection device uses and injury outcomes in the road traffic injury surveillance data collections in NSW

Data items	Possible categories observed in use	Coding categories or coding standards							
		MDF	NCIS	FRCD	APDC	HEDSS	TADS	MAACR	WCDC
restraint use	unrestrained, lap belt only, shoulder belt only, lap shoulder belt, infant seat, child restraint, booster, improper use of adult belt, improper use of safety seat;	-	?	-	-	-	adult belt worn, belt fitted (but not worn), no restraint fitted to this position, child restraint, Unknown/ not stated [b]	-	-
airbag presence	fully-deployed, half-deployed, not-deployed, first or second generation airbag, frontal/side airbag to either driver or specific passenger seat, rear side airbag;	-	?	-	-	-	deployed, not deployed, not fitted, unknown	-	-
injury severity	died, hospitalised, treated, no injury, Abbreviate Injury Scale (AIS), Injury Severity Score (ISS), International Classification of Disease (ICD) codes - based Injury Severity Score (ICISS);	Died	Died	Died	ICISS [c]	ICISS[c]	Died, injured	AIS, New ISS	Death, permanent total disability, permanent partial disability, temporary disability
injury nature	fractures, abrasions, dislocation, open wound, burns, traumatic rupture;	International Classification of Disease (ICD) codes	free-form narrative description	-	ICD codes	ICD codes	-	fractures, cut, burns, etc	Australia's Type of Occurrence Classification System (TOOCS)
injury counts	number of injuries;	Multiple cause fields	free-form narrative description	-	55 Multiple diagnosis fields	?	-	Up to 5 multiple counts of injuries	Only the most serious injury
injured body region	head, neck, abdomen, spine, extremities, brain, internal organs, eye, skin;	ICD codes	free-form narrative description	-	ICD codes	?	-	head, abdomen, spine, etc	TOOCS

[a] A "?" sign refers to possible inclusion with uncertainty. For example, the NCIS may have description of different restraint use, but such inclusion is not guaranteed. A "-" sign refers to a definite exclusion.

[b] The TADS also records information about helmet usage (open face helmet worn, full face helmet worn and no helmet worn) in the "restraint use" data items.

[c] ICISS is not recorded in the APDC datasets, but can be subsequently calculated based on ICD codes. APDC also records "died" as a separate outcome.

However, this would consume substantial resources and it is questionable whether it is necessary for all agencies to have a "complete" collection of all WHO recommended road traffic injury surveillance data items.

Alternatively, it would be possible to employ data linkage processes to provide more complete road traffic injury surveillance at a reasonable cost [5]. Data linkage links records from two different data collections on a common unique identifier [10] or using common data items (such as name and date of birth) recorded in both collections [11]. For example, linkage of the MDF and APDC data collections has been conducted, to combine mortality information from the MDF and hospitalisation details from the APDC [10]. Linkage of the TADS and APDC data collections has added details of crash circumstance from TADS to details of injury outcomes from the APDC [11]. By reviewing the 10-year experience of linking population health data from various data collections in Western Australia, Holman et al [12] have demonstrated that data linkage can provide more complete information and increase the scope of available data items to facilitate and enhance population health research. The same is likely to apply to the epidemiological analyses of road traffic injuries in NSW. An example of the value of NSW linked data for undertaking risk factors for road crashes in older people has recently been published [13].

Nonetheless, data linkage can be resource-consuming, and can involve records not being matched on many occasions, in part because the populations sampled by different data collections overlap only incompletely [11]. Further, linkage rates (i.e., the proportion of records that are matched) can vary among different subgroups, introducing biases. These biases involve some known factors (such as age, gender or injury severity) and are also likely to involve some undetected factors (such as educational background or insurance status) that may influence the likelihood of a case of interest being captured by different data collections. For example, a data linkage between hospital and police data from July 2000 to June 2001 recruited 92 injured child passengers aged 0-8 years [14], whereas individually using hospital separation data for the same period and same study subjects recruited 150 cases [15]. Therefore, the feasibility of matching records and the usefulness of the resulting data needs further investigation.

While it may be possible to develop a classification system to take into account all information regarding a vehicle crash, in practice this is not realistic because of operational difficulties, such as need for collection of information at different stages of the injured person's injury journey, limited data collection resources or the data collectors' lack of expertise. Nevertheless, it would be valuable for road traffic injury surveillance to include consistent information on particular data items, such as occupant protection devices.

Even when particular data items are present in the specific road traffic injury data collections examined, data quality (e.g., data completeness, sensitivity, specificity) may influence their usefulness in road traffic injury studies. For example, many values are "missing" for in-crash delta-speed due to the practical difficulty of collecting data after the occurrence of a crash, the use of "unspecified" codes affects the completeness of case inclusion [16], and misclassification of the use of seat belts may bias estimates of the effectiveness of their use [17]. Because data quality issues are a challenge for all data collections, continuing commitments are required from each agency to make vigilant efforts for quality assurance [16,18].

Conclusion

This paper describes the characteristics of road traffic injury in eight data collections commonly used in NSW with a focus on data item availability and the ability of each collection to record different information. It describes the availability of information on two common occupant protection devices and on injury outcomes in each data collection. It also identifies some issues associated with data item availability for road traffic injury identification and prevention. In conclusion, the selection of the most appropriate data collection to examine for information regarding road traffic injuries in NSW will depend upon the nature of the research question and the data items that are required to fulfil the research objectives. Overcoming the challenges for etiologically-based analyses warrants further efforts to record the information on road traffic injuries that is recommended by the WHO, or by protocols that have been developed specifically for the road traffic injury context such as the protocol for the Australian National Crash In-depth Study (administered by Monash University Accident Research Centre, Victoria) that collects in-depth information for both crash scenes and injurious outcomes [19]. An exploration of conducting routine data linkage between road traffic injury data collections should be considered in NSW, as has previously been recommended based on a time-limited data linkage project conducted in NSW [11,13,20].

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