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# Journal of the Australasian College of Road Safety

Formerly RoadWise — Australia's First Road Safety Journal


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- Making a Safer Systems Approach to Road Safety Work
- Towards Survival on the Road
- Landmark Case on Hands-free Mobile in UK

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# From the President

*Dear ACRS Members,*

**Governor General and an ACRS Ambition**

I was delighted to have the opportunity to meet with the College Patron, Her Excellency Quentin Bryce at Government House in early April. I outlined to her the nature of the College, how we had a diverse skills base of members and told her we were very appreciative of her acceptance of being Patron. She said she had been involved in road safety issues many years ago, particularly in the area of encouraging seat belts for children and as the mother of 5 children and 5 grandchildren was always concerned about their safety. She would be happy to work with us to see how she could assist.

I presented her with a statement of ambition; a declaration of what the Executive Committee agreed was what the College believed were the key issues to be addressed in road safety in Australia. She thought that the aspirational role was worthwhile for the College and that it was also important to have specific campaign issues. The statement of that ambition, which the Executive Committee see as a "living document", is set out on page 3 and will be revised from time to time. In essence the importance of recognition of the "safe systems approach" in setting targets and management programs to reduce unnecessary road trauma should be addressed at the highest levels.

**ACRS Comes of Age**

The College passed its 21st birthday mark in February 2009. The inaugural meeting of the College was held in Armidale on 19 February 1988. It was held in conjunction with the second National Traffic Education Conference. The subscription was set at $15 personal and $30 corporate (including four editions of the journal). In March 1988 there were 17 financial members and by the end of the year 55 members (29 personal and 26 corporate). Due to changes of name it has been impossible to fully track those original members but I am very pleased to report that at least six of the original personal members (Geoff Quayle, Jim Murcott, Graeme Horsnell, Colin Grigg, Brian Connor and Harry Camkin) are still members with Harry having recently re-joined the NSW chapter executive.

I recently met with Graeme Horsnell and he is keen to continue to contribute to improve road safety outcomes based on his extensive work with schools. Nine of the original corporate members including one represented by Mary Sheehan are still members of the College, although again name changes may add to this total.

From those beginnings more than 20 years ago we have now reached a membership of 400, including 77 corporate at the end of 2008. Some of the corporate members are very large organisations indeed so I think as a College we can congratulate ourselves on what has been achieved in the period since our establishment.

We now have chapters in NSW, Victoria, South Australia, Queensland, the ACT and WA as well as our most recently established New Zealand chapter. An undated early document of the College states that it was formed to "network professionals working …across Australia." It goes on to say "The College aims to increase the professionalism of road safety workers and to promote road safety measures which have been found to be effective. …the College recognises the inter-disciplinary nature of road safety endeavours and the complexity and inter-relatedness of issues involved when dealing with this matter."

I think we have been true to our original charter and over the 20 plus years of our College establishment we have seen a great deal of improvement in road safety. Unfortunately while we can see that there is a lot more than can be done to reduce the number of crashes, as well as reduce the trauma from the crashes, we can overlook the good results achieved in that 21 years.

In 1988 2,887 people died on our roads and 29,705 were seriously injured. This was at a rate of 17.5 deaths per 100,000 population, a rate that has dropped to 7.0 deaths per 100,000 population. The cost to the community was estimated by the Bureau of Transport Economics as $6.18 billion in 1988, a figure which has risen to around $17 billion today. While the deaths have dropped to around 1,700pa, serious injuries are estimated still around the 30,000. I recognise we need to be careful with comparison over time as many factors often change; however there is good news in the data and also some messages to set agendas for the future.

As a College we have an emphasis now on the Safe Systems Approach, based on the Vision Zero or Towards Zero concepts. Last month the WA Government confirmed their commitment to those Toward Zero concepts.

The death rate per 100,000 population has dropped from 26.8 in 1967, to 17.5 in 1988, to 7 in 2009. I am sure there were many who thought we could not achieve the drop from 1967 to 1988 and from 1988 to 2009.

**National Road Safety Council**

You may have noted that the Council for Australian Governments, COAG, have agreed on a new National Road Safety Council of seven at its last meeting in Hobart in late April. The College will take the opportunity to recommend our aspirational ambition to them. We have offered to assist the Council in their vital task which has been set by COAG to;

"To contribute to the reduction in death and serious injury on Australian roads by enhancing the national implementation of effective road safety measures.
"http://www.coag.gov.au/coag_meeting_outcomes/2009-04-30/docs/national_road_safety_council_npa.pdf

**ACRS Activities**

Last year members identified the value of the Journal in the small survey of the benefits of the College. We have identified the potential of a more interactive and also more comprehensive data base which could run on our website. We are considering how we can add value for members as well as provide the best information to the community on road safety developments through the Journal and the Website.

At the Annual General Meeting of the College in late May we are aware there will be changes in the Executive Committee as some of our members have indicated they will not be standing for re-election. On behalf of the College may I express my thanks to Paul Simons, Anne Harris and Alexandra McManus for their commitment and contributions to the College.

**Lauchlan McIntosh AM, FACRS**

*President*

# The ACRS Statement of Ambition

A highly ambitious vision needed for the next decade in road safety. A declaration by the Australasian College of Road Safety May 2009

Too many die and are injured unnecessarily in road crashes in Australia and the world. Not only are the social costs tragic, but the economic burden can exceed 2% of GDP.

The College supports the key recommendations of the 2008 OECD report Towards Zero: Ambitious Road Safety Targets and the Safe Systems Approach .Adapted for Australia these are;

- Adopt a highly ambitious vision for road safety
- Set interim targets to move systematically towards the vision
- Develop a Safe Systems multi-disciplinary approach, essential for achieving ambitious targets
- Continue to exploit proven interventions for early gains
- Conduct in-depth and population based data collection and analysis to understand crash risks and current performance
- Strengthen the "Safe Systems" road safety management system
- Accelerate knowledge transfer
- Invest in road safety

The OECD report calls for "interventions that are some steps removed from prevailing best practice and will require the development of altogether new, more effective interventions."

The College believes that cost effective, ambitious, mass action programs must be built on many existing programs and implemented quickly.

A major change in interventions, not only resources invested, but in national leadership and vision of that change in road safety management and in safer transport systems is required to realise the achievement of ambitious road safety targets.

The College urges the highest level of commitment to a results focused approach to road safety management to achieve the nation's road safety ambition and targets.

A "vision zero"", that there be no deaths and injuries from road crashes represents an ethical approach to mobility and is based on the belief that any level of serious trauma arising from the road transport system is unacceptable.

Many industries have that view of their workplace Car manufacturers must continue to design crash free cars for decades ahead, road authorities need to design and build crash free roads and the community has to support a collective commitment to crash free driving.

While Australia has made good progress in reducing road trauma, targets set ten years ago have not been met. The College calls for a new long term vision, a new step-up in commitment, and a new high level leadership to reduce unnecessary road trauma for the next decade.

The College believes Australia can set and achieve ambitious targets, make a major step change in the way we manage road safety not only here but in a range of assistance programs across the world.

Australia should commit to the international call for a "Decade of Road Safety" from 2010.This declaration is supported on behalf of the College by its Executive Members;

**Lauchlan McIntosh**
**AM FACRS, FIEAustCPEng, FAICD**

*President*

# Diary

**28 - 29 July 2009 the Sixth National Roads Summit and John Shaw Medal Dinner,** the Novotel Brighton Beach, Sydney. For more information or to register to receive the Summit Brochure, view http://www.halledit.com.au/roadsaus09 or contact Denise McQueen, 03 8534 5021 or via email denise.mcqueen@halledit.com.au

**5-6 November 2009 ACRS Conference 'Road Safety 2020: smart solutions, sustainability, vision'** Perth. WA. Sub themes: advances in technology; research advances and solutions (smart systems); high risk road users; current issues. For further information contact: eo@acrs.org.au.

**8-9 October 2009 Victorian Biennial RoadSafe Conference,** Rydges Bell City Event Centre, Preston, Victoria. The Conference will feature keynote speakers, presentations from local specialists, a conference dinner and associated expo. Be informed and inspired by a number of high profile local speakers from the road safety industry. For more information visit: www.iceaustralia.com/roadsafe09

**11-13 November 2009 Australian Road Safety Research, Policing and Education Conference,** Sydney. For further information, please visit www.roadsafetyconference2009.com.au

# RRSP Profile

This is a new feature in which we will 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, visit www.acrs.org.au/professionalregister). To be an 'RRSP' is an indication that an ACRS member has attained high standing as an expert in their particular field/s of road safety work. This edition's focus is on Associate Professor Rebecca Ivers RRSP (Research and Evaluation).

Associate Professor Ivers is the Director of the Injury Division at The George Institute for International Health. She directs a research program with a strong focus on prevention of road traffic injury. Dr Ivers has published widely in the field of road traffic injury, and has recently been awarded a Young Tall Poppy award in Science and an Achievement Award from the National Health and Medical Research Council of Australia for her road safety research. She is an investigator on studies in a diverse range of areas including child restraints, novice drivers, Indigenous road injury, heavy vehicle crashes and motorcycle safety in Australia as well as in China, India and Vietnam. Contact email: rivers@george.org.au. We asked Professor Ivers the following questions:

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

For seven years.

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

I value the way the ACRS keeps people with an interest in road safety updated with news about what is happening around the country. ACRS also facilitates communication and networking through the series of high quality research seminars and conferences which ensures there is good linkage between road safety practitioners, policy makers and researchers.

**Tell us about your particular expertise in road safety.**

I am an epidemiologist and am skilled in research methods studying the "epidemic" of road traffic injuries. I conduct large scale population based studies that seek to understand and prevent road traffic injuries. This ranges from studies looking at issues for young drivers, motorcycle safety and heavy vehicles, to others focused around Indigenous road injury, and road safety issues in low income countries.

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

I am involved in a range of work – unfortunately I often spend many hours in an office in front of a computer dealing with emails, analysing data or writing papers! However, when I get out in the field things get more interesting. For example, in the past few weeks I spent time in China talking to driving instructors and driving schools about a novice driver trial we are running in Beijing, spent a few days with colleagues from Vietnam discussing research strategies to prevent road injury, then worked with Indigenous people from a remote Australian community to develop funding proposals for work needed in their community around road safety. I teach at the University of Sydney and supervise 5 PhD students and this adds another interesting dimension to my life! Another important aspect of my work is making sure the results are widely available - I talk at conferences, seminars and to the media to disseminate research findings, and also work closely with Government to ensure we understand their research priorities.

# The Australasian College of Road Safety (ACRS) Conference

## Road Safety 2020: Smart solutions, sustainability, vision

**5 – 6 November 2009 – Duxton Hotel, Perth, Western Australia**

**Reminder Call for Abstracts**

Researchers and practitioners are reminded to submit abstracts of papers or posters for our annual conference. This is a great opportunity to share the range of projects that have been undertaken in the area of road safety. The program is shaping up to cater to a broad range of road safety interests, drawing on WA expertise from other sectors such as mining for lessons learnt.

**Keynote speakers:**

- Mr Eric Howard, Road safety practitioner with more than 35 years experience in state and local government
- Professor Ian Johnston, Interim Director of Curtin-Monash Universities Accident Research Centre
- Dr David Sleet, Associate Director for Science, Center for Disease Control and Prevention (CDC), Atlanta USA
- Professor Mark Stevenson, Senior Director Medicine, the George Institute for International Health, Sydney University

Submissions should be submitted electronically to abstracts@acrs.org.au. Deadline for submissions is COB on 29 May, 2009. For more information, visit the ACRS conference website http://www.acrs.org.au/activitiesevents/2009conference/

# Quarterly News

## Chapter News

### Australian Capital Territory and Region

The Chapter made substantial comments on the draft 2009/10 ACT Road Safety Action Plan, suggesting significant additions on speed, impaired driving, ANCAP and AUSRAP and program evaluation. The high quality input from six Chapter members was greatly appreciated by Roads ACT.

The Chapter is arranging a networking session with AITPM and the Institution of Engineers Transport Group in June; and is planning a seminar on speed for August. *(Robin Anderson, ACT and Region Chapter Representative on the ACRS Executive Committee)*

### New South Wales (Sydney)

The Chapter is running a workshop on 'Heavy Vehicle Transport Safety and Fatigue Risk Management' on Wednesday 20 May, 2009, 8:30 am - 12.30 pm at the George Institute for International Health. This workshop is aimed at professionals involved in road safety and the heavy vehicle industry. Attendance is free to members of the ACRS and $25 for registration of non-members. Plans are being developed for a 'Drink Driving and Alcohol' seminar in July. *(Raphael Grzebieta)*

### Queensland

The Queensland Chapter held its AGM on Tuesday, 3rd March 2009. The following were elected for positions in 2009: Chair - Dr Kerry Armstrong (CARRS-Q), Deputy Chair - Mr Lyle Schefe (Education Queensland at Roadcraft), Secretary - Associate Professor Barry Watson (CARRS-Q), Treasurer - Ms Veronica Baldwin (CARRS-Q), Committee Members - Chief Superintendent Michael Hannigan (Qld Police Service), Ms Pam Palmer (Qld Transport), Ms Kelly Sultana (Qld Police Service), Ms Clare Murray (CARRS-Q), Mr Graham Smith (Roadcraft Driver Education).

The Queensland Chapter also held its quarterly seminar on 3rd March 2009. The seminar "An overview of the iRAP project" was presented by Mr Rob McInerney, CEO, iRAP Asia Pacific. The next Queensland Chapter meeting and seminar is scheduled for Tuesday, 2nd June 2009. *(Veronica Baldwin)*

### Victoria

The issue of ongoing active participation in the life of the College by members remains a challenge. Developing seminars that are of broad appeal to members and non-members alike remains a central issue as does the role of advocacy by the College at the State level.

Looking to the 2009/10 financial year, the Chapter intends to develop a State-based business plan that will serve both the national plan as well as look to grow the active membership within Victoria as well as stage a significant conference during the year. *(David Healy, Co-Vice-President and Victorian Chapter Representative)*

### Western Australia

**The ACRS National Conference:** The WA Chapter is gearing up for the National Conference in Perth on 5-6 November 2009. The keynote presenters are confirmed (Mr Eric Howard, Professor Ian Johnston, A/Prof David Sleet and Professor Mark Stevenson), the abstracts are starting to flow in and the venue is located a block away from the beautiful Swan River. This unique conference is one of the few that offer both practitioners and researchers with an opportunity to present and share their work. Presenters can opt to be included in sessions that are non-peer reviewed, that mean you can tell us what you are currently doing in your work to make a difference in the road safety arena without necessarily being part of a designated research program or project. The College has worked hard to provide an opportunity for the road safety community to attend this 2 day world class conference at the exceptionally low cost ($390 members, $450 non-members). We would encourage you to support the ACRS's endeavours by submitting an abstract and registering for the conference before the end of May. Your support is needed to ensure its' success. The conference website is at http://www.acrs.org.au/activitiesevents/2009conference/

Indigenous Road Safety: I am thrilled to announce that we will also have a keynote presentation from a prominent Indigenous road safety researcher at the conference - Watch this space!!!

**WA AGM:** The WA Chapter's AGM will be held on 21 May 2009 at Main Roads in East Perth beginning at 1.30pm with a short seminar by the CEO of Kidsafe WA, Sue Wicks. Sue will be presenting on Child Car Restraints. Child injury and death on our roads continue to be major concerns. We know that many of these deaths and injuries could be avoided by using the right restraint that is correctly fitted. We are looking forward to a good attendance at this seminar and at the WA and National AGM's to follow. We look forward to your support.*(A/Prof Alexandra McManus WA ACRS Chapter Chair)*.

# Australian News

## Australian Government Ups Spending on Roads

The Rudd Government's $4.7 billion Nation Building Package includes $711 million, brought forward this financial year and next, to accelerate the commencement of a number of major road projects. The package also allows for an increase in spending this financial year in the Black Spots program from $50 million to $110 million. The Federal Government has committed $24.2 billion to roads spending for the period between 2008/09 and 2013/14.

Seven key roads have been added to the National Land Transport Network, which is central to the Government's nation building agenda and Australia's international competitiveness. The national network accounts for only three per cent of Australia's total road length, but it carries 15 per cent of all traffic and 18 per cent of the country's freight. New research shows that the nation's highways and major arteries are set to become even busier, particularly the routes into and out of Australia's largest cities. The total distance driven by Australians on the non-urban part of the national network is expected to reach 55.8 billion kilometres a year by 2030.This is almost 50 per cent greater than in 2005.

The Federal Government has also announced the allocation of $1..75 billion to Australia's City and Shire Councils over the next five years (2009/10 to 2013/14) from the Roads to Recovery program. The funds can be used to make urgent repairs and upgrades to local road networks. The funding is untied and can go towards the local priorities identified by local communities. *(Source: Roads Australia Insider)*

## New Fatigue Risk Management Program for Heavy Vehicles

The Fatigue Authorities Panel (FAP)* recently endorsed three applications to operate heavy vehicles in Australia under the new national Advanced Fatigue Management (AFM) scheme. Registrations for two 'fatigue experts' have also been approved and their contact details are now available on the NTC website at www.ntc.gov.au/viewpage.aspx?documentid=1819

"We've been encouraged by the quality of AFM applications, which set a new benchmark for Australian road safety. The applications are supported by expert advice to ensure high safety standards and are in place and driver fatigue risks are properly managed," said FAP Chairman Don Leone. Unlike 'one-size-fits-all' work and rest limits (Standard Hours), AFM can be tailored for the needs of different truck and bus operations by applying a genuine fatigue safety risk management approach. The national scheme is based on successful trials pioneered by the Queensland Government and a number of transport operators.

AFM accredited operators must comply with 10 auditable standards, including scheduling and rostering, operating limits, readiness for duty, health, management practices, workplace conditions, fatigue knowledge and awareness, responsibilities, records and documentation and internal review. General Manager Safety & Environment Tim Eaton said truck and bus operators now have the clear choice. They can set rosters and schedules around standard work and rest limits, or step-up to a higher-level of audit-based safety risk management through AFM that better suits their own needs.

Mr Eaton encouraged the wider application of AFM through industry-specific templates. "Industry-specific AFM templates can help simplify the accreditation process for transport operators," he said. "NTC applauds the leadership of livestock transporters in developing an AFM application to manage the practical realities of pre-dawn starts and animal welfare."

Transport operators interested in applying for AFM accreditation should contact their local road agency. Fatigue experts wanting more information on becoming registered to provide advice on AFM applications can contact the FAP Secretariat on 03 9236 5000.

*The Fatigue Authorities Panel is a statutory body comprising representatives from implementing state and territory road agencies. The Panel's role is to facilitate a national outcome; it does not 'approve' applications but provides consistent advice to state and territory fatigue regulators on the suitability of AFM applications. The regulators must follow the Panel's advice or clearly justify reasons for not doing so. *(Source: National Transport Commission, March 2009)*

## Road Safety Key Component of Youthsafe

Road safety continued to be a major focus of the Sydney-based Youthsafe organisation. In 2008 Youthsafe addressed the risks associated with young drivers carrying more than one peer passenger, linking to the NSW legislative changes from July 2007 that restricted passenger numbers for P-platers. Consultations were held with Years 10 and 11 school students on this issue and a new sticker postcard resource was distributed promoting strategies for preventing overcrowding in vehicles driven by young people.

Over 26,000 fact sheets were distributed to parents to provide advice on helping new high school students (a high risk category) travel safely to and from school. Another concern regarding young adolescents was the use and correct fitting of cycle helmets. This led to the publication of a new fact sheet 'Heads up on Helmets'. *(Source: Youthsafe Annual Report 2008)*

## Victoria to Review Cycling Accident Patterns

The Victorian Government announced a new Cycling Strategy in March 2009 that included plans for a review of cycling accident patterns, in order to develop appropriate counter measures. The overall aim of the Cycling Strategy is to increase cycling levels across Victoria and position cycling alongside cars, trains, trams and buses as a viable and attractive transport option. The strategy will deliver a better cycling network, promote a culture of cycling, reduce conflicts between cyclists and other road users, better integrate cycling with public transport and integrate cycling with land use planning.

Priority actions in the strategy include:

- Significantly improving the cycling network within 10km of the CBD
- Establishing a public bike hire scheme for Melbourne
- Installation of bike cages at 33 train stations by the end of 09
- Completing cycling networks in central activities districts and regional centres
- Developing bicycle facilities as part of major transport projects
- Developing safe cycling programs in Victorian schools and launching a 'look out for cyclists' campaign to educate other road users about cyclist safety
- A review of cycling accident patterns to develop appropriate counter measures.

*(Source: Victorian Government media release 23 March 2009)*

## Small Decline in Australian Road Fatalities

In the last six years there has been a small overall decline in road fatalities in Australia, as shown by the table below. The best outcomes in 2008 occurred in Victoria and NSW. However, last year's fatality rate of 6.9 deaths per 100,000 people was well above the 2009 target of 5.6, set in the National Road Safety Strategy of 1999. The only state or territory to see a dramatic increase in fatalities was the Northern Territory, up from 57 in 2007 to a 20-year high of 75 in 2008. [Ed: To achieve the National Road Safety Strategy 2010 target will require a substantial improvement this year. One factor that could result in additional lowering of fatalities in 2009 - 2010 is the anticipated reduction in commercial and industrial activity due to the impact of the global financial crisis on Australia.]

| Year to March | Number of deaths |
|---|---|
| 2003 | 1,716 |
| 2004 | 1,618 |
| 2005 | 1,565 |
| 2006 | 1,655 |
| 2007 | 1,589 |
| 2008 | 1,571 |

*(Table source: Strategy and Analysis Section, Road Safety Branch, Dept of Infrastructure, Transport, Regional Development and Local Government)*

## Report from Motorcycle & Scooter Safety Summit

The Federal Government's Motorcycle Safety Consultative Committee released in March 2009 'The Road Ahead', the report of the Motorcycle and Scooter Safety Summit held in Canberra 10–11 April 2008. The report recommends seven 'Key Actions' to the government, and also suggests future directions in government regulations and practice regarding motor cycling. The 'Key Actions' are as follows:

1. Data and Analysis: a working group of stakeholder representatives be set up to develop an information strategy to define data needs in the short, medium and long term.
2. Rider Protection: implement a star rating system for protective clothing based on the European Union Standard supported by appropriate testing and widely disseminate the information including use of appropriate websites and other media.
3. Training and Licensing: the Motorcycle Safety Consultative Committee to convene an expert working group to develop key criteria for national graduated training and licensing systems for motorcycles and scooters.
4. Education: ensure that public education strategies for motorcycle and scooter safety include key messages for both riders and other road users.
5. Risk Taking: implement education campaigns which acknowledge that riders must have high attention levels, manage risks in everyday riding and need to take responsibility for themselves and their rider groups by not engaging in unnecessarily risky behaviour.
6. Enforcement: implement community policing campaigns (education and enforcement) aimed at educating other road users to be mindful of motorcyclists and for motorcyclists to be responsible for their own safety.
7. Road Infrastructure and Roadside Hazards: develop an Australia-wide website for reporting local road hazards which allows for uploading data and photos and includes details of treated hazards.

In the Future Directions sections there are many detailed suggestions on motorcycling issues. Some of the main ones were:

- Include motorcycling in all transport planning;
- Improve the analysis of crash statistics to identify the various categories of motorcycle;
- Seek GST exemption for motorcycle clothing that meets minimum standards as safety gear;
- Implement post-licence training, particularly for returning riders;
- Explore new ways to communicate motorcycle safety messages;
- Address rider fatigue, speeding and drinking issues;
- Target enforcement at high-risk behaviour with both covert and overt police activity; and
- Ensure that auditing schemes for roadside hazards take into account specific hazards for riders of motorcycles and scooters.

*(Source: Motorcycle and Scooter Safety Summit 10-11 April 2008 Report of 23 March 2009)*

## RACQ wants Joint Response to Challenge of Making Roads Safer

The RACQ wants to see a whole-of-government approach to make Queensland's road safer and reduce road trauma. At a Roads Australia industry lunch in Brisbane in April, RACQ

Chief Executive Ian Gillespie said that road crashes were costing the Queensland economy $4 billion annually, with medical bills accounting for $650 million of this figure.

Mr Gillespie said the "health" of the state's road network should not simply be the responsibility of the recently amalgamated State Transport and Main Roads Department and the Queensland Police Service.

"Last year in addition to 328 road deaths, 6000 people were hospitalised with serious injuries from road crashes in Queensland," Mr Gillespie said. "If this is not a major public health issue for Queensland, the RACQ would like to know what is…While we've some evidence in recent years of greater interest and involvement by the health and emergency services departments in helping make our roads safer, RACQ is not yet convinced that George Street really does see the need for a genuinely proactive whole-of-government approach to the problem."

Mr Gillespie told the gathering of roads industry and government representatives a far more "forgiving" road system needed to be developed. This could demonstrably save more lives than safer road users and safer vehicles combined. He said the RACQ would continue to press for road upgrades and the introduction of initiatives designed to reduce accident trauma, such as protective barriers around roadside poles and the use of wire barriers to separate traffic on single-carriageway roads. *(Source: Roads Australia Insider April 9, 2009)*

## Community Road Safety

Austroads has recently released its Austroads Guide to Road Safety Part 4: Local Government and Community Road Safety. This provides an overview of how local government and community road safety programs are structured in Australia and New Zealand, what types of activity they involve, and how they contribute to road safety outcomes. It outlines and discusses:

- the road safety responsibilities of local government;
- the advantages of working closely with the community in meeting those responsibilities;
- the growing importance of capacity building;
- social capital and social networking in the delivery of government services and their particular relevance to local road safety.

The Guide includes advice on the development and funding of local road safety strategies, mobilising resources, and evaluation and review. Case studies of various strategy plans are presented along with examples of road safety activities. Communication and reporting are also addressed. There is also a list of useful resources for local government and community road safety programs. This is the latest in the now completed nine part Guide to Road Safety. Copies are available from www.austroads.com.au. *(Source: ALGA News April 2009)*

## Fatality-free Friday

Fatality-free Friday, an event that originated in Queensland in 2007, has now become more widespread in Australia and will be held on Friday 22 May this year. The aim of the event is to focus people's attention on road safety by emphasising that about 1,600 people are killed in Australia annually in crashes and that individuals can make a difference. Individuals are encouraged to 'take the pledge' to behave in a safe way on the road so that at least one day in the year could be fatality-free. For more information visit www.fatalityfreefriday.com.

## Contrary Views on Shock Ads

A former political spin doctor says shock tactic advertisements fail to convince young people to change their risky behaviour. However, Victoria's Transport Accident Commission remains convinced their ads are helping to save lives. *(Source: Wotnews Daily News Report, 28 April 09)*

## The Sixth National Roads Summit

The Sixth National Roads Summit 2009 will be held in Sydney from 28 - 29 July 2009. This conference is the peak annual gathering for the major stakeholders in Australia's road industry. These include: Australian Local Government Association; ARRB; Australian Automobile Association; Australian Constructors Association; Boral; Currie and Brown; Cement Concrete & Aggregates Australia; ConnectEast; TBH Group; AON; ACP; Australian Asphalt Pavement Association; Abigroup. The presentations and discussion will focus on important issues and challenges, from Sustainability to Managing Infrastructure in Adverse Financial Conditions. For more information or to register to receive the Summit Brochure, view http://www.halledit.com.au/roadsaus09 or contact Denise McQueen, 03 8534 5021 or via email denise.mcqueen@halledit.com.au

## National Transport Commission Review

The future direction of the National Transport Commission (NTC) is being reviewed, and the industry sector and members of the public have been encouraged to have their say.

The nation's transport ministers, through the Australian Transport Council, have asked an expert panel to review the operations and effectiveness of the NTC, the independent statutory body established to advise governments on the development and implementation of uniform or nationally consistent transport regulations. Mr Bruce Wilson AM will chair the Steering Committee for the review, The Committee will consult with industry and key transport organisations and will examine:

* The effectiveness of the Commission in delivering regulatory and operational reforms to improve road, rail and intermodal transport; and
* The future of the Commission in light of the future transport policy and regulatory challenges.

The review will provide recommendations on the future of the National Transport Commission, including possible amendments to the relevant legislation. The review's findings and recommendations are due to be presented to the ATC in the middle of the year, which in turn will report to the Council of Australian Governments in September. *(Source: Roads Australia Insider, January 30 2009)*

## Anticipated Traffic Increases

Federal Infrastructure and Transport Minister, Anthony Albanese, has released new research that shows the nation's highways and major arteries are set to become 50% busier by 2030, particularly the routes into and out of Australia's largest cities.

The research shows the total distance driven by Australians on the non-urban part of the national network will reach 55.8 billion kilometres a year by 2030, almost 50 % greater than in 2005. *(Roads Australia Insider, March 13, 2009)*

## NSW to Make Demerit Point Scheme Fairer

Preliminary advice has been given that the NSW Government will make changes to the licence demerit point scheme. The justification is to make the system fairer for motorists without compromising road safety. The proposal is that lower level speeding offences would be defined in 10kmh zones to better reflect advice about speeding and road safety and align them more closely with speed zones.

The lowest range offence would only incur one demerit point, rather than the current three. The minister, Mr Daley said "There is no such thing as safe speeding, but we acknowledge the system could be fairer which is why we are lowering the number of points for the lowest range speeding offences". *(Roads Australia Insider, March 13, 2009)*

## Survey of Community Attitudes to Road Safety

Data from the Federal Government's latest Survey of Community Attitudes to Road Safety has been released. The survey involved interviews with 1,600 people from across the country about their road safety beliefs, attitudes and practices.

Results show widespread public awareness about the main causes of road trauma - such as speeding, alcohol, driver distraction and fatigue. The findings also show strong support for existing traffic regulation and enforcement. Analysis of the data also shows that, although Australians are well informed on road safety matters, yet many still choose to take unnecessary risks on the road.

The survey found that:

* 90 per cent supported the ban on using hand-held mobile phones while driving;
* 98 per cent approve of random breath testing;
* 88 per cent think that the level of speed enforcement activity should stay the same or increase; and
* 38 per cent believe the 60 km/h speed limit should be strictly enforced - and a further 42 per cent that motorists should be penalised for travelling more than 5 km/h above the limit.

The full 2008 Survey of Community Attitudes to Road Safety can be downloaded from:
http://www.infrastructure.gov.au/roads/safety/publications/2008/comm_att_08.aspx

## International Road Safety Comparisons: The 2006 Report

The International Road Safety Comparisons report presents detailed tables of road death rates for Organisation for Economic Co-operation and Development (OECD) nations and Australian states/territories. These rates allow Australia's road safety performance to be compared with other OECD nations while taking into account the differing levels of population, motorisation and distances travelled.

**Road Deaths per 100,000 people**
OECD Median - 8.8
Australia - 7.7 (Population 20.7 million; road deaths 1,598)

**Road Deaths per 10,000 registered vehicles**
OECD Median - 1.4
Australia - 1.1 (Total vehicles registered-million 14.4; total number of road deaths 1,598)

**Road Deaths per 100 million vehicle kilometres travelled**
OECD Median - 0.9
Australia - 0.8 (Total deaths 1,598; total vehicle kilometres travelled 2,094)

The report may be viewed at:
http://www.infrastructure.gov.au/roads/safety/publications/2008/Int_Comp_06.aspx

## Fatal Heavy Vehicle Crashes Australia

During the 12 months to the end of June 2008, 279 people died from 245 crashes involving heavy trucks or buses. These included:

- 168 deaths from 144 crashes involving articulated trucks
- 95 deaths from 87 crashes involving heavy rigid trucks
- 24 deaths from 22 crashes involving buses.

Fatal crashes involving articulated trucks:

- increased by 5.9 per cent compared with the previous 12-month period
- increased by an average of 3.3 per cent per year over the three years to June 2008.

Fatal crashes involving heavy rigid trucks:

- increased by 24.3 per cent compared with the previous 12-month period
- decreased by an average of 0.6 per cent per year over the three years to June 2008

For further information see:
http://www.infrastructure.gov.au/roads/safety/publications/2009/fhvca_q22008.aspx *(Source: Quarterly Bulletin, April-June 2008)*

# New Zealand News

## Safety Focus on State Highway

February saw the start of Operation Tāhi, a South Island-wide five-month traffic police program to help make State Highway One a safer place to drive, as it cycles through key traffic target areas.

The operation began by addressing speeds around schools as children returned after the holidays. Acting Canterbury Road Policing Manager, Senior Sergeant Neville Hyland, said "Given the surprisingly high number of schools on or near State Highway One, plus the high traffic volumes and speed associated with this route, we wanted to start Operation Tāhi by reminding all drivers to take extra care around schools at this time." There are 75 schools and childcare centres on or within 250m of State Highway One in the South Island – 13 in Tasman, 25 in Canterbury and 37 in Southern districts.

Another phase will target alcohol, and the 88 pubs and hotels that are located on or near State Highway One – 21 in Tasman, 28 in Canterbury and 39 in Southern. "The operation will move on through several phases, not just speed, alcohol and drugs, but also careless and dangerous driving, high-risk and disqualified drivers, and those not wearing seat belts," said Senior Sergeant Hyland. "Then we'll start over again, and cycle through repeatedly for five months."

The project will see an unprecedented level of cooperation between traffic units, and will involve staff from Tasman, Canterbury and Southern districts and the Commercial Vehicle Investigation Unit. "Operation Tāhi combines the resources of all South Island traffic policing units, and we're working closely together to bring a coordinated attack on high-risk driving," said Tasman Road Policing Manager, Inspector Hugh Flower.

Research shows that Thursday, Friday and Saturday have a higher number of crashes than the rest of the week, peaking on Friday between 12 noon and 3pm. "It's no surprise that this corresponds with the days and times that we see peaks for speeding, and careless and dangerous driving," said acting Southern Road Policing Manager, Senior Sergeant Stephen Larking. "Research also tells us that average urban speeds have not been dropping in line with the open road trend of recent years, particularly in Canterbury and Southland, so we'll also focus on places where State Highway One passes through cities and small towns."

Another area to come under scrutiny is heavy motor vehicle (HMV) traffic. Commercial Vehicle Investigation Unit South Island Manager, Senior Sergeant Warren Newbury, said that although crashes involving HMVs made up only 14 per cent of all South Island State Highway One crashes from February to June 2004 to 2008, they accounted for half of the fatalities. *('Ten-One', the New Zealand Police online magazine, February 2009)*

## More 'Rumble Strips'

Rumble strips, formally known as audio tactile profiled markings, are raised road markings used along road edges and centerlines. They have been found to be an excellent device for giving drivers a 'wake-up call' if they allow their vehicle to stray out of lane. The NZ Transport Agency intends to add a further 750 kilometres of rumble strips to the state highway network in 2009. This will increase the total length of rumble strips on the network to approximately 1,350 kilometres. Wherever possible, a one-metre sealed shoulder for cyclists will be maintained outside the rumble strips. *(Source: 'Pathways' NZ Transport Agency News April 2009)*

## New TV Ad Highlights Intersection Safety

The key message of the latest road safety television advertisement is "Intersections are not a game – it's your call". Each year around 2,500 crashes occur at intersections because someone fails to stop or give way. This results in over 3,000 injuries and 26 deaths per year. The latest campaign is especially targeting city drivers aged between 25 and 39 years. The NZ Transport Agency and NZ Police that are running the campaign believe that these drivers consider the risk of having a serious crash at an intersection to be low and are therefore prepared to take higher risks in certain situations, such as when they are running late. *(Source: 'Pathways' NZ Transport Agency News April 2009)*

# European News

## Lifesaver Project

The European Traffic Police Network (TISPOL)'s Lifesaver Project has been launched to raise the standard of traffic policing in six TISPOL member countries (Hungary, Poland, Portugal, Romania, Slovenia and Spain). The project focuses on three priorities: speeding, seat belt use and drink driving. A key part of Lifesaver will be the exchange of 600 officers from these six countries to other TISPOL member countries, such as Belgium, France, Germany, Netherlands, Norway and the UK, to learn and experience good practice at first hand. The Lifesaver Project will also run seminars where information and knowledge of good practice can be shared at the strategic, middle management and operational levels, with benefits for all TISPOL member countries.

## Round-up of EU Drink Driving Developments

Drink driving continues to be a major focus of enforcement efforts in the European Union (EU) to reduce the road toll. Unfortunately, the fate of the proposed Cross Border Enforcement Directive, that foresees a system that would transmit and communicate drink driving offences between Member States, hangs in the balance. Member States have not been able to agree on the Directive following months of discussions. It is now up to the leadership of the Czechs and the Swedes, who take up the EU Presidency this year, to find a way forward.

Slovenia is in the pilot project phase of the voluntary installation of interlock devices for private cars and public transport. They have introduced the interlocks to Ljubljana`s public transport company and for the first experiment 7 buses were fitted with devices for 2 months. The aim was to show passengers and other traffic participants that bus drivers perform their job with a high degree of responsibility, that they drive sober and are ready to prove this every minute using an interlock. All non-professional drivers were urged to follow this example of sober driving.

Hungary is taking a strong approach towards drink driving. In January 2008 a 'Zero Tolerance' to drink driving was introduced. Whenever a driver is found to be under the influence of alcohol the driving licence is withdrawn in every case. So far 7,500 drivers have had to give up their licences. It is thought that this approach has had a significant influence on a reduction in fatalities of 24% in the first 9 months of 2008 compared with 2007. This means that 221 less people have lost their lives on Hungary's roads. There has also been a significant reduction in the number of drink driving accidents (- 22%).

The Spanish Parliament has urged the government to begin the process needed to prepare the framework law for alcolocks in vehicles used for public transport and for repeat offenders. It has also urged that a proper consultation process be convened to see how this could be implemented most effectively. In parallel the Road Safety General Prosecutor is considering the introduction of alcolocks to repeat driver offenders, as a voluntary tool to replace other penalties.

In the UK the Government is considering modifications to its current drink driving procedures and alcohol level. The legal limited is 0.8 BAC at present. The Government is investigating lowering the limit and also introducing checkpoint testing.

Figures from the Department of Transport on drink driving in Ireland published recently found that 1 in 3 crashes between 2003 and 2005 were alcohol related. Furthermore, where blood alcohol levels were available for killed drivers, almost 6 out of 10 (58%) had alcohol in their blood. *(Source: ETSC Drink Driving Monitor No.7, January 09)*

## Child Mortality on Europe's Roads

At least 600 child deaths could be avoided each year if the level of child mortality from road collisions were the same across Europe as in Sweden.

## Success story from Sweden

Sweden's holistic approach to protect children from road dangers was based on a new philosophy: it should no longer be the child that should adapt to traffic conditions, but the traffic conditions that should be adapted – as far as possible - to children' limitations. So, ultimately, it is the adults' responsibility to protect children from road danger. Sweden has had a history of high seat belt usage. In addition, parents place children in rearward facing restraints up to the age of 4, as recommended by the government. As a result, only two children (0-6) were killed in a car in 2008.

Road safety education is integrated into other subjects at school. Recent intensive discussion in Sweden about traffic education for children has led to the conclusion that it is not feasible to educate them about traffic, at least not up to the age of 12, and then trust them to be completely road safety savvy. They are simply not developed enough to handle complex situations such as road traffic.

Instead the Swedish Road Administration and Local Authorities are trying to improve the environment to make it more suitable for them. Since the 1960s, road safety education in school has been reduced by more than 50%, while road deaths of children 0-14 decreased from 120 down to 6 in 2008. This supports the idea that there is no direct connection between road safety education and low child road mortality. Training is, however, still considered to have an important role, especially regarding matters such as cycle helmet and seat belt use.

In its Blueprint for the EU's 4th Road Safety Action Programme 2010-2020, the European Transport Safety Council (ETSC) is proposing a separate target for reducing road deaths amongst children. As population forecasts predict that the proportion of the EU population aged 0 to14 is likely to continue falling steadily in the next decade, ETSC argues that a single target for all ages would be less challenging in respect of children than other age groups. ETSC is therefore recommending the EU to adopt a target of a 60% reduction between 2010 and 2020 in child deaths on the roads (compared to a 40% overall reduction). *(Source: ETSC Road Safety Performance Index Flash 12)*

## Concern over Forward-facing Child Restraints

A study by the British firm Vehicle Safety Consultancy Ltd., commissioned by the European Association for the Co-ordination of Consumer Representation in Standardisation (ANEC), showed that children in forward-facing seats during a vehicle crash suffered head, neck, chest and abdominal injuries in circumstances in which a rearward facing restraint would have provided much better protection. Rearward-facing restraints offer a higher level of safety over forward-facing restraints to children aged up to four years. Rearward facing restraints are used in Nordic countries up to the age of 3 or 4 years old, whereas in the rest of Europe children travel facing forward at one year of age or less. This practice is based on the European legislation which implies that it is safe for a child to travel forward-facing from 9 kg onwards. ANEC is urging legislators to revise the law on the use of child restraints, and calls on the manufacturers of child-restraint systems and cars to collaborate voluntarily in order to make Scandinavian-style rearward facing seats for children up to 4 years available to consumers throughout the rest of Europe. *(Source: ETSC Road Safety Performance Index Flash 12)*

## Poland's Roads under Scrutiny

European Road Assessment Program (EuroRAP) Risk Maps have been produced as part of Poland's efforts to curb the more than 15 deaths that occur each day on the nation's roads. The EuroRAP Poland report contains colour coded Risk Maps for 5,500km of roads across the nation. The maps are based on fatal and serious casualty crashes that occurred during the three-year period 2005-07. Individual Risk Maps show that 55% of the network is high risk. The report identifies 21 critical road sections where both Individual Risk and Collective Risk is high. *(Source: iRAP e-newsletter, Issue 3, Apr/May 2009)*

# Asia

## High-Risk Roads the Target in Vietnam

Roads vital to Vietnam's economic growth, trade and employment are being targeted by the International Road Assessment Programme (iRAP) for road safety assessments. The project focuses on 3,000km of the nation's high-risk roads, including 2,000km of the busy National Highway 1 which connects Hanoi in the north with Can Tho in the south. iRAP Vietnam is supported by the World Bank Global Road Safety Facility.

Vietnam made outstanding improvements to safety with the introduction of a new motorcycle helmet programme in 2007. The Government aims to build on this success by targeting high-risk roads for improvement, especially for motorcyclists, which still account for nine out of 10 road deaths. *(Source: iRAP e-newsletter, Issue 3, Apr/May 2009)*

## Making Roads Safer in China

iRAP and the Research Institute of Highways (RIOH) have begun safety assessments in China. iRAP China will initially involve assessment of 2,100km of roads in and around Beijing during the next 12-18 months. It will produce Risk Maps using historical crash and traffic data, Star Ratings which illustrate the level of safety 'built in' to roads, and the development of affordable and economic countermeasure plans. The partnership is part of China's efforts to manage the tremendous growth in transport during recent years and will complement existing programmes, such as the Highway Safety Improvement Project which, by the end of 2005, had seen more than RMB6.5 billion invested in China's low-class highways. China is aiming for fewer than 90,000 road deaths annually by 2010. *(Source: iRAP e-newsletter, Issue 3, Apr/May 2009)*

# Middle East News

## New ARRB Regional Manager for the Middle East

John Hughes was appointed ARRB's new Regional Manager for the Middle East on 1 March 2009. John has extensive Middle East experience, most recently working as Principal Engineer (Highways and Transportation) Middle East and North Africa (MENA) for SMEC in Qatar and Kuwait. John has skills in highway engineering, institutional strengthening and expertise in international consulting. He is a qualified Senior Road Safety Auditor and holds a Master of Engineering degree.

When asked about his priorities for the Dubai office, John said 'ARRB in Dubai has strong expertise in specialist areas like pavement engineering, asset management, road safety and road safety auditing, besides being able to draw upon ARRB's skills from Australia. In this way, ARRB is unique because it is independent of the major firms that have been involved in the design and construction of the region's infrastructure projects, and therefore it can offer truly independent advice to Government and private sector clients.'

From late April, ARRB's former Regional Manager for the Middle East, Dave Jones, will return to Australia in the role of Regional Manager - Research and Consulting, for Victoria, Tasmania and New Zealand. *(Source: ARRB Media Release March 2009)*

# Latin America and Caribbean News

The International Road Assessment Programme (iRAP) and the Inter-American Development Bank have signed a five-year agreement to tackle road deaths and injuries. More than 50,000 people are killed annually on roads throughout the region. Road crashes are estimated to cost Latin American and Caribbean countries almost $US 19 billion each year, representing a significant barrier to economic and social development.

To date, iRAP has assessed more than 10,000km of roads in Costa Rica, Chile, Peru, Argentina and Cordoba. Initial results from these projects, which were supported by the World Bank Global Road Safety Facility, identify affordable opportunities to prevent more than 40,000 deaths and serious injuries during a 20 year period. *(Source: iRAP e-newsletter, Issue 3, Apr/May 2009)*

# North American News

## US Motor Vehicle Traffic Fatalities Down 9.1% in 2008?

Using statistical projections, the National Highways Transport and Safety Administration in the USA has announced that in 2008 fatalities in motor vehicle traffic crashes are estimated to have dropped to 37,313 - a 9.1-percent decline from the 41,059 fatalities reported in 2007. The actual count of fatalities will be reported in August 2009. Preliminary data reported by the Federal Highway Administration shows that vehicle miles travelled (VMT) in 2008 dropped by about 3.6 percent to 2,922 billion miles. The fatality rate, computed per 100 million VMT, dropped from 1.36 in 2007 to 1.28 in 2008 The projected decline in 2008 will represent the third-largest decline, both in the number and percentage, on record (since 1961). The largest decline since 1961 was 16.4 percent in 1974, followed by a 10.9-percent decline in 1982. *(National Highway Transport Safety Administration - Traffic Safety Facts - Research Note, March 2009)*

# Contributed Articles

**Please note that our November 2009 Journal will have a major focus on motorcycle safety. If you would like to write a 'Letter to the Editor' or submit an article, please send it as a MS Word document to journaleditor@acrs.org.au by 10th September.**

## Interface Design: The Next Major Advance in Road Safety

*By Dr George Rechnitzer, Shane Richardson, Maxwell Shifman & Dr Andrew Short*
*Delta-V Experts, Melbourne, Australia Web: www.dvexperts.net Tel: (03) 9481 2200.*

### Abstract

Road safety initiatives over the years have been heralded by concepts such as behavioural issues, new safety features in vehicles and road improvement projects. These have progressively reduced the road toll by targeting high priority issues, but without new directions the initiatives may have diminishing returns over time. Furthermore, it is well known to engineers that holistic and system wide approaches such as Vision Zero are fundamentally more powerful as they target elimination with a coordinated approach to the problem rather than progressive reduction with isolated actions.

This paper identifies the concept of "Interface Design" as a potential catalyst for the next major advances in road safety. Interface Design is a holistic approach which encourages players in the development of systems to consider all possible interfaces of their project. The authors show some examples of interface design and in the process hope to highlight how this design and engineering approach represents a new frontier.

### Introduction

There are various paradigms in Road Safety, including Vision Zero [1, 2]; the Safe Systems approach - safer people, in safer vehicles on safer roads [3]; and Crashworthy Systems [4, 5]. The authors advance the concept of "Interface Design" [6, 7, 8] which can be applied to all facets of road safety, from behavioural through to road and vehicle design. Interface design draws from and extends previous road safety system paradigms; in doing so, it provides a powerful conceptual framework for road safety analysis and countermeasure development, as well as an equally powerful applied methodology to ensue effective outcomes for a safer road transport system.

In Interface Design, we explicitly recognise that failures in our road safety system occur because of breakdowns in system safety at various interfaces. These inadequately designed interfaces either cause collisions to occur, or cause them to occur in a way which increases the risk of injury. Through proper attention to interface design at all levels of the transport system we can reduce crash risk, crash severity and injury risk.

While various aspects of Interface Design have been applied and can be arrived at through other road safety paradigms [compatibility, crashworthy systems, intersection conflict analysis, Vision Zero; behavioural change, etc], Interface Design requires a more detailed and systematic examination of the effectiveness of the design and implementation of road safety measures at all levels.

The authors in this paper argue that further significant advances in road safety will arise from the understanding and purposeful incorporation of Interface Design in road safety programs. By paying due attention to interface design we open up our thinking to an increased range of countermeasures possibilities, and provide opportunities for improving road safety and reducing risk.

The interface design paradigm is fully compatible with the Vision Zero philosophy, as it explicitly recognises that responsibility for safety is shared by the system designers and the road users. A key principle from Vision zero is that [1]:

"The designers of the system are ultimately responsible for the design, operation and use of the road transport system and thereby responsible for the level of safety within the entire system".

Interface design occurs at three main levels:

1. **Behavioural interfaces.** Interface design when applied to the vehicle operator is concerned with vehicle control and crash avoidance by the vehicle operator or independently. This includes the gamut of behavioural issues, including: the fundamentals of driver attitudes and training; the area of ergonomic and human factors (man-machine interface); in-vehicle systems interfaces (GPS, mobile phones etc.); vehicle control systems (such as ABS, ESC etc.); and through to the interaction with the road environment (road design, signage etc.), and other road users (other vehicles, cyclists, motorcyclists, pedestrians

etc.). Operator vigilance and effects of alcohol, drugs and fatigue as well as personal factors must also be considered. Similarly motorcyclists, bicyclists and pedestrians are faced with a range of interface issues regarding their behaviour in traversing the road transport system.

2. **Vehicles and Road interfaces.** This relates to the opportunity available in the road transport system for collisions of all sorts. Interface design for vehicle crashworthiness includes vehicle-to-vehicle crashes as well as compatibility with heavy vehicles and road infrastructure, level- crossings and so on. An example of a typically effective road-vehicle-driver interface design is the roundabout. This provides an effective interface for vehicles changing direction at an intersection, as it reduces both crash risk and injury risk due to the intersection design and reducing driver vehicle speeds (in the form of reduced conflicts, simplified driver decision making, reduced crash speeds). Another example is heavy vehicle design where energy-absorbing underrun barriers are fitted which provide an improved geometric and stiffness interface in crashes with other vehicles or other road users.
3. **Human-impact interface.** Injury prevention in a crash is a function of the interface between the human and whatever is impacted or restrains the human during an impact. In this sense, we need to differentiate the macro (vehicle) level impact interface from the micro (human – object contact or restraint) level interface where injury actually arises. For example, at the macro level we are concerned with maintenance of vehicle structure and occupant compartment integrity as key criteria, such that the human-vehicle-outside environment interface is kept viable. At the micro level, safety systems such as airbags typically provide an interface between a person's head and vehicle internal (e.g. front airbag and steering wheel) or external (e.g. side airbag and pole) structure. Airbags provide both very good load distribution and good deceleration or 'crush' characteristics. On the other hand for pedestrians, the micro level can be important such as head impact with a steel bull bar fitted to the front of a truck or car, with such structures representing an incompatible interface.

The following sections present a series of examples to illustrate the application of the Interface Design method to various areas of road safety. The consideration of the practicality or otherwise of the various interface design examples presented is not the focus of this paper, and hopefully will not distract the reader from appreciating the method and wide range of utility. We trust that this paper will motivate a strong interest in the use of the Interface Design approach in road safety (and indeed in other areas).

## Level Crossing Crashes

Crashes at level crossings provide a good illustration for application of the Interface Design method, as interface issues range from driver behaviour, human factors, road and rail track design and train-vehicle interfaces.

Clearly, the most effective interface between trains and other road users is to have no interface at all – i.e. complete separation, by underpass or overpass. In the absence of complete separation, we are left with dealing with level crossings. One approach relates to crash severity reduction by altering the interface between the impacting objects. We argue that even the most extreme crash scenarios can be ameliorated by applying the appropriate interface [7, 8, 9].

An extreme example used to demonstrate these principles is the case of an unprotected pedestrian standing on a railway track in the path of a train travelling at 100km/h [Figure 1]. Simply put, if the so called 'mass effect' had any significance, it should be in this scenario. In this case the use of a large airbag (the interface) fitted to the front of the train could, in principle, render survivable this seemingly unsurvivable impact [8, 9].

In reality, such an outcome for this train example should not be surprising. It clearly follows the laws of physics and use of frames of reference. In the above example, by changing the frame of reference to the train instead, the train would appear 'stationary' and the 'pedestrian' would be moving at 100km/h, running into the front of the train. The issue of injury prevention can then be seen more clearly as one of putting something 'soft' (energy absorbing) on the front of the train to decelerate the impacting person. Changing the frame of reference clearly shows that in such crash scenarios involving objects of vastly different masses, the energy that must be managed is not that of the heavy vehicle, but the energy imparted to the lighter vehicle, which is a much easier problem to deal with.

Hence, if a pedestrian was struck by a train travelling at 100km/h, which had a large airbag fitted to its front (resulting in 4m crush of the airbag, and an average 10g acceleration on the pedestrian), the impact would be quite survivable with the pedestrian likely to be uninjured!

Similarly, considering a car-train crash at a level crossing [Figure 2], for example, by adding an appropriate interface, such as an airbag on the train between the impacting vehicles, a train impact speed of 80km/h train, for an average 10g acceleration level, requires air bag 'crush' (displacement) of 2.5 metres [9, 10].

The vital factor to note from these calculations and previously cited research is that it is not the mass difference that is important but the interface between the impacting vehicles that determines the injury risk. We are not trying to stop the train but rather we are trying to accelerate the car (or pedestrian) up to the speed of the train! This is an entirely more practical and solvable task.

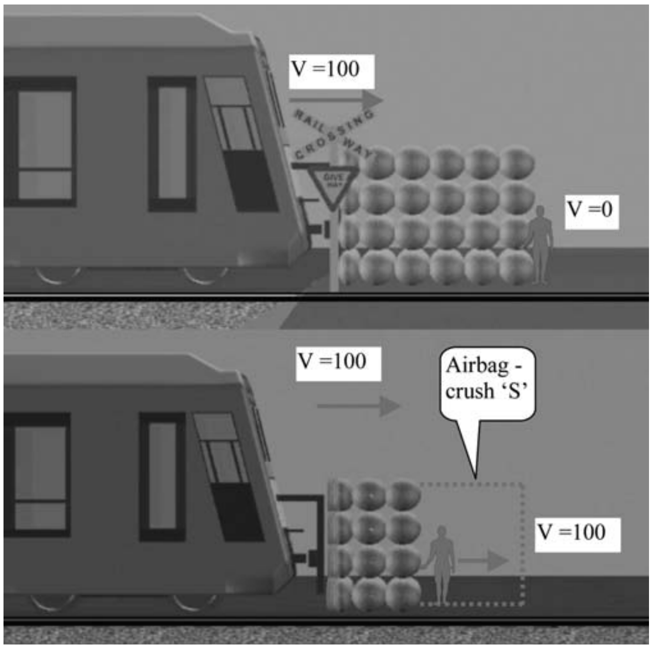


**Figure 1. Upper view, at point of impact between pedestrian and train with front airbag deployed. After initial impact, airbag has compressed distance 'S', and accelerated the pedestrian up to the speed of the train [100km/h]**

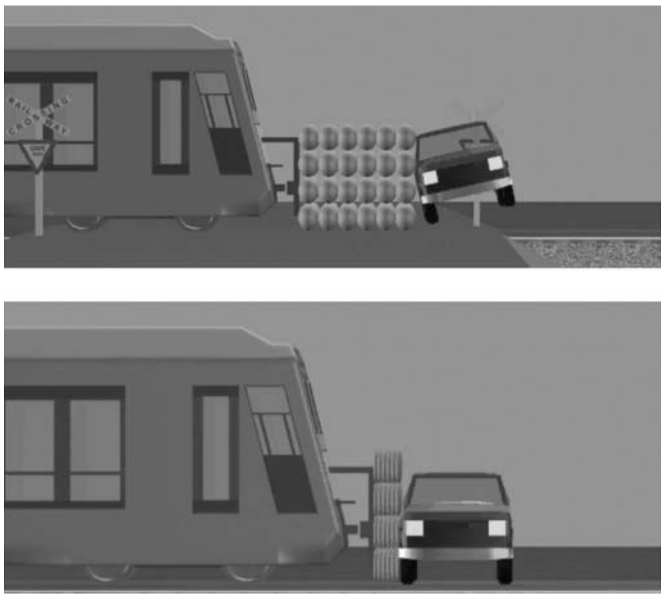

**Figure 2: Illustration of improved collision interface compatibility at a level crossing between a vehicle and train with front airbag deployed**

## Intersection and Visibility Interfaces at Level Crossings

The fatal collision of a fast train and semi trailer carrying a large 'granite boulder' and heavy cast forging at the Trawalla level crossing demonstrated a number of major interface failings. These include:

- Visual interface failure: the crossing geometry - the roadway and track intersected at an angle; the driver's view out of the cab of the prime-mover was severely restricted by the cabin design [large B pillar]; landscape and pole obstructions.
- Poor crossing design providing no visual or other aides to the driver to identify when and where a train was approaching the crossing.
- Train and truck speed interface incompatibility: the high speed of the train coupled with the long duration required for the semi-trailer to clear the crossing, and thus the distance the train was away from the crossing when it need to be first sighted by the driver;
- Impact incompatibility with a high-speed train impacting heavily loaded semi trailer.

This example also illustrates the vital necessity to deal with interface design at both the macro and micro level. The macro level could be considered as the overall interface design between a high speed train and an uncontrolled intersection. At a micro level, unless the Interface Design of the visual environment is properly considered from the truck driver's viewpoint (i.e. by literally sitting in his seat at the crossing, in a prime-mover), the macro level solution will be negated).

The following photographs [Figure 3, Figure 4 & Figure 5] illustrate some of the above interface issues at the level crossing and the Trawalla collision.

## Crashes between Cars and Heavy Vehicles

Other interface examples involve underrun crashes with heavy vehicles [8, 11, 12]. Here we see the most adverse interfaces, both with geometric and stiffness incompatibility.

**Figure 3: View of the Trawalla level crossing showing a prime mover stopped at the crossing (part of the DVE incident investigation and reconstruction). Note the acute angle of the crossing to the roadway.**

An appropriate interface includes the fitment of energy absorbing underrun barriers to the front side and rear of trucks [Figure 6 & Figure 7]

**Figure 4: Trawalla level crossing - reconstruction showing a similar semi-trailer and the load involved in the level crossing crash. Note the extreme collision interface incompatibility between the front of the high speed train and the trailer and large 'rock' impacted.**

**Figure 5: Trawalla level crossing - reconstruction showing the view from the driver's seat and the severely restricted length of track able to be seen. This is an example of very poor visual interface design at the crossing, arising from the level crossing design and the prime-mover cabin design.**

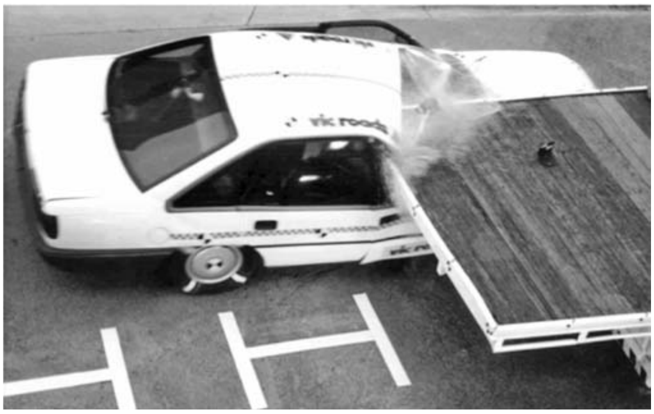

**Figure 6: Rear underrun crash test of commodore sedan at 50km/h into rear of tray truck without an underrun barrier)**

**Figure 7 Detail showing interface height of front of Corolla and the underrun barrier.**

The importance of such interface analysis and countermeasure development, including the vital role of testing and evaluation as illustrated in these examples, is that it helps ensure clarity of understanding in terms of crash and injury causation and countermeasure development. For too long in the authors' experience, there have been many examples of clouded and confused thinking both as regards causal factors and the range of options for countermeasure development. Let us be clear on these factors, and then, with clarity, debate what measures can be taken.

## Vehicle Rollover

The following examples illustrate a solution to the problem of vehicle roof crush arising in rollover crashes and increasing the injury risk to vehicle occupants. The "SWAN" Rollover Protection Structure (ROPS) design was developed for BHP-Billiton and other resource companies to provide a structural system to prevent or minimise structural deformation or collapse of the vehicle roof and cabin structure, and reduce injury risk to the driver and other occupants [13]. It is an external structure which provides both a geometric and structural [strength] interface with the road surface that shields the cabin from direct loading in a rollover [Figure 8, Figure 9 & Figure 10].


**Figure 8: (Above and Below left)The 'SWAN" ROPS fitted to utility type vehicles to provide occupant compartment protection a rollover**

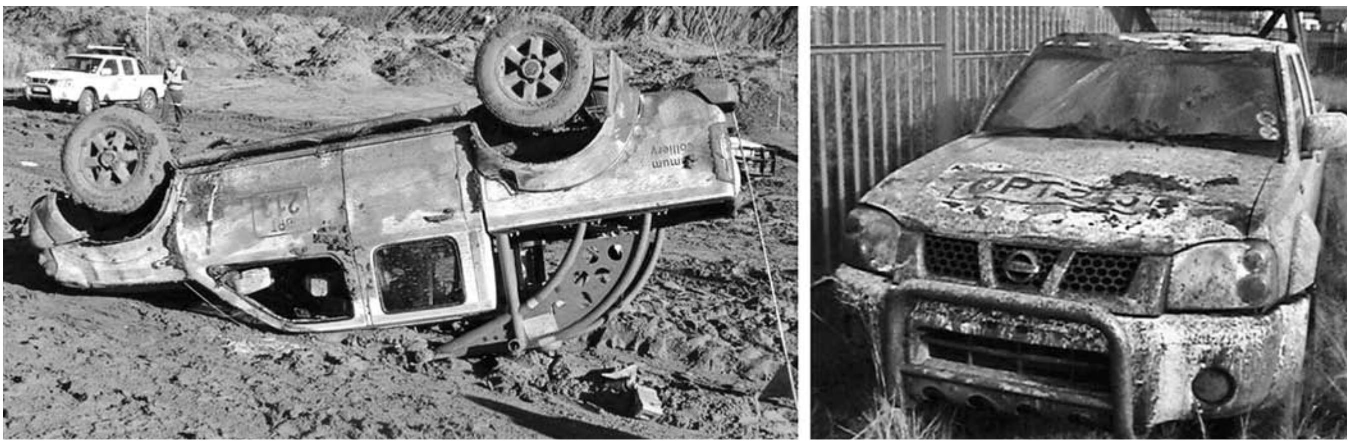

**Figure 9: (Above Middle & Bottom) Third rollover of a vehicle equipped with Swan ROPS resulting in maintenance of occupant survival space and only minor injuries.**

**Figure 10: Side-by-side comparison of testing conducted at 60km/h on OEM vehicle with ROPS (left) and without ROPS (right)**

## Pedestrian Involved Crashes

The authors have investigated many vehicle-pedestrian impacts, both in city and suburban areas, and some other interstate regions, around Australia. The issue of pedestrian safety involves numerous interfaces, from behavioural, road design, traffic flow, and vehicle design. We will focus on a few areas out of many [14].

## Vehicle-Pedestrian Impact Interface

In a well-publicised pedestrian incident, Richmond AFL footballer Graham Polak was struck on the head and seriously injured by a tram on the night of 28 June 2008. This unfortunate incident once again reminds us how little is done (yet how much could be done) with the interface design of the front of our trams and buses to reduce severe and fatal injury risk to pedestrians.

Trams, trains and buses have stiff, hard front structures which can and do inflict serious head and other injuries even at low speeds [15]. Energy absorbing surfaces, i.e. Interface Design, could be practically added to the front of trams and buses to makes these structures "crashworthy" for pedestrians [Figure 11] but for some unknown reason this is not happening. Such recommendations were made in a Monash University Accident Research Centre Report for VicRoads in 1993 [11]. Public transport authorities need to apply attention to the opportunities to implement known, practical safety solutions to reduce the horrible consequences of brain injury.

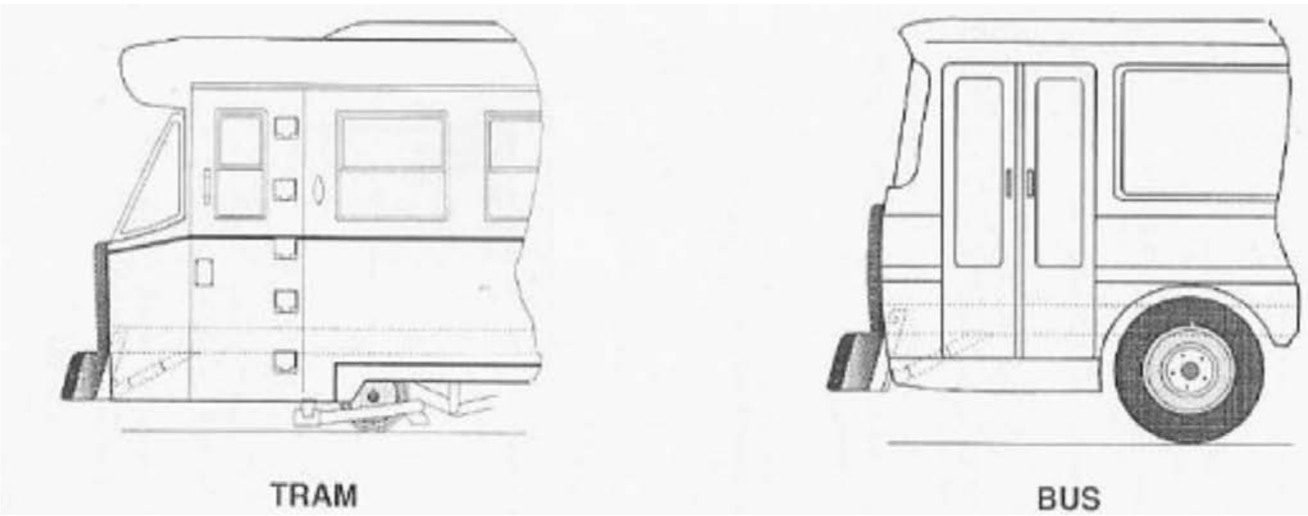


**Figure 11: Figure showing the addition of simple but effective energy absorbing structures added to the front of a tram and a bus to reduce pedestrian severe injury risk [10]**

Other well-known examples of hazardous interfaces for pedestrians include steel bull bars on the front of cars and trucks [Figure 12]

**Figure 12: View of a vehicle that impacted a pedestrian [fatality]. Note stiff bull bar structure**

Other examples of increasingly hazardous interfaces arise between bicycles and pedestrians on shared pathways. A MADYMO model [16] of a serious injury collision between a pedestrian and bicyclist on a shared pathway in Sydney is shown below [Figure 13].

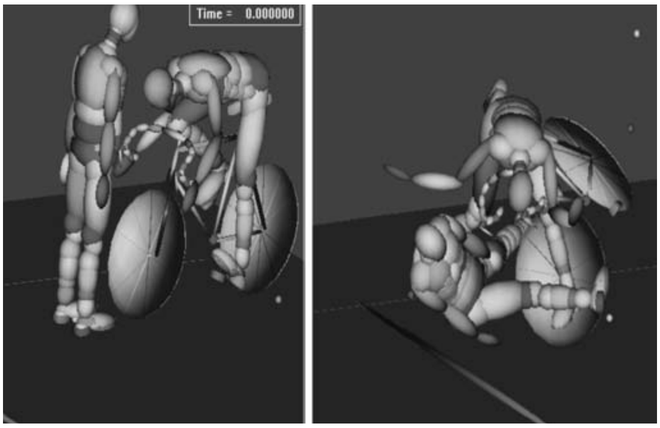


**Figure 13: MADYMO computer model of cyclist-pedestrian impact [see Short et al, 2006]**

With the increasing push for more cycling, much attention needs to be paid to the interface design for bicyclists, pedestrians, and vehicles. Even now ideas such as so-called 'shared pathways' are gaining increased attention in our transport plans. From an Interface Design viewpoint, the concept of "shared pathways" is fraught with high injury risk potential. In road safety we must always be vigilant against being blinded by politically correct sounding words such as "shared", which can shield such schemes from deserved critical safety scrutiny. In terms of attempting a "quantum leap" for improved pedestrian safety, the 2004 MUARC study [17] attempts to systematically integrate all the factors which relate to pedestrian injury risk and prevention. This is based on the Vision Zero paradigm for road safety.

Figure 14 is a diagram from the 2004 MUARC report in which a vehicle's kinetic energy is the injury risk source, and in a systematic way considers how the pedestrian can be protected both from crash risk and injury risk.

Of particular interest in this paper is that such a fundamental analysis of pedestrian collisions and injury risk can be used to

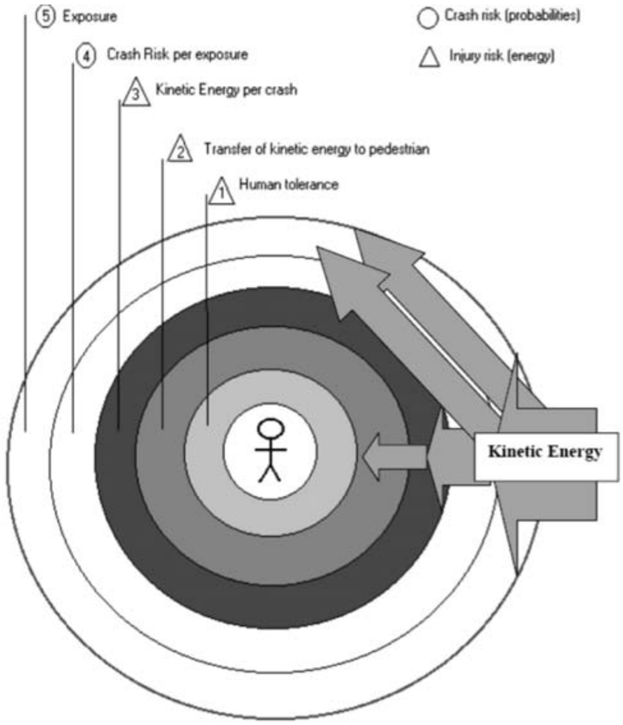


**Figure 14: Conceptual model for fundamental analysis of pedestrian injury risk considering "Kinetic Energy and the five layers of protection' using the MUARC developed "Visionary Research Model' [17]**

identify and consider appropriate Interface Design options at each stage. For example, "Exposure" can involve removing the interface (overpasses, tunnels, reduced travel needs etc.); in "Human Tolerance" the interface may include design modification to the vehicle front, or reduced speed, or other measures.

## Motorcycle Safety – Impacts with Guard Rails

Current roadside guardrail systems, such as W-beams, wire ropes, provide a hazardous interface between a motorcyclist and the barrier. These interfaces may have been designed and tested to cater for occupants encapsulated in a vehicle body, but they are not designed to safely interface with unprotected or vulnerable road users.

Current W-beam assemblies typically consist of thin metal sheeting with a "W" shaped cross section that is mounted to metal or wooden posts (see Figure 15). The risk associated with motorcycle impacts to W-beam barriers lies in the presence of the exposed posts and sharp metal edges. The exposed posts concentrate the impact forces on the rider and can easily trap body parts instead of allowing the smooth metal sheeting to ride-down the impact over a distance as would occur with an automobile. Further, sharp edges or connected roadway signs, e.g. chevrons, can sever human body parts. Protruding bolts, reflectors and other projecting components can cause further exacerbated injury. The metal sheeting has relatively (for a motorcyclist) little elastic deformation and thus does not provide a soft or padded [energy absorbing] impact for a motorcyclist.

Current wire rope barriers, although they can vary in design, are typically comprised of three or four lengths of woven wire "rope" which are fed though grounded posts and are anchored into the ground at the ends (see Figure 16). Similar to W-beam barriers, the risk associated with motorcycle impacts to wire rope barriers lies in the presence of the exposed posts and relative sharp edges along with a potential risk of a "cheese grater" type scenario. The exposed posts and highly tensioned cables concentrate the impact forces on the rider and can easily trap body parts instead of allowing them to ride-down the impact via a "catching" mechanism as would occur with an automobile (see Figure 16).

The ideal interface design [Figure 17] for a motorcyclist and barrier includes:

- A smooth interface for an impacting rider which allows maximum deflection to increase crash pulse durations [and hence reduced crash severity].
- High level of deformation crush distance to further reduce the risk of severe head and chest injury;
- Totally shields the rider from interface with the steel sections of the guardrail.

**Figure 15: Example of typical W-beam guardrail (manufactured by Armco)**

**Figure 16: Motorcycle interaction with a typical wire rope barrier. Other interactions involve the motorcyclist sliding or vaulting into the barrier**

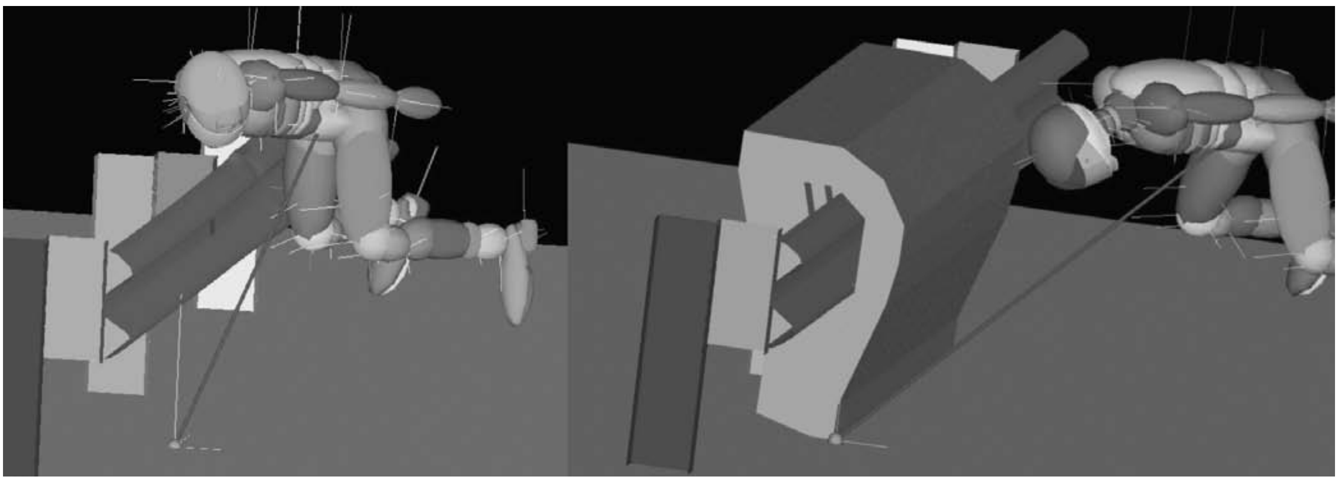

**Figure 17: Computer model of a displaced rider impacting a 'W' beam guardrail segment [very hazardous interface], and one fitted with a well design energy absorbing system [ low injury risk impact interface ].**

## Bus Rollover Crashes

The final example of interface design relates to bus rollover crashes. The bus structure in rollovers typically adequately caters for compliance with the requirements of ADR59, and occupant restraint by the use of 3-point seatbelts. However a glaring Interface Design deficiency resulting in serious injury and death is the lack of security side glazing, permitting partial ejection of occupants with consequent catastrophic injuries (crushing, amputations, etc.). As stated in [18], a needed improvement for bus [and truck safety] is the retention of windscreen and other glazing:

The majority of large trucks and buses have windscreens and side glass that pops out or shatters upon impact in a rollover collision. The result is a large, wide-open portal from which occupants can easily be ejected. If the windscreen and other glazing is retained by being plastic or laminated, ejections will be reduced.

We strongly recommend that the requirements for bus side-glazing design are modified by the inclusion of an internal plastic laminate or any other effective method. This is to ensure that the interface between the occupant and bus sliding on its side after a rollover remains the inside of the bus and not the highly hazardous road surface due to failure of the occupant containment barrier.

## Conclusions

The authors in this paper argue that further significant advances in road safety will arise from the understanding and purposeful incorporation of Interface Design in road safety programs. In Interface Design, we explicitly recognise that failures in our road safety system occur because of breakdowns in system safety at various interfaces. By paying due attention to interface design we open up our thinking to an increased range of countermeasures possibilities, and provide opportunities for improving road safety and reducing risk.

By the proper consideration of the interfaces at all levels of our road transport system from behavioural, road design and vehicle design, significant safety benefits can be achieved. This is true whether the interfaces are considered on a macro level, as with the example of level crossing design and impacts, or on a micro level as is given in the paper with the example of head impact with a stiff object. Importantly however, Interface Design must be considered at all levels to ensure that overall system safety is achieved.

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# Making a Safer Systems Approach to Road Safety Work

## "Damned if we don't" – Exciting Times, 2009 and Beyond

*By Paul Hillier, ARRB Group*

This article comments on two seminars on road safety held in Sydney shortly before Christmas, before putting forward for broad discussion some of the key messages from a number of recent road safety related documents and journals.

### Introduction

In the lead up to Christmas I attended two events hosted by the Sydney Chapter of ACRS. The first was an insightful presentation by Jeanne Breen from the UK providing a commentary on progress with Vision Zero in Sweden, as well as road safety capability review techniques being used by the World Bank in rapidly developing and mechanising countries. A healthy and interesting debate ensued regarding some of the contemporaneous issues in Australia and how best we might overcome them.

This session was complemented a few weeks later by presentations from Dr Soames Job of RTA and Professor Raphael Grzebieta of University of NSW. Information was imparted regarding recent achievements in reducing the road toll and in securing positive road safety outcomes. The presenters provided their personal insights into the opportunities and challenges ahead in making further gains. Again, the need to keep moving forwards, through the implementation of a Safer Systems approach, came across as a common message.

This will require coordination and interaction on a multi-disciplinary and multi-agency basis - a considerable challenge of course, but the presenters hoped that major break-throughs would be made in 2009 and beyond. These are exciting times for road safety professionals, with a realistic chance to aspire to, and achieve, much more than consolidation of past gains.

The recent Towards Zero: Ambitious Road Safety Targets and the Safe System Approach, published by the OECD's International Transport Forum provides positive and practical guidance on the implementation of a Safe Systems approach and meeting ambitious, stretch targets, such that as a profession we have moved from an historical 'no win' position of often being "damned if we did something, damned if we didn't" to a position where we have requisite levels of knowledge, skills, tools and experience at hand that will rightly leave us 'damned if we don't' act together to implement Safe Systems.

Shortly ahead of completing this article, I received the inaugural issue of Vision Zero International technical journal, which provides an amazing Aladdin's cave of information regarding latest actual, and likely and possible future, developments in vehicle technology and in-vehicle safety systems. The potential of these technologies to spearhead future reductions in the road toll is obvious and vast. However, an over-reliance on the features, such that progress in other areas slowed or was curtailed, would be unfortunate and ultimately misguided. The potential for a raft of measures to co-exist and complement each other must surely be even greater.

### How do you Assess an Organisation's Capability in Road Safety ?

The presentation given by Jeanne Breen, an internationally renowned Road Safety Consultant, based in the UK, provided her personal thoughts as a review team member on a high-level review of road safety management in Sweden in 2007. It was shown how an established World Bank assessment framework was used in the undertaking of the review. The main finding was that Sweden's road safety management capability and associated systems were at a highly advanced phase of development when benchmarked internationally.

However, it was also recognised that even the Swedes require a degree of institutional strengthening to support the crusade towards Vision Zero, not least the strengthening of the lead agency role, the setting of further interim targets, and further key stakeholder co-ordination and co-working to keep momentum going.

The Swedish Road Administration's commitment to the review actually taking place was also noted and encouraging, helping to emphasise the importance of not resting on one's laurels as an organisation or group of stakeholders, regularly appraising progress and conducting fine tuning. The World Bank assessment framework was explained as a highly effective tool that has worked well throughout the world, and ultimately pinpoints and encourages development areas towards rapid growth in the delivery of effective and accountable Vision Zero activity. It was explained how developing countries are able to make useful short term gains through adopting national and international best practice, but more sustainable gains can only come from a shift towards protective systems and safer vehicle fleets and compliant travel behaviours.

## An RTA Perspective on Implementing and Encouraging a Safer Systems Approach

The presentation given by Dr Soames Job was of particular interest to me as a resident of NSW and a driver of around 40,000km a year on the state's roads. I took away the following key points, concepts and challenges from the presentation:

- It is important to look back at what has been achieved, but also to consider and plan for future challenges;
- Partnering with key stakeholders and external agencies will be crucial to a true Safe Systems approach. This stimulated me to think of the successes of the Highways Agency in the UK and more locally, Queensland Department of Main Roads (to name just two), in becoming active mentors to, and partners with, local road agencies. Notwithstanding past and current levels of interaction, I consider that this is perhaps an area that the RTA could elevate to being a major component of the implementation of a Safe Systems approach in NSW;
- Recent developments within the RTA have elevated Road Safety awareness. There is now road safety representation on the organisation's Executive, driving the function's mainstreaming. The establishment of the Centre for Road Safety, around a Safer Roads, Safer Vehicles, Safer Drivers model, also seems to have stimulated positive results (more later);
- Whilst the treatment of 'blackspots' has been extremely important in NSW, there is an emerging change of approach, with the focus being on crash analysis in identifying and addressing routes where the most severe crashes are occurring, ie. the highest risk routes;
- A co-ordinated, multi-disciplinary approach will continue to be crucial, eg. engineering, behavioural and enforcement issues all being addressed, but in a joined up way;
- The RTA continues to invest in the analysis and research of key and emerging issues. A recent initiative is looking at crashes taking place at curves to determine whether common characteristics can be identified for the curves where fatal and serious incidents occur, such that mitigation measures can be developed;
- There will be significant expectation regarding 'Safer Vehicles', with pedestrian protection and rollover crash worthiness being examples of potential significant gains. In addition, it was reported that the NSW state government had recently introduced a co-ordinated fleet policy. It was hoped that this would show a 'lead' to other organisations as well as ensuring that a number of vehicles with high levels of safety features would subsequently find there way onto the second hand car market. In addition, the RTA is considering its stance on vehicle modifications, further legislating against modifications that have an adverse effect upon a vehicle's handling;
- 'Safer People' will also be a key focus of the Centre for Road Safety. Significant past successes, such as the 'pinky' campaign against speeding, will encourage further anti-speed campaigns aiming to socially alienate and de-glorify speeding. In fact, it is recognised that a broader reduction of speed across the network will play a major role. Over-represented groups in crash statistics, such as young drivers, will continue to receive co-ordinated attention, with deliberate attempts being made to reduce the number of in-car distractions faced by drivers within this demographic.

A Learned Perspective on Developments in Road Infrastructure and Vehicle Engineering Professor Grzebieta's presentation focused on infrastructure and vehicle engineering issues, with the following key points catching my eye:

- There has been a period of impressive successes, but the profession must keep striving for positive road safety outcomes. The importance of road agencies working together was reinforced, with universal support being given the support of strong initiatives;
- Understanding and acceptance need to grow that the Safe Systems principle is fundamentally about recognising that humans do not have a high tolerance to physical force, and accordingly devising and implementing active and passive systems to protect occupants of vehicles travelling at survivable speeds. Reducing the speed of impacts is all important. We must do all we can in educating and encouraging engineers and designers to do all they can to consider errant vehicles and above all, prevent them from striking unguarded structures / infrastructure;
- Engineering features such as clear zones and wire rope safety fence (WRSF) have given excellent road safety outcomes (eg. Professor Grzebieta stated that the introduction of WRSF in the Melbourne area had reduced trauma by some 90%). However, there is a need to consider and where necessary, challenge, historical provision and to assess whether the science behind, and pertinent codified standards originally derived for, a particular item remain applicable and robust. Standard design criteria developed for items such as crash barriers have historically been very useful and have provided a level of confidence in provision, but we must now go further to

learn more about what happens in real life incidents with as much certainty as we can muster through active research and incident investigation, ideally at the scene of incidents. Similarly, we need to always recognise that it is possible to place some engineering features incorrectly or at an inappropriate location or situation, with a negative outcome being possible, despite the best of intent;

- Contemporaneous engineering issues such as roadside trees / poles and road edge drop off, still require further consideration and practical solutions through a combined agency approach. Similarly, further work towards 'self explaining roads' will derive nothing but positive benefits;
- Vehicle engineering issues were also discussed, with the need for Australian Design Rules to more appropriately consider high risk, real life scenarios, such as vehicle roll-overs and resultant outcomes such as the ejection of occupants. Vehicle compatibility (and vehicle aggressivity) will remain key issues, and it was stressed that more can be done in improving the survivability of side impacts and indeed, pedestrian impacts;
- The case for intelligent safety systems on vehicles, such as ABS, ESC, traction control etc is compelling. Intelligent Speed Adaptation (ISA) looms large on the horizon as a potential colossus in preventing road trauma, and it is certain that more will become known regarding this interesting technical area during the year, not least at the first national conference on ISA being hosted by RTA in Sydney in November, 2009.

I left the ACRS seminar encouraged and heartened by the fact that the profession still had 'shots to fire' in further reducing the road toll, and that notwithstanding the challenges faced, all within the profession have an opportunity to make a positive personal contribution and encourage others to do the same….an inspiring message to take into 2009 and beyond !

## The Christmas Road Toll Provides Further Encouragement

Whilst it is of course true that every incident on our roads is a negative occurrence, sometimes with associated trauma, pain and suffering, the reductions in the 2008 Christmas road toll should serve as further encouragement that as a profession we are improving in a number of key areas and getting better at selling our road safety message. The apparent hardening of public attitudes toward those involved in street racing is a good example of the latter. However, it is similarly true that with success comes a need for further and on-going improvement and success, and often the law of diminishing returns can come into play.

As the Christmas period came to a close, followed by a return to work, further interesting reading material came into my possession.

## Towards Zero – Ambitious Road Safety Targets and the Safe Systems Approach

The author considers this OECD resource, developed under the leadership of Australian, Eric Howard, to be a most excellent and comprehensive document, providing practical and sensible guidance on some of the aspects of the Safe Systems approach that perhaps had been difficult to comprehend given traditional approaches or had been previously without guidance. The document is a credit to the working party involved, which includes a number from our profession in Australia.

I focus within this article on guidance within the OECD publication in the following four areas, given the contemporaneous professional issues we face within Australia in 2009 and beyond:

- Aspirational goals versus SMART targets – I am sure that many have been brought up on a diet of SMART targets and key performance indicators, and therefore may have found the concept of a long term aspirational goal (ie. Vision Zero) took a little time to sink in and truly appreciate. The main issue I have grappled with is how to encourage and ensure genuine accountability under Vision Zero. However, the OECD document comes to the rescue here, explaining the concept of setting and achieving ambitious (stretch) targets over a defined interim period that contribute towards the longer-term aspirational goal. This subtle difference ensures that all 'keep their eye on the ball' over time and that there are no easy excuses for failing to contribute to a wider goal;
- It is encouraging that the continued importance of 'understanding crashes and other risks' is formally recognised as one of the key components of the Safe Systems approach. For a number of years now, I have advocated an approach whereby the in-depth investigation of crashes allows patterns and trends to be identified, such that the lessons learnt from such incidents can help practitioners devise control and mitigation strategies, policies and practical measures. In short, as we all recognise, prevention is much better than cure.

A particular area that I believe needs more attention is in the investigation of incidents involving commercial vehicles, and actively working with commercial fleet operators so that they can learn from unfortunate occurrences to keep their personnel and vehicles on the road, in safety. I have recently corroborated the need for further work in this area with an engineer based in Melbourne working within a major international insurance company, who expressed that even the most pro-active fleet operators often lack the training and skill set required to conduct thorough internal investigations, identify residual risks and put in place effective mitigation strategies;

- Identifying the range of key stakeholders in successfully implementing a Safe Systems approach – this is covered comprehensively on page 115 of the OECD document so it is not intended to repeat the material here, apart to provide a summary that the key stakeholders are "….all actors that professionally influence the design and functionality of the road transport system". The traditional road safety playing field is widened to include new target groups, and a silo mentality frowned upon, such that the power of a "we are all in this fight together" approach can be harnessed ("there is power in a union" a songwriter once wrote !). A truly positive interaction between government departments and national, state/regional and local road agencies is to be encouraged and I believe that this should involve active dialogue and workshopping on the challenge of achieving a Safe System together during the course of 2009 and beyond;

- The need for vision and innovation (as well as learning from the 'tried and trusted') – the document identifies the importance of having a vision ("It is not necessary to specify all the actions required to implement a Safe System approach, but it is necessary to reach a common understanding of what is to be achieved") and in that way recommends that a long term vision (likely to be over decades) with a very high level of ambition will transform and enliven policy and ultimately change community's view of the inevitability of road trauma.

Whilst it is recognised that 'tried and tested' strategies and practices will work well for some and can be replicated, a degree of imagination and forward thinking is also essential (especially within the most developed countries where large road safety gains are proving hard to maintain). This concept is articulated within the OECD document, which states "….that achievement will require interventions that are some steps removed from prevailing best practice and will require the development of altogether new, more effective interventions" and that "Part of its value lies in driving innovation".

This is some comfort to me, given that I gave a paper encouraging innovation in road engineering at the ARRB Conference in Adelaide in August 2008, within which I challenged the audience to consider the industry's aversion to risk and reliance on following national codified standards to the letter, regardless of the environment and conditions faced locally. I believe that areas where low technology solutions are desperately needed should ideally lead the race, eg. the quest for low cost engineering measures such as barriers made from recycled materials and/or engineering features to drag or trap vehicles safely to help mitigate the perennial problem of single vehicle run off roads on rural areas. I also believe that many of today's safety issues may only be truly addressed when practitioners adopt and evaluate innovative measures and solutions and find things that are fit for purpose and resource tolerant, yet work effectively.

A challenge, yes, and I think that we will need to be a lot braver than we are now in communicating our failures as well as our successes (which incidentally was an approach adopted by the Institution of Civil Engineers in UK recently, who issued an entire journal on the topic of actively 'learning from failures' in structures). Similarly, I am also keen to promote that codified standards will only move 'forwards', reflecting change and sharing and promoting innovative solutions if practitioners put forward success stories for consideration, inclusion and ultimately, wider adoption. There is simply no point, or efficiency, in a large number of road agencies effectively re-inventing the wheel.

## End of Year Road Toll Statistics - Yet Further Encouragement

The 'end of year' road toll statistics were also long awaited and were again positive, with (at the time of writing) the states of NSW (where a landmark target of less than 400 fatalities was achieved), Victoria and South Australia all having returned their lowest annual road tolls in decades, and other states and territories returning healthy reductions.

As with the Christmas road toll earlier, I believe that the 'end of year' results are a tonic and testimony to, the immense efforts throughout the year of a large number of road safety professionals and enforcement personnel around the country. It is hoped that such encouragement will also strengthen resolve to keep going and work even harder at achieving further reductions in our road toll - the profession has an underlying pride and integrity that nothing less would do [if any proof of this valuable trait is needed the author encourages all to remember the common air of frustration in the profession at the plateauing (rather than reduction) of fatalities on our roads in the years preceding 2008]. Indeed, I thought it was very noticeable that all of the announcements of record low state road tolls for 2008 were also accompanied by commentary on issues to be addressed and mitigating measures that will be introduced during 2009, ie. "there's more to do and it starts now".

## Vision Zero gets its own Technical Journal !

I speculate that if anyone had predicted a few years ago that the Vision Zero concept would have its own technical journal publication, then their sanity might have been questioned. However, a technical journal it now has, with the arrival of the launch issue of Vision Zero International in January 2009, and what an interesting and informative read. 'Well done' to all concerned (nb. the author has no alignment to, or involvement with, the publication).

The first issue, entitled "Safe At Any Speed" provides an amazing Aladdin's cave of information regarding latest actual, and likely and possible future, developments in vehicle technology and in-vehicle safety systems (albeit with a host of acronyms, both current and emerging, to come to terms with and remember !....ESC, WHIPS, CAMP, HANS, ABS, ISA, ASR, IVBSS, DSS and ADAS to name but a few).

I encourage all to take the time to read through the current publication themselves, but was particularly taken by the following specific items:

- Volvo's City Safety initiative based on providing in-vehicle safety systems with the potential to be particularly effective in urban environments and driving conditions, but which have a functionality that is fully accepted by all drivers (pages 20-26);
- The need to ensure that drivers still receive feedback from their vehicle's systems to ensure that an influx of safety technology does not lead to drivers taking appreciably more risks (John Miles, pages 46-49);
- The emergence of a raft of technologies aimed at improving a driver's visibility and detection of emerging obstacles, particularly in the hours of darkness;
- Improvements in in-vehicle safety technology impart a challenge to tyre technologists to develop tyres that are "in sync" with those technologies to ensure that safety benefits are optimised. Two of the immediate responses have been: to work towards 'intelligent tyres' that collect and relay information about the level of friction between the tyre and road surface; and to develop in-road scanners capable of measuring tyre profiles and tread depths at traffic speeds at high risk locations to learn more about in-service levels of tread depth. Additionally, Tyre Pressure Monitoring Systems (TPMSs) are likely to become a feature in all vehicles in the future;
- The on-going development of ADAS (Advanced Driver Assistance Systems), using digital maps in real time to provide key early warning indicators to the driver of his/her inability to operate safely, due to known road environment features/characteristics, emerging hazards, or detected adverse driver behaviour (pages 107-109);
- The importance of more actively using data from in-vehicle 'black boxes' (Event Data Recorders or EDRs) in the investigation and reconstruction of crashes (pages 91-93). This development is pleasing, as I, and colleagues at ARRB, have been alerting road safety professionals of this emerging technology for a while now, and further coverage of this issue is healthy; and
- The emergence of an International Standard on Traffic Safety, which has met with a glowing endorsement: "….I am also really happy with the new ISO 39001 management standard for traffic safety, for those organisations that wish to eliminate health losses as a result of traffic accidents. This is a milestone in the history of traffic safety" (Claes Tingvall, page 9).

Perhaps the key feature of the publication is that the potential of the in-vehicle technologies to spearhead future reductions in the road toll is obviously vast, but I (and indeed the publication itself) would urge a degree of caution; in that over-reliance on in-vehicle features alone, such that progress in other technical areas was postponed or even halted, would be unfortunate. The potential for a raft of positive measures to complement each other across the three headliners of Safer Roads, Safer People and Safer Vehicles must surely be even greater. Indeed, the following robust quote struck me as being particularly interesting on this aspect: "If you just throw technology at it [the road safety problem], you may come up with the wrong answer because technology alone isn't going to do it" (Sue Cischke of the Ford Motor Company emphasising that there is more to the challenge than simply providing advance vehicle technology, page 33).

## Closing Remarks

I would like to close by simply offering the following 'call to arms' by the Rt Hon Lord Robertson, Chairman of the Commission for Global Road Safety:

> "…..The Safe Systems approach can and should guide the policies of any and every country…..we want to see a decade of sustained global action taking place between the years 2010-2020 to implement these solutions……
>
> …..We have an opportunity to make a breakthrough on road safety. We must take it"

Here's to a further landmark year in 2009!

## Author Profile

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## Disclaimer

# Towards Survival on the Road

*by Graeme S. Horsnell*

## Introduction

An individual's road safety experiences in the first 1000 weeks of life provide a basis for the years beyond. A well-conceived and thorough learning program can provide a sound foundation on which to build.

At the moment, there seems to be a lack of a clearly-enunciated Road Safety Education Program which takes the individual from being a passenger, to life as a pedestrian, to cycling and, finally, to driving. Knowledge, skills and attitudes learnt at each stage should be seen as carrying over to the next.

Much work is currently being done at each stage, but the interrelationships of the stages is not made clear. The net effectiveness of a situation such as this needs to be questioned.

## Relevant Educational Theory

"Road Safety is most effective when it is part of a holistic approach to children's traffic safety"(1).

What better foundation on which to build a Road Safety Education Program? What is being advocated in this paper is a sequential program which lends itself to being formatted in table form showing the learning targets for each road user group and the educational relationships between those groups. Some examples, set out in table form, are presented as part of this paper. Highlighted in this approach is the need for planning and for the program to be progressive.

This approach to planning for education has been well-researched and it is timely to briefly look at the theory. A concise overview of some of the relevant theory is to be found in the Road Safety Research Report No.1, Department of Transport, UK. 1996 (2). In short, this report argues a case for psychological training set in a context of practical exercises in the context of the individual's personal developmental stage.

There have been centuries of educational research on how to structure a learning program and current programming practices seek to provide a scaffold on which to build a suitable scope for each element and an appropriate sequence for those elements. It is widely accepted in the field of child development that the teaching and learning process need to be well-structured and with clear aims at all times so that the desired outcomes can be achieved. The learner is the central figure and the appropriate balance needs to be struck between theory and practice. Such education theorists as the oft-quoted Piaget who expounded his theory based on stages, Vygotsky with his social and interactive scaffolding and the multiple intelligences of Gardner, lead one to the conclusion that any Road Safety Education Program needs to satisfy the following criteria:

- Be soundly based educationally
- have the best quality design
- be sequentially structured
- be learner-centred
- be targeted at the learner's current and future needs
- be competently delivered
- involve on-going evaluation by the mentor
- be evaluated for its relevance

All of these elements need to combine in order to maximize the positive powers of motivation on the part of the mentor and the learner. The concept of education being based on the mentor and the learner is being applied to programs targeted at increasingly younger learners. That which used to form the basis of adult education is being used for school-age students. The application of these principles can be seen in the ATSB's Novice Driver Education Curriculum for the ATSB (3) which adopts a co-operative learning approach. In essence, it is based on experienced drivers coaching novices and drawing on the motivation that can be engendered in such a setup.

The value of motivation is crucial and is referred to by Hatakka et al (4) in their overview of driver training programs. They emphasise the need for active learning and argue strongly for self-reflection as means of committing oneself to an appropriate road safety mindset.

## Programming for Road Safety Education

Thorough research on Road Safety Education shows that there are many programs in a large number of jurisdictions, but precious little evidence to show how those programs are linked or can be made to link up to form a continuum for the first 1000 weeks of life and beyond. The Department for Transport in the UK (5) does go down this path in guidelines separately for Primary and Secondary Schools Road Safety Education, but the vital preschool years are not part of these guidelines. It must be said, in the context of this paper, a holistic approach is not pursued by those UK guidelines: it is conceivable that secondary school teachers will not consult the primary school syllabus and vice versa. Also, the work that might, or might not have been done, in the pre-school years is not considered in the equation.

## A holistic approach

Current world's best practice in curriculum design revolves around two main elements:

- Scope – what and how much is to be learnt and
- Sequence – the order in which those things are to be learnt.

The scope is the quantum of what is to be learnt and takes into consideration the individual's developmental stage and aims to build on past learning in order to create the circumstances for future learning.

The sequence in which exposure to the road as a person grows up occurs is normally as a passenger, then pedestrian, followed by cycling and, finally, driving.

At each stage in a well-structured program, it must be assumed that the learner will progress from total dependence on the mentor through to the possibility of total independence. The progression along this continuum is for the mentor to assess.

It need not be presumed that all learners will progress from being a passenger, to being a pedestrian, then cyclist and then driver as some individuals, for example, might never ride a bicycle or a motorcycle or become a motor vehicle driver. It must be pointed out, however, that the ascending order of complexity of task would be:

- Passenger
- Pedestrian
- Cyclist
- Driver

This is not to say that being a passenger is necessarily a simple task. A common example is where an intending passenger has to decide whether to get into a vehicle whose driver has been drinking and the situation is that there are no transport alternatives. It should be noted at this point that some of the skills appropriate for a passenger of a private motor vehicle can be transferred to the public transport situation.

What can be said, however, is that the complexity of survival revolves around three elements:

- the use of the senses
- the development of skills – of thinking and decision-making and
- a set of appropriate attitudes, ie a thoughtful mindset.

## A Programming Sample

The scope and sequence style of Road Safety Education Program could simply be set out in table form for public access. A possible example is shown below:

It can be seen that this extract of a table aims to set out education targets for passengers and it would cover a number of years of learning experiences. A table can be constructed for each of the other road user groups. The tables can be cross-referenced in order to show the educational overlaps and connections that arise as an individual grows.

## Conclusion

To provide positive learning experiences is the best legacy we can pass on to following generations.

| **Road user group** | **Knowledge (Know about)** | **Skills (Know how to)** | **Samples of attitudes** |
|---|---|---|---|
| **passenger** | Choosing seat belts/ restraints by type | Attach the belt | Self-preservation |
| | One person per belt | Attach the belt | |
| | Safe places to sit | Choose the seating position | |
| | Boarding safely | Use kerbside if possible | |
| | Alighting safely | Use kerbside if possible<br>Open door safely | |
| | Keeping wholly within the vehicle | Maintain a comfortable position | Self-preservation |
| | Sufficient ventilation | Open/close windows safely<br>Climate control | Attaining personal comfort |
| | Driver needs to concentrate | Help the driver concentrate | Self-preservation |
| | Sit straight and not stand, avoiding submarining | Get comfortable | Self-preservation |
| | Map reading | Read names and coordinates | Being helpful |
| | Your driver becomes ill/incapacitated | Bring the vehicle to a stop | Being helpful |
| | First aid | Acquire skill appropriate to age/ability | Caring for yourself and other people |
| | Police, fire ambulance | Know the emergency numbers: 000 or from a mobile 112 | |

## Author Profile

After graduating with a BA and Dip.Ed from Sydney University, he taught in NSW Government Schools from 1971 to 1992 and then in the Independent School System of NSW until 2006. In those years he was responsible for the implementation of Road Safety and Driver Education Programs. He was instrumental in the writing of a Senior High School Road Safety Syllabus and assisted in the framing of the Safety strand of the Health Education Syllabus in NSW. He has also written educational programs for specific purposes in the field of Road Safety Education. In 1988, he received a special award from the Royal Australasian College of Surgeons for his work in Road Safety and has been a member of the ACRS for 20 years.

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**Online resources:**

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http://www.atsb.gov.au/pdfs/cr222.pdf

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# Landmark Case on Hands-free Mobile in UK

*By Dr Will Murray, Research Director, Interactive Driving Systems, UK Email: will.murray@virtualriskmanager.net*

In what is seen as a landmark case, a sales boss, called Marie Howden, who was using a legal hands-free phone when she crashed and killed another driver, was recently found guilty of causing death by careless driving. The prosecutor said: 'She lost control because she was distracted by the call. The collision would not have happened if she had not been on the phone and had been paying attention.' Her final call was to a work colleague at 8.23am which lasted five minutes before she lost control of her car. She later told officers: 'It is entirely legal to use a mobile phone with a hands-free kit. I regularly make and receive calls while driving. My car is effectively my office.'

The court heard Howden had earlier been seen swerving across the road and that 'minutes before the crash she was seen in the wrong lane and drove in front of a car. She was using a hands-free kit with wired headphones attached when she fatally crashed in November 2007.

This story, and news that the 3M company has recently banned all types of mobile phone use while driving, has added weight to the increasingly compelling body of research from around the globe quantifying the dangers of communication equipment use and driving:

- University of Utah research published in 2002 showed that drivers using a hand-held or hands free phone missed twice as many hazards as when not using the phone, due to attention diversion.
- Research from Western Australia, published in the British Medical Journal, found that driving while talking on a

mobile phone – whether hand-held or hands-free – increases the risk of a collision by four times.

- A study commissioned by a leading UK insurance company revealed that talking on any mobile phone while driving is so mentally distracting that it is as dangerous as driving when slightly over the UK and US legal blood-alcohol limit of 0.08. 'Cognitive distraction' from a hands-free mobile phone is just as serious as that from a hand-held.
- The Transport Research laboratory (TRL) identified the following stopping distances with different levels of impairment.
- Four TRL studies concluded that all car phone conversations and texting result in more drifting in lane, slower reaction time and more missed events.

Tony Holt, BT's Travel Safety Subject Matter Expert said: 'We suspect a lot of organisations will be nervously reviewing and tightening enforcement of their mobile phone polices again after seeing all this research, and the news generated by the Marie Howden case, which brings home the reality about driving using even a hands free mobile. Its vital that our drivers follow BT policy and the legal requirements at all times'.

We have therefore developed the following advice for managers and drivers.Our advice to managers is that it can be an offence to require people to use mobile communication equipment while driving – you are asking them to 'drive while not in control of the vehicle'. Managers must:

- Lead by example.
- Tighten and enforce company policies limiting work and personal use of all mobile communication equipment while driving.
- Not accept any breaches of the law or company policy concerning the use of mobile communication equipment in vehicles. Any evidence, including complaints from other road users, of employees breaking these rules must be treated with the utmost seriousness.
- Supply 'engine on mobile communication equipment off' that cannot be used when vehicles are in motion.
- Ensure drivers use voicemail or call diversion and stop regularly to check messages and return calls.
- Think about the 'culture of mobile communication equipment use in your organisation, and if you contact an employee who may be driving:

1. Ask if it is safe to talk.
2. State how urgent the call is.
3. Keep the message brief and ask the driver to call you back when they stop.

## Our advice to drivers is:

- Be fully aware of the legal requirements and company policy regarding use of mobile communication equipment.
- Plan each aspect of your journey before you start, enabling you to take regular breaks and deal with calls.
- If your phone rings while driving, allow the call to divert to message bank or voicemail.
- Stop in a safe place to take regular breaks to make a call or retrieve messages. Do not stop where you pose a hazard for other vehicles or pedestrians.
- Never take notes, write messages, look up phone numbers, read or send SMS messages while driving.
- Use mobile communication equipment in a responsible manner, being aware of your surrounding environment, respecting the reasonable expectation of others in your immediate vicinity, particularly in locations such as in hospitals and airports and on airplanes and trains.
- Do not use a mobile phone whilst driving as your major task is to arrive safely at your destination.
- Under no circumstances participate in conference calls while driving.
- Avoid using mobile communication equipment while driving.
- Ensure your Voicemail is activated or set up automatic diverts to other team members.
- Undertake critical calls and other mobile communication equipment use before starting your journey.
- Take regular breaks to deal with calls and messages.
- Ask your passengers to take and make calls on your behalf.

Even in cases where organisations feel the need to stop short of banning all use of mobile communication equipment while driving, managers and drivers should do everything they can should take all reasonable steps to ensure the safety of themselves, their people and other road users in the wider community.

**Distance travelled before response at 70mph**

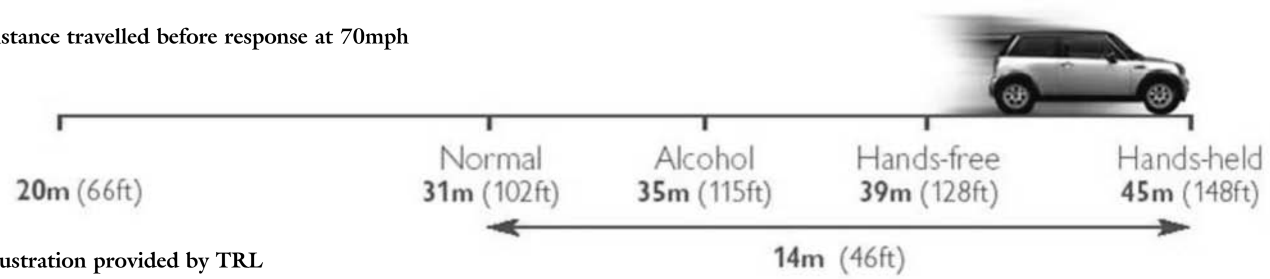


**Illustration provided by TRL**

# Peer Reviewed Papers

**Please note that our November 2009 Journal will have a major focus on motorcycle safety. If you would like to submit a paper for peer review, please send it as a MS Word document to journaleditor@acrs.org.au by 10th September**

## The Effectiveness of Designated Driver Programs

*By AL Nielson*, B Watson**

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### Abstract

Designated driver programs aim to reduce alcohol related crashes by encouraging and facilitating a safe means of transport for those who have been drinking and by influencing attitudes and knowledge. This review discusses the use and effectiveness of designated driver programs in preventing drink driving and ultimately reducing alcohol related road trauma. The limitations of studies examining designated driver programs and recommendations for further research are also discussed. The available evidence suggests that while designated driver campaigns can successfully increase the awareness and use of designated drivers, it is less clear whether these programs lead to a reduction in drink driving and/or alcohol related crashes. Differences in the way that designated driver programs have historically been implemented may account for the inconsistent evidence for their effectiveness in reducing drink driving. There are also a variety of methodological problems relating to the evaluation of designated driver programs which need to be addressed by future research.

### Introduction

It has been suggested that if it is understood why people drink and drive, countermeasures can be better designed to prevent it from occurring [1]. Research into the factors involved in drink driving has shown that it is a complicated problem which requires a variety of different approaches to be taken in its prevention [1]. Factors suggested to influence drink driving include:

- attitudes toward drink driving (both the individual and their social group);
- personal factors (eg, alcohol dependence; [2]);
- deterrence (fear of getting caught and punished [3]);
- knowledge (eg, the effects of alcohol on safe driving); and
- situational factors (eg, transport availability; [2]).

Designated driver programs primarily aim to target the situational factors by providing safe transport home after drinking and hence an alternative to drink driving [4]. It has also been suggested that designated driver programs can also influence attitudes and knowledge [4].

This review will discuss the use and effectiveness of designated driver programs in preventing drink driving and ultimately reducing alcohol related road trauma. The limitations of studies examining designated driver programs and recommendations relating to further research and program development will also be discussed.

Sources of information for this review included empirical journal articles and websites found using databases such as the Australian Transport Index (ATRI), PsychINFO, ScienceDirect, and TRIS Online (Transportation Research Information Services), and web based searches.

### What Are Designated Driver Programs?

A designated driver is usually defined as: *"A person who agrees to abstain from drinking alcohol and drives for one or more persons who have consumed alcohol" [5, p.549]*.

It should be noted however that in some programs, the designated driver does not necessarily have to abstain from drinking alcohol but instead keep their blood alcohol concentration (BAC) below the legal limit. In Australia and other countries, designated drivers are also often referred to as "Skipper", "Bob" and "Des" [6].

A key aspect of most designated driver programs is the use of mass media campaigns. Mass media campaigns promote the general use of designated drivers across the community, using newspaper, television and radio advertisements. In the United States the designated driver message has also been incorporated into the scripts of popular television programs [4]. The key elements of the designated driver message include:

- a designated driver be selected prior to drinking;
- the designated driver stays sober (or in some cases, under the legal limit); and
- the designated driver drives his/her passengers home safely [7].

In order to encourage wider use of designated drivers, some programs also involve an in-premises incentive component. These more formal programs systematically promote the use of designated drivers by offering incentives such as free soft drinks to those acting as designated drivers. These programs are promoted in and around the drinking establishments involved as well as through the media in the community.

## Potential Benefits Of Designated Driver Programs

The aim of designated driver programs is to reduce alcohol related crashes by:

- providing an alternative to driving under the influence (DUI);
- promoting the non-drink driving norm; and
- encouraging responsible travel planning [8].

Some researchers suggest that designated driver programs are quite widespread and popular *"because they are viewed as simple, pro-social, voluntary, inexpensive, widely applicable, requiring a modest behaviour change, and as translating easily into mass media campaigns to change social norms" [9].*

Mass media campaigns have been extensively used to prevent drink driving, including the promotion of messages about the dangers and consequences of the behaviour [10]. However, some have argued that messages that simply warn or encourage individuals not to drink and drive, without providing specific alternative behaviours, are less likely to have a significant impact [11]. Designated driver campaigns aim to encourage a specific alternative behaviour and if presented in conjunction with the usual messages may have a greater impact than general mass media campaigns on the prevention of drink driving.

Besides providing a specific alternative to drink driving, the designated driver concept also aims to change the attitudes and norms of people at risk of drink driving. *"By encouraging drivers to remain alcohol-free, the designated driver [concept] both promotes a social norm of not mixing alcohol with driving and fosters the legitimacy of the non-drinking role" [12].*

Others have also noted that the designated driver message could promote planning ahead when going out drinking [13]. Lack of planning, especially in young people, has been noted as a significant factor in drink driving behaviour [14].

## Designated Driver Programs Overseas

Perhaps one of the largest designated driver programs worldwide took place in the United States as part of the Harvard Alcohol Project. This campaign, initiated by the Harvard School of Public Health in 1987, involved major television networks producing and broadcasting public service announcements promoting the designated driver concept as well as incorporating it into the storylines of popular television programs [4].

In Europe, collectively known as "Euro Bob" there have been campaigns in France, The Netherlands, Belgium, and Greece. A summary of these programs is provided in Table 1

| Country | Running period | Program type | Campaign elements |
|---|---|---|---|
| France | 23/12/2001-6/01/2002 | Mass media | TV ads; radio ads; internet |
| Belgium | 29/11/2001-15/01/2002 | Mass media | Billboard posters; TV ads; radio ads; internet; merchandise |
| Greece | 1/02/2002-30/09/02 | Mass media | Billboard posters; TV ads; radio ads; internet; |
| Netherlands | 14/12/2001-28/02/2002 | Mass media | Billboard posters; TV ads; radio ads; merchandising |

**Source [15]**

## Designated Driver Programs In Australia

There have also been several designated driver programs implemented in Australia, including:

- 'Pick-a-Skipper' (Geraldton, Western Australia)
- 'Sober Bob' (Northern Territory)
- 'Who's DES Tonight?' (Burnie, Tasmania); and
- 'The Skipper' (Gold Coast, Queensland).

'Pick-a-Skipper' involved a mass media campaign developed by the Liquor Industry Road Safety Association in Western Australia to encourage people to select a non-drinking designated driver to drive drinkers home [15]. This program was applied in Geraldton (a rural town in Western Australia) as both a mass media campaign and in-premises program. The mass media campaign involved television advertisements aired in Geraldton during a 3 month period from October 1994 to December 1994. The in-premises portion of the program involved the promotion of the campaign in two participating licensed premises including the offering of free soft drinks to any driver designated to drive home two or more drinking passengers [6]. This program was subsequently evaluated and will be discussed in detail in the following section.

'Sober Bob' is a designated driver program that has been operating in the Northern Territory since 1997 [16]. Sober Bob involves both mass media and in-premises components similar to the 'Pick-a-Skipper' campaign in Geraldton. To date, 'Sober Bob' has not been formally evaluated.

'Who's DES Tonight?' is a designated driver program operating in Burnie, Tasmania since December 2004 [16, 17]. It was developed by the Burnie Community Road Safety Partnerships (CRSP) Committee in conjunction with local hotels and the Australian Hotels Association. This program is an in-premises campaign with supporting marketing material such as posters, flyers, and radio and newspaper advertisements. The licensed premises offer free soft drinks to any person agreeing not to drink any alcohol and provide transport home to one or more passengers. There was also an added incentive of a fortnightly draw of a $50 petrol voucher for those who registered at participating venues [16, 17].

It is likely that there have been other programs that have operated in Australia and overseas, however they have not been formally documented or evaluated.

## Research Into Designated Driver

Research into designated driver has taken a variety of forms. Some studies have explored characteristics of designated drivers and their users. Others have examined how people use and act as a designated driver, the reasons for using and being a designated driver, and the behavioural outcomes of using and being a designated driver. There have also been a small number of evaluations of specific designated driver programs.

### Evaluations

In 2005, a review of the effectiveness of designated driver programs was conducted in the USA [9] and showed that designated driver programs seem to have been successful in increasing the use of designated drivers (see Table 2). Some of the studies reviewed had relied on an assumption that an increase in the use of designated drivers will automatically translate to less drink driving [18, 19, 20]. Other researchers, however, have not relied on this assumption and have also included a measure of drink driving behaviour in their evaluations [6, 21]. An evaluation of the 'Pick-a-Skipper' program in Geraldton, Western Australia was conducted in 1999 [6]. As mentioned previously this designated driver program involved television and newspaper advertisements as well as in-premises incentives (free soft drink for designated drivers). As part of the evaluation, surveys were conducted on a random sample of Geraldton residents one week prior to the introduction of the campaign.

These results were then compared to surveys conducted one week after the three month trial. This comparison showed greater use of designated drivers among the sample following the campaign which, like other studies in the review [9], appears to indicate the program's success in persuading drinkers to utilise a designated driver. In attempt to measure the impact of the program on drink driving outcomes, the evaluation in Geraldton assessed the self-reported drink driving behaviour of the participants. However, based on this measure, no reduction in drink driving was found following the introduction of the program. It is possible however, that the general community-based nature of the survey was not sensitive enough to identify changes in behaviour among the key target groups.

In this regard, an evaluation of a designated driver program in Melbourne used a similar methodology but this study surveyed the patrons of three licensed premises instead of a community sample. In this study, post-test surveys also revealed an increase in the use of designated drivers; however unlike the results in Geraldton, there was also a decrease in reported drink driving. Specifically, they found a decrease in the percentage of people (-6.5%) reporting being in a vehicle (either as a passenger or a driver) where the driver was believed to be over the legal limit (i.e., blood alcohol concentration of 0.05%) [21].

**Table 2 Overview of evaluations of designated driver programs**

| | | | | | Measures | | Results | | |
|---|---|---|---|---|---|---|---|---|---|
| Author | Program type | Sample (Location) | Pre-post | Method/s | DD Use | Drink driving | DD Use | Drinking in DD | Drink driving |
| Boots & Midford (1999) | Mass media & Incentive | Community (Australia) | ✓ | Survey / Focus groups | ✓ | ✓ | ↑ | N/A | - |
| Simons-Morton & Cummings (1997) | Incentive | Drinking establishments (USA) | ✓ | Observation | ✓ | ✗ | ↓ | N/A | N/A |
| Brigham, Meier, & Goodner (1995) | Incentive | Drinking establishment (USA) | ✗ | Observation | ✓ | ✗ | ↑ | None | N/A |
| Meier, Brigham & Gilbert (1998) | Incentive | Drinking establishments (USA) | ✓ | Observation | ✓ | ✗ | ↑ | N/A | N/A |
| Boots (1994) | Incentive | Drinking establishments (Australia) | ✓ | Survey | ✓ | ✓ | ↑ | ↓ | ↓ |

Source: [9]

A review of the literature found one experimental design in which the effects of designated drivers on drink driving were explored. Although not an evaluation of a specific program, it did systematically assess the impact of the designated driver message on drink driving. An experiment was conducted in 2002 on college students travelling across the Mexico/United States border [7]. Prior to crossing the border into Mexico, participants were given surveys and a breath-test and were randomly assigned to one of six conditions. Participants were also breath tested on their return to the United States and results showed that drivers exposed to the designated driver message had lower BACs on their return.

It should also be noted that an evaluation of the 'Skipper' designated driver program is currently underway in Queensland (22, 23). This evaluation is utilising a before/after design to compare the impact of the program in an experimental area (Mackay) with a purposefully selected comparison area (Rockhampton). A range of outcome indicators are being examined including awareness of designated driver, use of designated driver, acting as a designated driver; as well as self-reported drink driving and actual drink driving (as measured by Random Breath Testing rates). While the preliminary evidence suggests that the program has been associated with increased awareness and use of designated driver, no clear impacts on behaviour change have yet been established [22].

## Barriers to effective designated driver programs

Despite the fact that designated drivers seem to be widely used there is some evidence that essential program elements are not applied [7, 23, 24]. As noted previously, for a designated driver program to be successful, it is suggested that the certain criteria must be met. If any of these conditions are not met, it is possible that the program will not be successful in reducing drink driving nor alcohol related crashes.

There have been a number of studies that may provide support for this suggestion. For example, research has shown that a significant number of people do not specifically select their designated driver before drinking [25, 26, 27]. In fact, in one study, the majority of participants believed that selecting a designated driver did not necessarily need to occur prior to drinking [27].

Research has also shown that many designated drivers continue to drink. Studies have indicated in fact that anywhere between 33% and 94% of designated drivers continue to drink after being selected [5, 8, 28]. In one study, alarmingly, 94% of participants indicated that their designated driver consumed alcohol (although it is not known whether they were over the limit when driving) [5].

In some cases designated drivers are chosen simply on the basis of who among the group is the least intoxicated [25]. In this case two of the conditions may be violated: choosing the driver prior to drinking and the designated driver remaining sober.

It has also been suggested that even though the designated driver message may have increase awareness, change attitudes, and therefore increase use, the cognitive processes of participants are not necessarily changed. Specifically, despite the designated driver message being understood and accepted, individuals exposed to the programs may still be failing to plan ahead [7]. Further research is required in order to understand the mechanisms underlying this failure to plan.

## Other issues of concern

Despite its widespread use around the world, designated driver programs have been criticised for a number of reasons. Primarily, the programs have been criticised for the competing messages between road safety and general health. For example, it has been suggested that designated driver promotes the idea that it's ok to drink as long as you don't drive afterwards [8]. Following from this idea, designated driver programs have been criticised for possibly promoting excessive drinking among passengers [5, 8].

A number of studies have examined this issue in detail, and have found no support for this criticism [29, 30]. For example, Glindermann, Clarke, and Hargrove [29] collected BAC readings of pedestrians leaving licensed premises. The study found no differences in the BAC levels of those who were travelling with a designated driver and those who were not. This finding has been supported by other studies examining excessive drinking among passengers [30].

Contrary results, however, have been found in studies where passengers drinking levels were compared to drivers [5], or when passengers drinking levels when travelling with a designated driver were compared to their average level of consumption [25]. However, comparing passengers drinking levels to those of drivers may not be a fair comparison as it would be expected and possibly preferred that the driver is not as intoxicated as their passengers. Also, comparisons between average consumption and drinking levels when travelling with a designated driver may simply indicate that some drinkers plan to use a designated driver when they intend to drink more than usual and do not want to drink and drive [30]. These studies do not clearly show that the use of designated drivers leads to excessive drinking but further research on this issue may be warranted.

In addition, it has been suggested that some drivers may decide to use drugs other than alcohol when it is their turn to be the designated driver. For example, a study by Stevenson et al (28) found that a number of the students surveyed reported being a designated driver while feeling the effects of a drug. While drink driving still remains of greater concern to road safety, the increase in use of drugs while driving, especially among young people, may warrant the inclusion of anti-drug driving messages in designated driver campaigns.

## Research limitations

The available evaluations of designated driver have typically suffered from a number of limitations. The first issue is the lack of outcome measures in the evaluations that have been conducted. A majority of evaluations have measured the success of the program solely based on whether there has been an increase in the use of designated drivers. Very few studies have also measured drink driving behaviour to assess whether the use of designated drivers actually decreases driving under the influence.

A possible reason for this is that much of the research conducted to date has focused on marketing rather than road safety outcomes. It may be that for many researchers, designated driver is viewed as a product and the increase use of designated driver indicates that the product has been purchased and hence the campaign has been successful. However, this approach shows little interest in whether the consumers are using the product as directed or whether it is effective in dealing with the problem the product is designed to address (i.e., reduce drink driving).

Another common limitation is the use of self-report and observational methods. These methods are often criticised for being subjective and for introducing potential biases [31]. Some researchers have argued that more objective measures of drink driving behaviour may be more appropriate, such as offence data [8]. There is however potential problems with this measure of drink driving. For example, not all drink driving occasions are detected and this may lead to an underestimate of the drink driving problem [3]. Also, offence data may provide a biased view of the effect of designated driver on the drink driving problem due to other factors such as variations in enforcement practices. The use of a drink driving detection rate could be a way to control for the effect of drink driving enforcement, by taking into account the number of breath tests performed.

Despite the fact that the ultimate aim of designated driver is to reduce alcohol related crashes, few evaluations have examined actual crash outcomes. There are a number of possibilities for why this is the case, including the fact that the random and infrequent nature of crashes makes it difficult to make comparisons and find significant effects particularly over the short-term [10].

There have been a few studies that have reported drink driving offences, crashes, and use of designated driver but have failed to include appropriate controls or baseline data [15, 17]. These studies would therefore be unable to accurately determine the effect of designated driver on subsequent behaviour, over and above other contextual influences.

A final and major limitation is simply a distinct lack of research into the effectiveness of designated driver programs [22]. Researchers have suggested, even recently, that this situation has not changed [9]. There are many designated driver programs currently running around the world; however a large proportion of these have never been evaluated.

## Conclusion

The available evidence suggests that designated driver programs can successfully increase the awareness and use of designated drivers. However, whether these programs lead to a reduction in drink driving and ultimately alcohol related crashes is less clear.

Differences in the way that designated driver programs have been implemented in different locations may account for the inconsistent evidence of their effectiveness in reducing drink driving [7]. In this regard, it is possible that some of the programs evaluated in the past have failed to meet the criteria considered necessary for a successful campaign (e.g., lacked public education support). Alternatively, it may be the case that these programs in isolation can encourage the greater use of designated drivers but not necessarily change the behavior of people likely to drive after drinking.

Research has supported this by showing that designated drivers are often not chosen prior to drinking and that the designated driver does not always remain sober [5, 8, 25, 26, 27]. It is not clear however, why some designated driver programs may have failed to achieve these outcomes.

Another possible explanation for the lack of clear evidence is due to the inherent limitations of the studies into designated driver conducted to date. There are a variety of methodological problems in how designated driver programs have tended to be evaluated, including:

- lack of suitable control or comparison groups;
- lack of baseline measures to establish pre-intervention behaviours;
- the reliance on self-report data; and
- lack of road safety outcome measures.

The lack of clear evidence confirming the effectiveness of designated driver programs does not necessarily mean that such programs should be discouraged. On the contrary, it highlights the need for them to be better implemented and evaluated.

Based on this review, it is recommended that current and future programs are improved by ensuring that the designated driver message is properly conveyed. It also highlights that the use of mass media needs to be recognised as an integral component of any designated driver program, in order to raise general awareness of the initiative and to support the behavioural objectives of the program.

It is also important that further research be conducted to investigate the barriers to effective program implementation, to evaluate current programs, and plan future evaluations using before/after designs, appropriate control/comparison groups, relevant baseline measures, and road safety outcome measures including self-reported drink driving, actual drink driving detection rates and alcohol related crashes.

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# Utilising the Driver Behaviour Questionnaire in an Australian Organisational Fleet Setting: Can it Identify Risky Drivers?

*By J Freeman, D Wishart, J Davey, B Rowland and R Williams*

## Abstract

In this study the Manchester Driver Behaviour Questionnaire (DBQ) was employed in an Australian fleet setting to examine the self-reported driving behaviours of a group of professional drivers (N = 4792). Participants agreed to complete surveys advertised through the internal mail system. Analysis of the DBQ revealed a three factor solution with two of these factors consisting of a combination of both aggression and highway code violations from the original DBQ. The results indicate that further to the driving error construct common to both the original and present study's DBQ factor structures, the two additional factors are most accurately represented by aberrant driving behaviours involving low-level aggression and serious highway code violations. Logistic regression analysis revealed that, of the traditional DBQ factors, driving errors was the only significant predictor of self-reported crashes after controlling for driving exposure. However, similar analysis with the modified DBQ factors revealed that both driving errors made and low-level aggression were significant predictors of self-reported crashes. This paper further outlines the major findings of the study, highlights implications regarding professional drivers' involvement with aberrant driving behaviours in fleet-based settings and considers the utility of self-report measures to identify "at risk" drivers.

**Key words:** Driver Behaviour Questionnaire (DBQ), fleet drivers, road safety.

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## Introduction

### DBQ and the present driving context

The Manchester Driver Behaviour Questionnaire (DBQ) is currently one of the most prominent measurement scales to examine self-reported driving behaviours [1]. The DBQ has been extensively utilised in a range of driver safety research areas, such as: age differences in driving behaviour [2], the genetics of driving behaviour [3], cross cultural studies [4] as well as factors contributing to accident involvement [2,5,6] and demerit point loss [7]. In addition to the versatility of the DBQ, it's popularity is demonstrated via the utilisation of the instrument in a number of countries, including China [8], Australia [7,2,9], New Zealand [10], Finland [3], Spain [11] and the United Kingdom [12,5].

The popularity of the DBQ within road safety settings is also reflected in the considerable evolution of the scale since its inception. The original DBQ was developed by [13] and focused on two distinct driving behaviours that were identified as errors and violations. An additional factor referred to as "slips and lapses" was also developed that focused on attention and memory failures, which were traditionally not considered to affect overall road safety. Specifically, such behaviours were associated with attention and memory problems, while errors included more serious mistakes such as failures of observation and misjudgement [1]. Since this time, the original DBQ scale has undergone further modification by [14], incorporating additional items to assess other factors that have been proposed to contribute to driving violations. Currently the scale distinguishes between two forms of violations that are Highway code violations (e.g., speeding & running red lights) and Interpersonal aggressive violations (e.g., chasing another motorists when angry & sounding one's horn).

Given the popularity of the assessment tool, there has been a high level of variation within the literature regarding the number of factors identified from using the DBQ. Firstly, earlier research confirmed the original three factors of errors, violations and lapses [15,16,5]. For instance, Aberg and Rimmo [15] identified inattention and inexperience error factors from a large group of Swedish drivers, but overall found the same factor structure. In contrast, there has been evidence of four factors reported by Sullman and colleagues [10] that focused on errors, lapses, aggressive violations and ordinary violations. Similarly, Lajunen and colleagues [1] identified four factors with a group of UK drivers, and Ozkan and colleagues [17] reported from two to four factors (errors, lapses, speeding & interpersonal violations) when examining the driving behaviours of Finish motorists. In addition to the different number of factors identified, research has generally reported differences in factor structure, as specific items often load on different factors depending on the driving context [7], which ultimately influences the naming and interpretation of each factor. Despite such variability, previous applied research has demonstrated that the DBQ is robust to minor changes to some items that have been made to suit specific cultural and environmental contexts [16,7,18,12]. As highlighted above, the DBQ has been utilised in a number of motorised countries and has thus been translated and modified to tailor a vast array of driving situations.

## Professional drivers and fleet safety

Despite the tremendous amount of research and proven utility of the DBQ to investigate motorists' driving behaviours, there is currently only a small (but expanding) body of knowledge regarding the self-reported driving behaviours of those who drive on public roads for professional reasons [7,19,20,9,10,8]. At first this appears to be a surprising oversight, as early estimates suggest work related road incidents cost approximately AUD$1.5 billion (21), with the hidden costs somewhere between 3-36 times vehicle repair/replacement costs (22). Given evidence suggesting that drivers who drive company sponsored vehicles are at a greater level of risk to accident involvement [20,10], due to either increased exposure to the road or as a result of time pressures and other distractions [23], research is needed to determine the factors associated with negative driving behaviours within fleet settings e.g., crashes.

Nevertheless, in recent times there has been an increasing amount of research focus being directed towards assessing driving attitudes and behaviours within work-settings, as well as attempts to develop methods to identify "at risk" drivers. The DBQ has remained the prominent tool to assess behaviours within such work settings, and similar to general motorist research, findings that have utilised the DBQ have also found variations in the factor structure. For example, research that has focused on taxi, bus, and company drivers have identified three factors [8], truck driving research has demonstrated four factors [10], and earlier research that has focused exclusively on drivers of company vehicles have reported six factors [24]. One of the few Australian studies by Davey and colleagues [7] utilised the DBQ to examine the behaviours of a group of fleet drivers and reported a traditional three-factor solution of errors, aggressive and speeding violations, although it is noted that a greater number of traditional items considered to be speeding violations actually loaded on the aggressive violation factor. That is, the aggressive violations factor consisted of a mixture of emotion-oriented responses to driving situations and traditional highway code violations.

However, apart from research that has focused on the specific factor structure, less research has utilised the DBQ to identify individuals who are engaging in risky driving behaviours. Research by Chliaoutakis and colleagues [25] utilised the DBQ to investigate the relationship between socio-demographic characteristics of urban Crete drivers and aberrant driving behaviours. Although this study gave some indication of the lifestyle characteristics of motorists who are predisposed to risky driving behaviours, results were based on a cross-section of drivers that did not specifically address professional driving conditions. In Australian-based research, Newnam and colleagues [20] utilised aspects of the DBQ to investigate the driving behaviours of 204 individuals who drove for work purposes and identified that participants reported higher crash involvement in their work vehicle compared to private vehicle, and were less likely to engage in vehicle safety checking practices e.g., tyre pressure. Similarly, as noted above, Davey and colleagues [7] utilised the DBQ to examine a group of fleet workers' driving behaviours but found that kilometres driven per year was the only predictor of incurring demerit point losses in the past 12 months. Apart from this research, Australian research that has utilised the DBQ scale has focused on either the driving characteristics of women only [2] consisted of abbreviated DBQ measures [20,26] or contained small sample sizes e.g., <150 [16].

Considering the limited research available in this area, the aim of the present study was to utilise the DBQ to specifically investigate risky on road behaviours within a sample of Australian professional drivers. This study was designed to include a much larger sample of both men and women than previously accessed as well as determine the relationship that DBQ factors have with the likelihood of employees being involved in crashes. To operationalise this, the self-reported driving behaviours of a group of Australian drivers within a fleet setting were analysed. In particular, this study endeavoured to:

(a) examine the factor structure and applicability of the DBQ to a sample of professional Australian drivers; and

(b) investigate the relationship the DBQ has with self-reported crash involvement.

## Method

### Participants

A total of 4792 individuals volunteered to participate in the study who were all employees of an Australian organisation. The response rate was 45%. There were 4195 (88.9%) males and 597 (11.1%) females. The average age of the sample was 44 years (range 18-68yrs). Participants were located throughout Australia in both urban and rural areas. The largest proportion of vehicles driven by participants were reported to be for tool of trade (56%), although vehicles were also salary sacrificed (43%), and a small proportion were leased or participant's own vehicle (1%). Vehicles were reported to be sedans (85%), four wheel drives (12%) or other (3%). The majority of driving by participants was reported to be within the city (46%), or in the city and on country roads (40%). On average participants had held their licence for 26 years (range 5 – 48yrs), had been driving a work vehicle for approximately 5 years (range 1 – 33yrs), with the largest proportion driving between 11 and 20 hours per week (43%), and between 30,000 – 40,000kms per year.

## Materials

### Driver Behaviour Questionnaire (DBQ)

A modified version of the DBQ was used in the current study that consisted of 20 items. Questions relating to lapses were omitted due to previous research indicating that this factor is not associated with crash involvement [14, Stradling, Personal Communication, 2003]. In addition, the authors of the current paper made minor re-wording or rephrasing modifications, in order to make the questionnaire more representative of Australian driving conditions. For example, references to turning "right" were removed on some items as there are instances where drivers may attempt to overtake someone who is turning left[1]. Respondents were required to indicate on a six point scale (0 = never to 5 = nearly all the time) how often they commit each of the errors (8 items), highway code violations (8 items) and aggressive violations (4 items).

**Demographic Measures**

A number of socio-demographic questions were included in the questionnaire to determine participants' age, gender, driving history (e.g., years experience, number of traffic offences and work-related crashes) and their weekly driving exposure (e.g., type of car driven, driving hours). The overall questionnaire contained 36 items.

## Procedure

A letter of introduction, the study questionnaire and a reply paid envelope were distributed through the company's internal mail system to the participants.

## Results

Factor structure and reliability of the Driver Behaviour Questionnaire for an Australian sample. The internal consistency estimates for the DBQ scale are presented in Table 1. These estimates were analysed via Cronbach's alpha reliability index. The alpha coefficients show that the items for each factor exhibited reasonable internal consistency with only the alpha coefficient for aggressive violations falling below acceptable conventions of reliability (>.70). However, it should be noted that aggressive violations consisted of only 4 items which may have resulted in the lower coefficient reported for this factor. Overall, these results are similar to the findings reported in previous Australian research [16,7,2], which also included investigations involving professional drivers [10].

**Table 1: Alpha Reliability Coefficients of the DBQ Scale**

| | Current sample | Sullman et al. (2002) |
|---|---|---|
| Errors (8 items) | .78 | .71 |
| Highway code violations (8 items) | .77 | .62 |
| Aggressive violations (4 items) | .56 | .57 |

Secondly, it is of interest to determine which of the behaviours measured by the DBQ were most often performed by participants. Table 2 shows the composite mean scores for the three DBQ factors and the highest ranked items. An examination revealed a significant overall difference between the three driving behaviours, $\square = .88$, $F(2, 4790) = 317.39$, $p < .001$ with follow-up pairwise comparisons (Bonferroni adjustment) indicating that highway code violations occurred significantly more frequently than both driving errors ($p < .001$) and aggressive violations ($p < .001$). The means reported in Table 2 are higher than has been reported in previous research involving college students [3] elderly drivers [12], and professional drivers [10,8], indicating that the current sample engaged in, or at least reported, a higher level of aberrant driving behaviours[2]. Table 2 also reports the three highest ranked mean scores for items included in the factors which were: Exceed the speed limit on highway ($M = 1.96$, $SD = 1.0$); and Stay in lane till last minute ($M = 1.65$, $SD = .82$) and Race away from the traffic lights with the intention of beating the driver next to you ($M = 1.63$, $SD = .86$). The results indicate that speeding is the most common form of aberrant behaviour reported by the fleet drivers in the current sample, and similar to previous research on professional drivers [9,10], speeding remains one of the major road safety concerns.

**Table 2: Mean Scores for the DBQ Factors**

| | M | SD |
|---|---|---|
| Errors (8 items) | 1.36 | 0.38 |
| Highway code violations (8 items) | 1.50 | 0.47 |
| Aggressive violations (4 items) | 1.38 | 0.43 |
| **Highest Ranked Items** | | |
| 1. Exceed speed limit on a highway | 1.96 | 1.00 |
| 2. Stay in lane till last minute | 1.65 | 0.82 |
| 3. Race away from traffic light | 1.63 | 0.86 |

In order to determine the structure of the tool, the 20 item questionnaire was subjected to a factor analysis. Principle components analysis with oblique rotation was implemented to determine the factor structure of the DBQ, which revealed a three-factor solution. The solution for this PCA model explained 42.77% of the total variance in driver responses. Table 3 presents the factor loadings for all items and reveals that ten items loaded on the strongest factor in the solution which accounted for 29% of the total variance. Most of these items were consistent with the driving error factor identified in the traditional DBQ, with the exception of two items that were originally identified as an aggression violation (e.g., cross

[1] Previous research has demonstrated that the DBQ is robust to minor changes to some items in order to reflect specific cultural and environmental contexts (Blockey & Hartley, 1995; Ozkan & Lajunen, 2005; Parker et al., 2000).

[2] However, it is noted that the DBQ questionnaire utilised in the current study most likely varies slightly on the wording of some items compared to previous DBQ research, which should be borne in mind when making comparisons with previous research.

junction even though traffic lights have changed) and another item originally identified as a highway code violation e.g., pull out of junction and disrupt traffic flow. The second strongest factor identified in this analysis explained 8.29% of the total variance and consisted of six items. Four of these items were originally identified as highway code violations and the other two as aggression violations in the traditional DBQ, with the two aggression violation items loading the strongest on this factor. However, similar to previous research in an Australian context [7], the highway code violation items may also be considered to be aggressive acts in some circumstances. Thus, this factor was labelled as aggressive violations to reflect the context of these items in a professional driving setting. The remaining four items loaded on the third factor and explained 5.49% of the total variance. Three of these items were originally identified as highway code violations with speeding offences implicated and the other item related to drink driving. Internal consistency estimates were again computed for the new factors and the alpha coefficients were: (a) errors = .82, aggressive violations = .79 and highway code violations = .75.[3]

## Inter-correlations between the variables

Table 4 presents the inter-correlation Pearson coefficients for participants' driving exposure, crashes, offences and DBQ factors. Consistent with previous research [27,10], age and years driving experience appear to have a significant negative relationship with highway and aggressive violations. One possible explanation is that as drivers gain more experience, they are less likely to engage in aberrant driving behaviours on public roads. However, contrary to previous research [15,27,5,10] a positive relationship was not identified between the number of kilometres driven each year and highway code and aggressive violations. Although kilometres travelled and hours driven were significantly correlated with errors reported, they were not associated with highway code or aggressive violations. Finally, there were no significant correlations reported between years licensed and self-reported crashes or driving offences.

**Table 3: Factor Structure of the Modified DBQ**

| Description | F1 Errors | F2 Aggressive | F3 Highway |
|---|---|---|---|
| Attempt overtake of someone turning in front | .56 | | |
| Miss stop or give way signs | .61 | | |
| Pull out of junction and disrupt traffic flow | .53 | | |
| Fail to notice pedestrians crossing | .64 | | |
| Non-attention and nearly hitting vehicle in front | .57 | | |
| Cross junction even though traffic lights changed | .40 | | |
| Whilst turning nearly hit cyclist | .59 | | |
| Fail to check rear view mirror | .55 | | |
| Underestimate speed of oncoming vehicle while overtaking | .65 | | |
| Skid while braking or cornering on slippery road | .47 | | |
| Stay in lane till last minute | | .53 | |
| Drive close to car in front as signal to its driver | | .58 | |
| Sound horn to indicate annoyance | | .70 | |
| Become angered by other driver | | .65 | |
| Impatient with slow driver and overtake on inside | | .53 | |
| Race vehicle beside at traffic lights | | .52 | |
| Intentionally exceed speed limit on highway | | | .64 |
| Drive while over the blood alcohol limit | | | .60 |
| Intentionally disregard speed limit on residential road | | | .70 |
| Angered by another driver and give chase | | | .43 |

[3] The prior between-group analyses were recomputed with the new factor structures that revealed the same findings e.g., Highway code violations still occurred significantly more often than errors or aggressive violations.

**Table 4: Pearson Correlations Between the Major Driving Variables**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Age | -- | .96** | .06** | .02 | -.02 | -.22** | -.14** | -.03* | -.02 |
| 2. Years licensed | | -- | .07** | .05** | -.01 | -.20** | -.13** | -.02 | -.01 |
| 3. Hours driving per week | | | -- | .52** | .13** | -.01 | .03 | .09** | .11** |
| 4. Kilometres per year | | | | -- | .10** | .01 | -.01 | .10** | .08** |
| 5. Errors | | | | | -- | .53** | .50** | .16** | .14** |
| 6. Highway violations | | | | | | -- | .59** | .12** | .10** |
| 7. Aggressive violations | | | | | | | -- | .14** | .13** |
| 8. Crashes past 12 months | | | | | | | | -- | .15** |
| 9. Offences last 12 months[1] | | | | | | | | | -- |

Note: [1] = fines or demerit points in the past 12 months
*p <.05, **p < .01.

## Prediction of crashes

Two logistic regressions were employed to evaluate the contributions of the traditional and present study's DBQ factors to participants' self-reported crashes after controlling for kilometres driven. Table 5 presents the model fit statistics, logit coefficients, standard errors of the parameter estimates, Wald statistics, odds ratios and 95% confidence intervals for the predictors in each model. Firstly, in regards to both models, the number of kilometres driven proved to be a significant predictor of crashes, as not surprisingly, individuals who drive greater distances per year are more likely to be involved in work-related crashes. However, after controlling for driving exposure, the model utilising the original DBQ factors indicated that errors was also identified as a significant predictor of work-related crash involvement, although at a weak level (wald = 10.31, p = .043). A similar analysis utilising the new factor loadings also revealed that kilometres travelled and errors were predictors of crash involvement (wald = 33.27, p = .013 & wald = 14.68, p = .013). Additionally, aggressive violations were also identified to be predictive within this latter model, indicating those who drive aggressive are also more likely to crash. However, it is noted that while the classification rate was high at 87.3% in both models (after controlling for kilometres driven), the overall model was more efficient at predicting drivers who are not involved in crashes, rather than those who reported engagement in traffic accidents (non-crash involvement = 87.3%, crash involvement = 0.0%).

## Discussion

The DBQ has been employed in a number of previous studies investigating driver behaviours [4,6], however little research has examined driving behaviours within the context of company driven vehicles [9,26]. The present research aimed to utilise the DBQ to examine the factor structure of the measurement tool along with determining its efficiency in predicting self-reported crashes.

Firstly, consistent with previous research [16,2,10], the traditional DBQ factors were relatively reliable. Although some items were altered to suite the driving conditions of Australian roads, this finding is encouraging for employing the DBQ with different driving populations such as found in fleeting settings. Furthermore, examination of the DBQ factor mean scores revealed that participants reported engaging in a higher frequency of highway code violations. This is consistent with previous research that indicated speeding is the most frequently reported aberrant driving behaviour on public roads [24,4]. Additionally, this result may be consistent with a general belief that minor speeding violations are acceptable in some circumstances and do not pose a serious road safety risk [7].

Secondly, similar to earlier research, an investigation into the inter-correlations between the driving behaviours also revealed moderately strong relationships between the traditional DBQ factors [7,2,18]. The findings suggest that individuals who engage in one form of aberrant driving behaviour (e.g., speeding) are also more likely to report other unsafe driving practices. To a lesser extent, while the three factors are usually considered discrete, at some level, they reflect related driving behaviours. And as discussed below, these differences between acts of speeding and aggression may prove to be more conceptual than practical, and thus may considerably overlap.

Thirdly, an exploratory factor analysis of the full scale DBQ was conducted to determine the consistency of the traditional DBQ factors for the current sample of Australian fleet drivers. Similar with a large body of previous research [15,16,4,5,13], a three factor solution was established from the DBQ in the present study. However, the structure is different to the majority of research that has focused on professional drivers [10,24]. Nevertheless, driving errors made was the most stable factor identified in the present study and item inclusion was reasonably consistent with the original driving error factor included in the DBQ. Item loadings suggested that this factor was predominantly represented by lack of attention and poor judgement issues on the part of drivers.

The other two DBQ factors identified in the present study were a combination of the aggression and highway code violation

**Table 5: Logistic Regression Analyses of Employees Self-Reported Crashes Over a One Year Period as a Function of the Traditional and Present Study's DBQ Factors after Controlling for Kilometres Travelled.**

| Predictors | *B* | *SE B* | Wald | Sig. | Odds Ratio | 95% CI Lower | 95% CI Upper |
|---|---|---|---|---|---|---|---|
| Model 1: Original DBQ factors | | | | | | | |
| Step 1 | | | | | | | |
| Kilometres per year[a] | 0.15 | 0.03 | 37.51 | .014 | 1.16 | 1.11 | 1.22 |
| Adjusted $R^2 = .02$ | | | | | | | |
| Step 2 | | | | | | | |
| Kilometres per year[a] | 0.11 | 0.04 | 31.48 | .014 | 1.10 | 1.07 | 1.14 |
| Errors | 0.43 | 0.13 | 10.31 | .043 | 1.53 | 1.18 | 1.98 |
| Highway code violations | 0.06 | 0.12 | 0.27 | .150 | 1.07 | 0.84 | 1.35 |
| Aggressive violations | 0.14 | 0.13 | 1.19 | .240 | 1.15 | 0.90 | 1.47 |
| (Constant) | -3.43 | 0.20 | 309.95 | .310 | 0.03 | | |
| Adjusted $R^2 = .03$ | | | | | | | |
| Block = $\chi^2$ (3, $n$ = 4638) = 30.23** | | | | | | | |
| Full model = $\chi^2$ (4, $n$ = 4638) = 70.85** | | | | | | | |
| Model 2: Present study's DBQ factors | | | | | | | |
| Step 1 | | | | | | | |
| Kilometres per year[a] | 0.16 | 0.03 | 40.09 | .008 | 1.17 | 1.16 | 1.23 |
| Adjusted $R^2 = .02$ | | | | | | | |
| Step 2 | | | | | | | |
| Kilometres per year[a] | 0.13 | 0.05 | 33.27 | .013 | 1.11 | 1.08 | 1.16 |
| Errors | 0.52 | 0.14 | 14.68 | .013 | 1.69 | 1.29 | 2.20 |
| Highway code violations | -0.18 | 0.12 | 2.10 | .160 | 0.84 | 0.66 | 1.07 |
| Aggressive violations | 0.23 | 0.11 | 4.66 | .046 | 1.26 | 1.02 | 1.55 |
| (Constant) | -3.41 | 0.20 | 305.45 | .290 | 0.03 | | |
| Adjusted $R^2 = .03$ | | | | | | | |
| Block = $\chi^2$ (3, $n$ = 4638) = 34.07** | | | | | | | |
| Full model = $\chi^2$ (4, $n$ = 4638) = 74.69** | | | | | | | |

*Note.* [a] = controlled in these models.
**$p < .01$

items included in the original DBQ. In regards to the second factor, the two strongest item loadings were original DBQ aggressive violation items e.g., sounding a horn in annoyance and becoming angered with other motorists. However, it is also noted that four additional items loading on this second factor, were originally identified as highway code violations. Nevertheless, it is noted that the four highway code items, within an Australian context, may also be considered to be acts of driving aggression. For example in some circumstances, staying in a lane to the last minute and forcing one's way into traffic, driving especially close to another vehicle and overtaking on the inside, whilst they are acts of highway code violation can also be considered acts of aggression. Further research is required to determine the conceptual differences in the factors within a fleet environment.

Similarly, the third factor also contained a mixture of items reflecting three highway code violations items and one act of aggression. Given such item loading, this factor was labelled highway code violations. However, the overall factor loadings are consistent with previous research that has highlighted considerable factor structure variability, thus indicating the specific combination and interpretation of factors may differ with both sample characteristics and environment.

## Prediction of crashes

The final aim of the study was to investigate the relationship the DBQ has with self-reported crash involvement. Both the regression models (e.g., traditional and current modified DBQ factors) revealed that the number of kilometres driven by professional drivers in an Australian fleet setting was predictive of crash involvement. This finding is consistent with previous Australian research [7], and not surprisingly, indicates that exposure to the road is predictive of crashes. Additionally, errors were predictive of self-reported crashes after controlling for kilometres driven in the traditional model, and both errors and aggressive violations were predictive of crash involvement when utilising the modified DBQ factors. This finding suggest that errors made when driving may be a particularly important behaviour that contributes to crashes for professional drivers no matter how much exposure this population has to driving.

Furthermore, it is suggested that within a work related driving context drivers that errors and also aggression may contribute to crashes due to other underlying or organisational factors related to driving. For example, within a work context driver error and acts of aggression may be closely associated with other contributory factors such as fatigue, multi tasking and work or time pressure. This is consistent with other recent research indicating factors such as fatigue and multitasking affects driving performance [28]. Nevertheless within the current context, it is noteworthy that the DBQ was able to assist in identifying that unintentional behaviours (such as lapses) as well as low-level aggressive driving behaviours were linked to crashes among the sample of employees. Subsequently, the organisation was able to specifically tailor the corresponding interventions to address these underlying issues, that not only included a general awareness program about responsible (e.g., non-aggressive) driving practices, but also a further investigation to determine whether the driving errors resulted from fatigue and scheduling-related issues or more of a general lack of concern regarding road safety awareness.

## Limitations

A number of limitations should be borne in mind when considering the results of the study. The reliability of self-report crash data used in the present study may be more susceptible to under reporting of crashes, due to social response bias issues and perceived implications associated with admitting to, engaging in aberrant driving behaviours while driving for work.

It is also suggested that this limitation may have also contributed to the current sample being over represented by drivers who reported no crashes in comparison to drivers who reported one or more crashes in the last 12 months. Future research may need to overcome the possible limitations associated with self report crash data and develop a process for accessing and utilising official crash data from companies without potential ramifications being experienced by employees. This process would enable research to be linked to actual crashes and thus demonstrate applicability within a work related driving context. This procedure would most likely vary between different organisations, but the essential components of a proactive approach that coordinates and utilises multiple data outcomes (e.g., claims data, licence checks, observations, etc), is likely to prove most effective at identifying "at risk" drivers. Currently, policy makers and practitioners would benefit from future research focusing on determining the most valid and efficient data collection and analysis methods to achieve the above mentioned outcomes. The current sample was also overrepresented by males which, although possibly representative of the organisational setting, does suggest that further research should incorporate a more equivalent sample of males and females within a work driving setting. Finally, the response rate was relatively low but consistent with other research in the fleet area [7].

## Conclusion

In sum, the findings of this study suggest that the traditional DBQ can be applied to professional drivers in an Australian fleet setting. However, similar to previous research, factor analysis revealed that although the number of factors remained stable, the structure of these factors changed considerably for two of the original DBQ factors. While the driving errors factor remained mostly unchanged, the other two factors involved a mixture of both the original highway code and aggressive violation items. It is suggested that within an Australian fleet setting acts of aggression and highway code violations may hold core similarities, and as a result, a person who is likely to do one is also more likely to engage in the other. For instance, while racing a vehicle at traffic lights may be considered as a highway code violation, in some circumstances, it may in fact be considered an act of aggression. It is suggested that the wording of such items may needed to be reconsidered due to reduce ambiguity and more accurately reflect the work-related driving context within Australia. Furthermore it is suggested that future research needs to explore other factors that may contribute to the likelihood of driver crashes in an Australian fleet setting. This may include organisation culture, as well as situational factors such as fatigue, time pressure and multi-tasking which have currently received little research focus yet would appear to have some association with factors such as violations and errors associated with work related driving. Exploring the contribution of such factors to aberrant driving behaviours can only complement the development of countermeasures that effectively reduce unsafe driving practices.

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**The next paper was published in the ACRS Journal of May 2008. Unfortunately in the graphic design stage some diagrams lost clarity, limiting their usefulness. The Editor apologises for this and is therefore republishing the paper in full.**

# ROLLOVER CRASHWORTHINESS:

## THE FINAL FRONTIER FOR VEHICLE PASSIVE SAFETY

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## Abstract

Fatalities and injuries to seat belted occupants resulting from rollover crashes is of considerable concern to road safety advocates around the world. Rollover crashes in Australia account for around 1 in every 6 road fatalities, in Europe approximately 1 in every 10, while in the USA it is an alarming 1 in every 4. Recent detailed analysis of the Australian National Coronial Information System fatalities for the year 2005 has revealed that almost 1 in every three vehicle (excluding motorcycle, bicycle and pedestrian fatalities) occupant fatalities (29%) can be attributed to a rollover crash and that of those crashes 16% occur in urban environments whereas 84% are rural crashes. Moreover, vehicle roll-overs are among the most common cause of spinal cord paralysis injury in Australia. Yet there still is no government mandated or consumer dynamic rollover test that protects occupants in such crashes. The main reason for this is considered to be two fold. Firstly, vehicle manufacturers continue to contend that there is no causal link between roof crush and occupant injuries and in particular neck injuries. Secondly, government and consumer groups are presently focussed on prevention of rollover via assessment and ranking of a vehicle's stability characteristics and promotion of electronic stability control.

This paper provides a brief summary of research work carried out and findings to date of an Australian Research Council (ARC) project "Protecting Occupants in Vehicle Rollover Crashes". It includes: the mechanisms that lead to neck injury and fatalities in rollover crashes; the causal link between serious head and neck injuries and excessive roof crush for seat belted occupants; and a proposed rollover crashworthiness testing device called a Jordan Rollover System (JRS) test rig; some preliminary results of a number of vehicles tested using the JRS test rig and a proposal of how vehicle rollover crashworthiness could be rated using the JRS test rig.

## Australian Rollover Crashes For 2005

Approximately 1268 of a total of 1627 road fatalities recorded for year 2005 were investigated using the Australian National Coroners Information System (NCIS). The remaining 359 fatalities were still associated with open files and hence could not be accessed. This meant that a total of around 77% of all road fatalities in 2005 were accessible. Table 1 shows the breakdown in percentage of all fatality cases accessible via NCIS in each state.

Out of this total (accessible) of 1268 road fatalities in 2005, 742 were vehicle occupants. This excludes motorcyclists, cyclists and pedestrians. Of the 742 occupant fatalities, 216 were in a vehicle involved in a rollover crash where around 63% were in cars, 30% in 4WD vehicles, 6% in trucks and the remainder were non-typical road vehicles such as tractors, etc. From a another perspective, nationally, around 29% of vehicle occupants killed were in a vehicle that was in a rollover crash, i.e. a little less than 1/3rd of vehicle occupants (excluding motorcyclists and cyclists). This figure is not dissimilar to the proportion of vehicle fatalities in the USA that are rollover crash related. Around 11,519 fatalities from a total of around 33,041 vehicle occupant fatalities (excluding motorcyclists and cyclists) occurred in the USA in 2005 that were rollover related, i.e. 1 in every three vehicle occupant deaths can be attributed to a rollover crash mode [1].

**Table 1: Percentage of all road fatalities for each state accessible using NCIS.**

| | % data accessible |
|---|---|
| ACT | 100% |
| NSW | 62% |
| NT | 93% |
| QLD | 76% |
| SA | 92% |
| TAS | 98% |
| VIC | 82% |
| WA | 68% |
| Total | 77% |

**Table 2: Percentage of vehicle only crashes where it was identified the vehicle rolled over and percentage of the rollover related crashes that were rural.**

| | % rollovers (vehicles only) | Rollover % rural divide |
|---|---|---|
| ACT | 27% | 0% |
| NSW | 13% | 89% |
| NT | 74% | 79% |
| QLD | 29% | 89% |
| SA | 32% | 96% |
| TAS | 22% | 63% |
| VIC | 26% | 76% |
| WA | 45% | 95% |
| Total | 29% | 84% |

Of the 29% of vehicle occupants involved in a rollover crash around 42% were in a vehicle that is involved in a secondary collision, and 58% were in a single vehicle crash. The secondary collision vehicles were either vehicles struck by another vehicle prior to or after rolling over, or the vehicle hit a fixed object such as a tree, pole, road side barrier, etc, prior to or after rolling over. Table 2 shows the percentage breakdown of vehicle occupant fatalities involving a rollover crash occurring in each state. It is worth noting that rollover related crash fatalities are over represented in Western Australia and the Northern Territory.

The rollover occupant fatalities were also analysed and segregated into rural and urban associated fatalities. The division of rural versus urban was based on assessing postal codes and using maps and assessing whether the crash occurred in an urban built up environment or not. Table 2 again shows the percentage rural rollover occupant fatalities for each state. Table 2 also shows that rollover associated fatalities predominantly occur in the rural divide at around 84% nationally but varies greatly and clearly the percentage of rollovers in each state is at least partially related to the amount of rural areas.

**Table 3: Categorisation of rollover crashes where a fatality occurred**

| Ejection | | Seatbelt Usage | |
|---|---|---|---|
| Yes | 43% | Yes | 19% |
| No | 32% | No | 35% |
| Partial | 6% | Unknown | 46% |
| Unknown | 20% | | |

Occupants who were killed in a vehicle that rolled over were further investigated for seat belt usage and ejection. This data is summarised in Table 3. It is interesting to note that 49% of the fatalities that occurred were either fully or partially ejected during rollover and around 35% of occupants killed were found to be not using a seat belt. Unfortunately, little can be said about the 46% of occupants killed involving a rollover crash where seatbelt usage is unknown. However, the authors suspect a large proportion of these occupants may not have been wearing seat belts. Thus significant gains in terms of injury reduction could be made by ensuring occupants wear seat belts and that systems are developed to ensure the occupants are contained within the vehicle during the rollover event.

## Rollover Crash Mechanism

The different ways in which a single vehicle rollover crash occurs has recently been described by Young et al [2], Gugler et al [3] and Viano and Parenteau [4]. As mentioned previously, vehicles can also become involved in a rollover crash as a secondary event after it has been struck by another vehicle [5]. For single vehicle rollover crashes, one of the most common ways a rollover crash occurs involves a vehicle loosing steering control, yawing sideways, and eventually "tripping" because of excessive tyre resistance to yaw sliding. Analyses of crash scenarios have revealed to date that this can either occur:

- because of excessive speed during a cornering manoeuvre inducing the yaw;
- as a result of the driver falling asleep at the wheel allowing the vehicle to drift onto the soft gravel shoulder, suddenly waking and then oversteering the vehicle in an attempt to guide it back onto the bitumen;
- from an excessive swerving steering manoeuvre to avoid a collision into another vehicle or object;
- or from an impact with a roadside concrete barrier or dirt mound.

Regardless of how vehicle tripping was induced, once the vehicle begins its rollover sequence, the safety of the occupants depends on the structural integrity of the roof, the seatbelt restraint and side air-curtain system. The majority of rollovers usually occur on flat terrain where there is little rise or fall of the vehicle during the rollover event [6]. Newton's first law of physics governs that any objects within the vehicle are usually thrown to the outside away from the centre of rotation of the vehicle unless they are restrained in some manner. The restrained occupant is held within the seat area by forces applied primarily by the seatbelt. If the occupants are not restrained, there is no air curtain and the vehicle's side windows are compromised and fractured as a result of roof crush, ejection of the occupants is most likely. If the roof structure is weak and readily collapses, then the internal survival space is compromised to a point where both the occupant's head and neck cannot fit under the roof structure unless the neck is broken as is obvious for the vehicle shown in Figure 1.

The vehicle shown in Figure 1 underwent two rollovers (two complete revolutions). Friedman et al [7, 8] have shown that around 90% of rollover crash related fatalities occur within 2 complete 360 degree rolls, i.e. 8 one quarter (90 degree) turns.

In other words, the authors believe that the vehicle's roof structure should be built to withstand at least 2 rollovers without intrusion into the occupant compartment. A strong roof also helps significantly reduce breakage of side and/or front glazing which in turn mitigates ejection (which constitutes a large proportion of rollover fatalities and serious injuries).

## Injury Mechanism

This paper focuses on injuries to seat belted occupants. A large number of papers have been published analysing how such occupants are injured during a tripping rollover event. It has been established that a seat belted person suffers serious, potentially fatal neck injuries, as a result of loading to the head which in turn loads the neck. Hence the large number of spinal injuries resulting from vehicle rollover crashes [9]. In other words, the head appears to be driven into the torso of the occupant.

Effectively there appear to be two different hypotheses in regards to how occupants are injured in this way. One proposes that the occupant "dives" into the roof during the rollover when the roof strikes the ground. This view was introduced by Moffat in 1975 [10], and supported by others [11], but continues to this day to be strenuously defended by vehicle manufacturers.

The basis on which the "diving" hypothesis is defended dates back to a series of FMVSS 208 dolly rollover tests carried out in 1987 by General Motors of their 1983 Chevrolet Malibu vehicle, with seat belted Hybrid III 50th percentile crash test dummies (ATD). The series is referred to as the Malibu II

**Figure 1: Tenting roof crush and pillar deformation leaves little room for survival**

rollover crash tests. Eight vehicles were tested. Four vehicles had roofs strengthened with a 'roll cage' and four 'production' vehicles had no strengthening. The ATD's were restrained with the vehicle's seatbelt systems. The belts were fitted to the ATD's with slack equivalent to the static inversion of a human surrogate in the vehicle. ATD neck loads were measured. Any neck load above 2000 N was identified as a Potentially Injurious Impact (PII). There were forty (40) such PII's recorded from the test series.

An alternate view, mostly promulgated by Friedman et al [6, 7, 8, 12, 13] and other crashworthiness experts [14, 15 and 16], states that roof crush is causally linked to fatal and serious head and neck injuries resulting from rollover crashes.

In an attempt to resolve the argument and hence fill a knowledge gap, the authors have analysed in detail the principles on which the "diving" hypothesis is based. A discussion of this can be found in two papers by Young et al [17] and Grzebieta et al [18]. Essentially the authors have developed equations based on a single degree of freedom dynamic model of an occupant that directly relates the magnitude of neck load to either the intrusion velocity of a roof and/or the velocity of the occupant "diving" into the roof. Further analysis of General Motors (GM) Malibu II vehicle rollover crash tests [11] was also presented in these papers illustrating how high neck loads in production (non-reinforced) vehicles cannot be attributed to "diving" alone. It was concluded that these significant forces must be resulting from roof crush and in particular the velocity at which the roof intrudes. Figure 2 shows the model used [18]. The following equations

$$F_{neck} = v_R \sqrt{km} \qquad (1)$$

$$F_{neck} = v_d \sqrt{km} \qquad (2)$$

relates the velocity of roof intrusion $V_R$ and the "diving" velocity $V_d$ to the neck loading where $k$ is the ATD's neck stiffness, $x$ the neck compression, $x_m$ the displacement of the torso, $m$ the mass of the torso, and $\ddot{x}_m$ the acceleration of the torso.

Consider the silhouette of a vehicle that is rolling over as shown in Figure 3. It rotates at a roll speed of $\varpi$ degrees per second and its Centre Of Gravity (COG) is travelling sideways at a velocity of VCOG. The rollover can be thought of as a smooth cylindrical barrel roll. Friedman and Nash [6, 7] on analysing the GM rollover Malibu II test data found that the COG of the vehicle does not rise or fall more than 4 to 5 centimetres such that the vehicle's COG vertical velocity at roof impact is never more than 2.5 m/sec. Thus each complete rollover can also be considered as being made up of four quarter turns where a small portion of the vehicle's kinetic energy is dissipated during each quarter turn [19]. During each quarter turn the corners of the roof, points B & C, and the tyres interact (touches down)

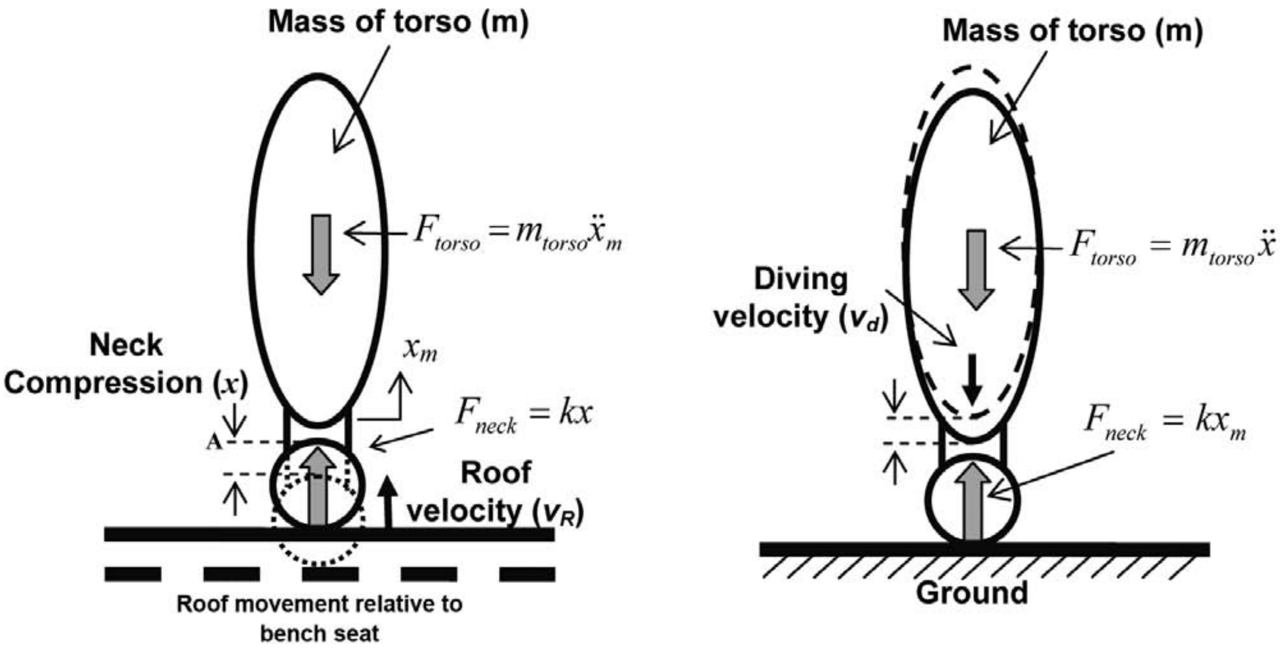


**Figure 2: Single degree of freedom dynamic model representing Hybrid III dummy**

with the road surface. Between each touchdown the vehicle can be assumed to be airborne.

We now assume that the roof and pillars are weak and will distort typically as an unbraced frame with weak joints at positions A, B, C & D. In other words, we assume the pillar AB sways sideways. The pillar on the non-struck side can also sway in a mechanism commonly referred to as 'match-boxing' or 'side sway' if pillar CD is weak in rotation (Figure 3(a)). In the case of the vehicle shown in Figure 1, the roof 'tented' rather than deform the opposite pillar as depicted by line DC in Figure 3(b). Note that the force in the opposite non-struck side pillar resolves in a direction that provides maximum resistance to any loading from the struck side impact. Hence, the roof 'header rail' at the front windscreen tends to deform instead because it provides a weaker resistance to movement than the far side pillar. Figure 3 (b) shows how the deformation mechanism and weak roof can result in an extra hinge point G forming in the header rail.

Regardless of how the opposite side pillar distorts, the occupants head is close to the struck pillar when contact occurs as shown in Figure 4. This occurs as a result of plastic deformation hinges forming at points A, B, C & D as shown in Figure 3(a) or at A, B, C, G & D as shown in Figure 3(b). Position A represents a hinge formation at the intersection of the 'a'-pillar and side roof rail and/or at the 'b'-pillar and side and header roof rails. We also assume this occurs when the trailing side at point B strikes the ground. That the trailing side usually distorts as a result of adverse load paths generated by rollover forces, as opposed to the leading side that better resist the forces, has been confirmed by a number of investigators [6, 11, 14, 20, 21].

Consider now in isolation pillar AB, e.g. the 'b-pillar', manufactured at an inclined angle $\alpha$. If the pillar roof connection is very weak in bending then as a result of striking the ground the pillar will distort sideways as it moves horizontally by an amount $\Delta$. This deformation occurs at the speed at which the vehicle is moving laterally, i.e. at a velocity VCOG. Geometry and kinematics then dictates that the roof rail drops down a distance of $\delta$ at a velocity directly related to the horizontal velocity. Bahling et al [11] found in their rollover crash tests of the Malibu vehicle where the occupants were seat belted that:

*"As a result of this rotational velocity, dummies moved upwards and outward to the extent which the lapbelt and vehicle side interior would allow. They tended to remain with their heads adjacent to the outboard roof siderail while constrained by the lapbelt and door and moved away from that point only by vehicle-to-ground impacts."*

This means that the head when in contact with the siderail near point B would undergo a vertical displacement of $\delta$ when the line AB ('b-pillar' and/or 'a-pillar' together) rotates sideways. Thus by calculating $\delta$ it is possibly to determine the vertical intrusion velocity of the roof onto the occupant head that causes both a vertical and lateral displacement of the head.

## Weak Roof

The relevant dimensions for length AB in isolation are shown in Figure 5 where the length of the 'b-pillar' is adopted as L. From this sketch when element AB is rotated the following relationship is obtained

$$\delta_T = \delta_0 + \delta = L - \sqrt{L^2 - (\Delta_0 + \Delta)^2} \quad \textbf{(3)}$$

This expression can be rearranged to

$$\delta = L - \sqrt{L^2 - (\Delta_0 + \Delta)^2} - \delta_0$$

and

$$\delta = L - \sqrt{L^2 - (\Delta_0 + \Delta)^2} - \left(L - \sqrt{L^2 - \Delta_0^2}\right)$$

and thus

$$\delta = \sqrt{L^2 - \Delta_0^2} - \sqrt{L^2 - (\Delta_0 + \Delta)^2} \quad \textbf{(4)}$$

or in trigonometric form

$$\delta = L(\cos\beta - \cos\alpha) \quad \textbf{(5)}$$

At point B touchdown if the roof is a weak structure, the 'b-pillar' can potentially reach the vehicle's COG horizontal velocity minus the velocity due to vehicle rotation at point B. Thus :

$$V_R = \frac{\delta}{\Delta} \times (V_{COG} - V_\varpi) \quad \textbf{(6)}$$

Substituting Equation (1) for the neck force from roof crush, the expression for the neck loading resulting for a vehicle with a weak roof is

$$F_{neck} = \frac{\delta}{\Delta} \times (V_{COG} - V_\varpi)\sqrt{km} \quad \textbf{(7)}$$

or in expanded form

$$F_{neck} = \frac{\left(\sqrt{L^2 - \Delta_0^2} - \sqrt{L^2 - (\Delta + \Delta_0)^2}\right)}{\Delta} \times (V_{COG} - V_\varpi)\sqrt{km} \quad \textbf{(8)}$$

or in trigonometric form

$$F_{neck} = \frac{L(\cos\beta - \cos\alpha)}{\Delta} \times (V_{COG} - V_\varpi)\sqrt{km} \quad \textbf{(9)}$$

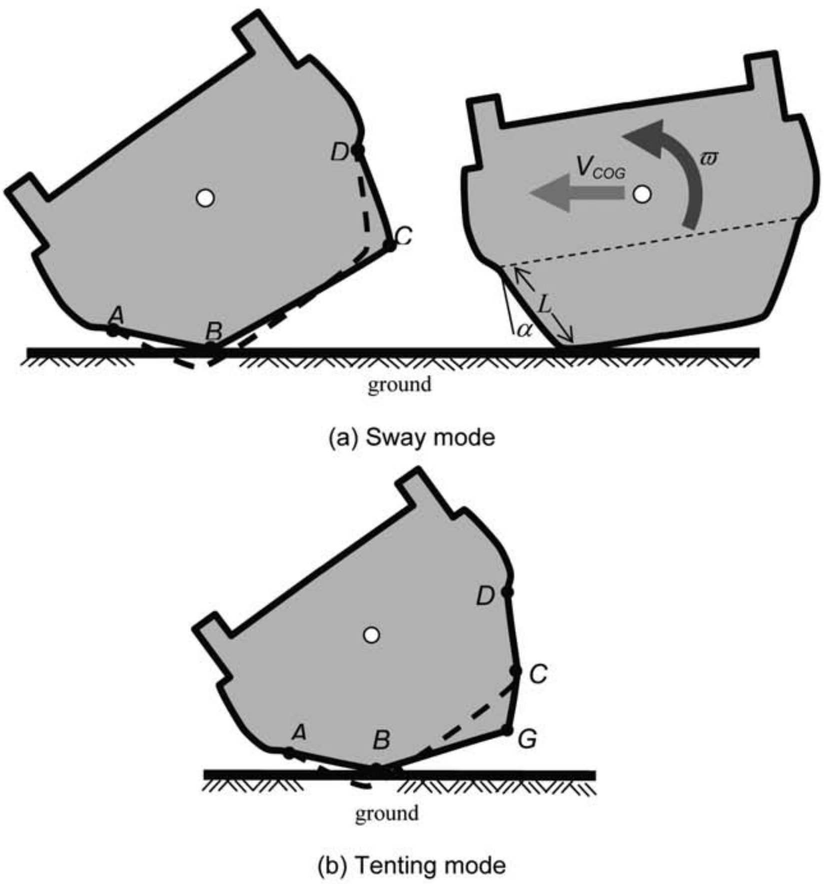


**Figure 3: Sedan vehicle rolling over striking the ground on the trailing side of the roof.**

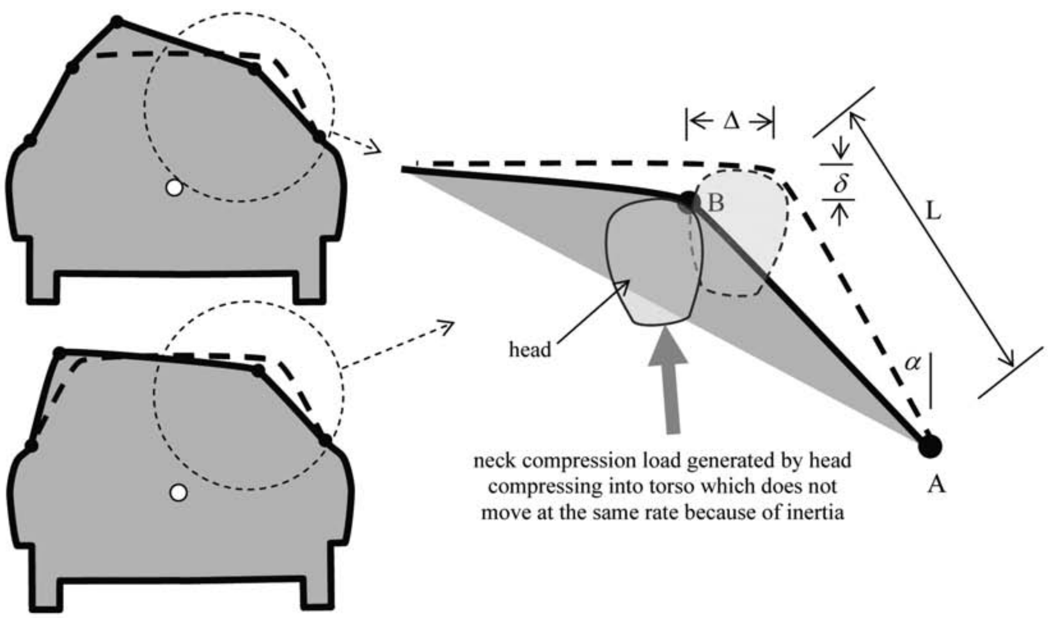


**Figure 4: Deformed 'weak roof' vehicle with head placed at intersection of side pillar and roof**

## Strong Roof

It is now assumed that the vehicle is subjected to an FMVSS 208 dolly rollover crash test on a bitumen surface and the roof is very strong. In general, for an FMVSS 208 dolly rollover crash test, the height of a vehicle's COG does not change significantly. If the roof is now so strong that it does not deform during contact with the ground, the vehicle effectively skids along the road surface each time contact is made in quarter turn. In other words, the steel-bitumen and tyre-bitumen contact surfaces slide against each other as shown in Figure 6 and a certain amount of energy is dissipated. It is for this reason scratch or gouge marks left in the road or gravel surface are often noted by crash investigators and reconstructionists, as points of contact and sliding, identifying how the vehicle rolled. It should be noted that rollover energy is also dissipated by the raising and lowering of the vehicles COG [19] albeit the COG height change is small as indicated by Friedman and Nash [6].

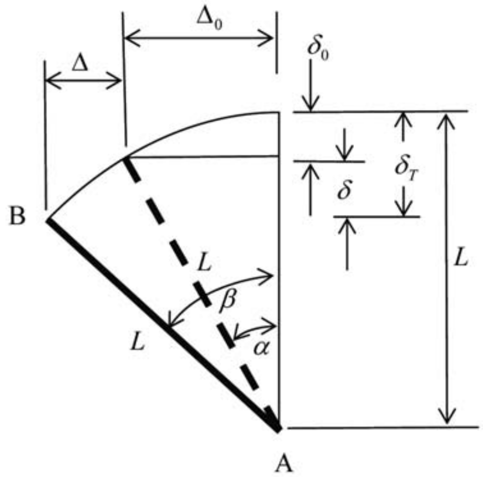


**Figure 5: Displacement of pillars sideways**

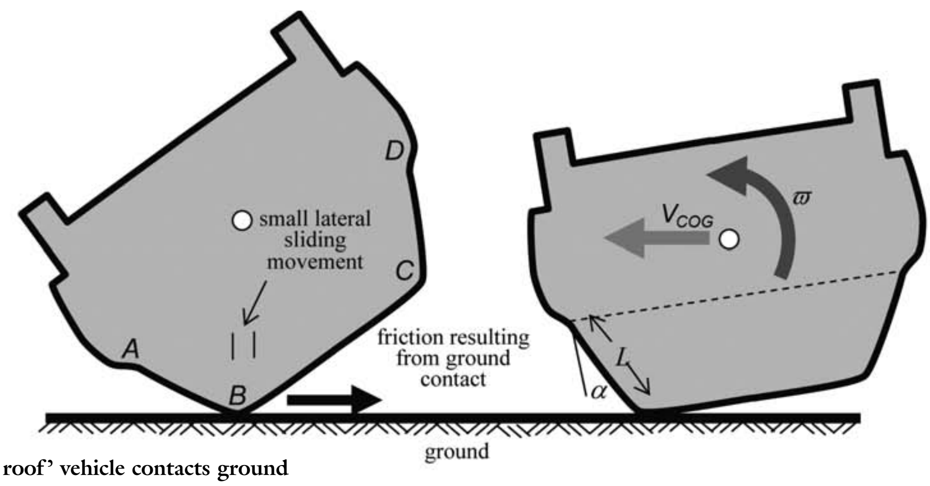


**Figure 6: 'Strong roof' vehicle contacts ground**

The car body can be considered as a rotating shell surrounding the occupant, slowing down each time it makes contact and the steel roof corner or tyres skid on the bitumen surface. To determine how much the vehicle decelerates each time touchdown occurs, the following equation based on Newtonian laws of physics governing the deceleration or acceleration of a body can be used

$$V^2 = 2fgd \tag{10}$$

where '$f$' is the deceleration drag factor, '$g$' is 9.81 m/sec$^2$ being the earth's gravitational constant and '$d$' is the distance over which a body decelerates, can be used. Equation (10) has been used by crash reconstructionists for over twenty years [22]. The key variable is the drag factor '$f$'. Coefficients of friction for steel against bitumen and for tyres against bitumen range from 0.55 to 0.7. In this instance a value of around 0.6 will be adopted.

The "diving" velocity of an occupant inside the vehicle can be calculated, knowing the rate of angular roll $\varpi$ , the distance $R_0$ from the occupants COG to the vehicle's COG and the vertical drop height '$h$' through which the vehicle's COG drops as it rolls along. Thus

$$V_d = \varpi R_0 + \sqrt{2gh} \tag{11}$$

However the rate of angular roll can be directly related to the change in velocity of the vehicle structure in each quarter turn as it strikes the bitumen, i.e.

$$V_d = \frac{R_0}{R_{COG}}\sqrt{2fgd} + \sqrt{2gh} \tag{12}$$

Again Equation (2) for "diving" velocity can be adopted in place of the roof crush velocity to be used to estimate the neck load. Thus

$$F_{neck} = \left[\frac{R_0}{R_{COG}}\sqrt{2fgd} + \sqrt{2gh}\right]\sqrt{km} \tag{13}$$

Equation (13) shows that the main factor that influences the severity of a rollover crash and the velocity at which an occupant will dive into a strong roof during each quarter turn is the height of vertical fall '$h$'. However, the authors and others [2, 6, 17 and 18] have shown that the vertical drop height is small for a rollover on level ground in the case of a rollover FMVSS 208 crash test.

What is interesting to note about Equation (13) is it is independent of the velocity at which rollover commences. Thus it should be irrelevant of the vehicle starts to rollover at 100 km/h freeway speed or 52 km/h as in the case of a dolly rollover crash test, so long as the vertical drop height 'h' is not large and consistent between the two events. The outcome will be that the occupant "diving" velocity will always reach a threshold value that is directly related to the coefficient of friction between the vehicle's steel body and tyres and the road surface. It also means that if the coefficient of friction becomes higher, i.e. ploughed earth, or the drop height becomes larger, the neck load will increase unless the occupant is firmly secured in a seat belt with adequate clearance between the head and the roof. The research work to confirm this finding is currently under way.

## Jordan Rollover Test Rig And Rollover Crash Testing

To confirm the validity of Equation (1), the authors requested results of measured neck loads from Hybrid III dummies placed into vehicles that were subjected to a repeatable, dynamic rollover test using the Jordan Rollover System (JRS) test rig as shown in Figure 7. Details of the test rig are provided by Jordan & Bish [23] and Friedman et al [7 & 8]. The test vehicle or occupant compartment only buck is supported by two drop towers along its longitudinal roll axis at the vehicle's COG. The vehicle can be positioned at any pitch or yaw angle. A mobile roadbed segment moves under the vehicle and is synchronised with the vehicle's roll so as to simulate the rate at which the vehicle's COG is moving as it rolls. When the test starts the vehicle is rotated and allowed to free fall to the roadway. The vehicle moving freely, strikes the near side and far side of the roof on the road bed. The vehicle is then caught by the towers as the road bed progresses through and beyond the towers so that the vehicle does not suffer any further damage. The vehicle, roadbed and Hybrid III Crash Test Dummy (ATD) are instrumented to record: vertical and lateral vehicle impact loads; roof displacement and roof intrusion velocity during roof impacts at several roof locations inside the vehicle; and dummy neck loads. High speed and real-time cameras record movement of the vehicle and ATD.

**Figure 7: Photograph of the JRS Test Rig [8]**

Real world crash analysis by Friedman et al [7 & 8] indicates that the most appropriate set up for the vehicle in the JRS is: a pitch angle of 5°; a yaw angle of 10°; a rotation speed of around 190 degrees per second; a free fall of 10 cm; and a roadbed speed of 24.1 km/h (15 mph). Under these conditions the vehicle strikes the near side of the roof at a roll angle of 135°.

A selection of US vehicles have been tested in the JRS under the initial test conditions outline above by Friedman et al [7 & 8]. The neck loads measured in the ATD are plotted against the speed of roof intrusion relative to the ATD and is shown in Figure 8. Theoretical values calculated using Equation (1) are also plotted using values of neck stiffness and mass as detailed by Young et al [17] and Grzebieta et al [18]. Correlation between theory and test is considered reasonable, indicating that peak neck loads appear to be linked to the speed of roof intrusion. The values at the far right of the plot in Figure 8 are instances where the vehicle roof was known to be weak, whereas the point on the far left of the plot where the load was around 2000 Newtons was a vehicle that was known to have a strong roof. In the instance of the two 'weak roof' vehicles, the ATD head was found to be to one side of the point in the vehicle roof where the intrusion and its velocity was a maximum, accounting for the underestimate in peak neck load for these tests. Suffice to say that many more tests need to be carried out to assess the validity of the above equations. This is one of the current tasks of the Australian Research Council (ARC) Discovery Project rollover grant research team.

Considerable biomechanical research has been carried out in regards to identifying what magnitudes of axial loading need to be applied to a vehicle occupant's neck to cause serious injury, and how ATD measurements relate to these injury levels. The impact velocity was shown by Alem et al [24] and Myers et al [25] to influence both the risk and severity of neck injuries in experimental crown impacts to the head. In parallel, Sakurai et al [26] and Sances et al [27] showed that measured Hybrid III peak neck loads also correlated with the impact velocity for a given impact scenario (see also Figure 8 for the present study). In particular, Hybrid III reconstructions of injurious events presented by Mertz et al [28] or Pintar et al [29] showed that severe injuries to the neck start to occur at compressive loads between 4000 to 6000 Newtons (N) measured on this ATD. However, as raised by Friedman et al [6, 7, 8 and 13], and based on recent results by Viano and Pellman [30], the current 4000 N Injury Assessment Reference Value may be underestimated for the Hybrid III. Therefore, it is considered more work is needed in order to precisely define the peak load/impact velocity combination that may be associated with a given injury level.

The above raises the issue of using the JRS rollover rig to assess the crashworthiness of vehicles and rate them in terms of protection for seat belted occupants. The JRS test rig is also capable of assessing the on-board safety restraint systems such as an aircurtains, pretensioners and seat belts. For example, a possible five star rated vehicle could be one where the neck load is less than its Injury Assessment Reference Value (IARV), the vehicle is installed with pretensioners and curtain airbag, and the roof deformation is such that no window rupture occurs.

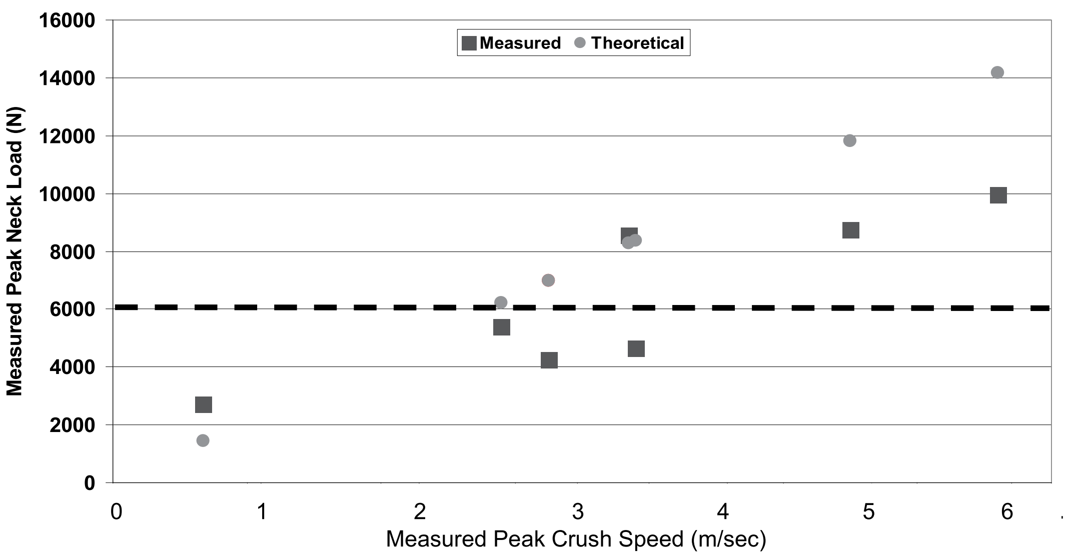


**Figure 8: Peak Neck Load v. Peak Crush Speed**

## Conclusions

The following conclusions have been drawn so far from the research work carried out to date:

1 Statistical data clearly indicates that rollover crashes are dangerous events and should be a priority in terms of mitigating injuries occurring to occupants;

2 Occupant protection in rollover crashes are not currently being addressed by design rules. There is an urgent need to introduce a system that will ensure seat belted occupants are adequately protected in a rollover crash;

3 It appears that the vertical load imparted to the neck of a seat belted occupant inside a vehicle that is rolling over, where the roof strength is weak, is directly related to the amount of lateral roof “match boxing” distortion a vehicle undergoes at the moment of touchdown;

4 In the case of a weak roof that can readily deform, the vertical intrusion velocity is directly related to the velocity of the lateral displacement of the roof and/or roof pillars. This deformation is in turn directly related to the velocity at which roof touchdown occurs with the ground surface which is directly related to the speed at which the vehicle’s COG is moving laterally;

5 If the vehicle roof is weak, the higher the lateral travelling velocity of the vehicle’s COG, the higher the speed of vertical intrusion and hence the greater the severity of injury to the occupants;

6 If the roof is strong enough to resist lateral and vertical movement during each quarter turn touchdown, the maximum “diving” velocity an occupant will be subjected to will be limited to the resistance to rollover afforded by friction between the vehicle’s roof structure, its tyres and the road surface (around 0.6 drag factor) and the height of drop the vehicle’s COG undergoes from one quarter turn to the next.

7 If the roof is strong, each quarter turn touchdown will slow the rotating vehicle approximately 4 km/h being a consequence directly related to the roof to ground friction coefficient of around 0.6 and the movement of the COG vertically – this movement is a non-injurious change in roll rate for a seat belted occupant;

8 If the roof is strong enough to resist lateral and vertical movement during each quarter turn touchdown, theoretically there should not be any difference in crash severity to a seat belted occupant between a vehicle being tripped at 100 km/h and 52 km/hr so long as the vehicle’s COG remains within 3-5 centimetres or so of vertical displacement and the occupant is adequately restrained. This fact has been proven time and again in racing cars that rollover where the roof has been substantially strengthened and the occupant is held in a full harness seat belt. Again the coefficient of friction between the vehicle’s body and the road surface is the main factor governing this outcome.

9 The Jordan Rollover System (JRS) test rig can adequately assess the rollover crashworthiness of a vehicle. A JRS test rig should be built in Australia for research and crashworthiness rating purposes.

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