AP-R268/05

AUSTROADS RESEARCH REPORT

Australasian Road Safety Handbook: Volume 2

Austroads
promoting improved road transport outcomes

AUSTRALASIAN ROAD SAFETY HANDBOOK: VOLUME 2

Australasian Road Safety Handbook: Volume 2
First Published 2005

National Library of Australia
Cataloguing-in-Publication data:

Australasian Road Safety Handbook: Volume 2
ISBN 0 85588 731 1

Austroads Project No. SS1102

Austroads Publication No. AP–R268/05

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AUSTRALASIAN ROAD SAFETY HANDBOOK: VOLUME 2

Austroads

Sydney 2005

Austroads profile

Austroads is the association of Australian and New Zealand road transport and traffic authorities whose purpose is to contribute to the achievement of improved Australian and New Zealand road transport outcomes by:

- undertaking nationally strategic research on behalf of Australasian road agencies and communicating outcomes
- promoting improved practice by Australasian road agencies
- facilitating collaboration between road agencies to avoid duplication
- promoting harmonisation, consistency and uniformity in road and related operations
- providing expert advice to the Australian Transport Council (ATC) and the Standing Committee on Transport (SCOT).

Austroads membership

Austroads membership comprises the six state and two territory road transport and traffic authorities and the Commonwealth Department of Transport and Regional Services in Australia, the Australian Local Government Association and Transit New Zealand. It is governed by a council consisting of the chief executive officer (or an alternative senior executive officer) of each of its eleven member organisations:

- Roads and Traffic Authority New South Wales
- Roads Corporation Victoria
- Department of Main Roads Queensland
- Main Roads Western Australia
- Department for Transport, Energy and Infrastructure South Australia
- Department of Infrastructure, Energy and Resources Tasmania
- Department of Infrastructure, Planning and Environment Northern Territory
- Department of Urban Services Australian Capital Territory
- Australian Department of Transport and Regional Services
- Australian Local Government Association
- Transit New Zealand

The success of Austroads is derived from the collaboration of member organisations and others in the road industry. It aims to be the Australasian leader in providing high quality information, advice and fostering research in the road sector.

PREAMBLE

Every so often a particularly horrendous crash or a rise in the road toll brings road safety to public attention. Invariably, a reasonably predictable set of 'solutions' is offered, including:

- compulsory training courses for young drivers
- more stringent licensing tests for young and old drivers
- reduced (or open) speed limits
- education programs for repeat drink-drivers
- the benefits (or otherwise) of road safety advertising
- whether drivers should be regularly medically examined
- vehicle confiscation for repeat offenders
- regular vehicle inspections to ensure roadworthiness.

These suggestions (often made through letters to the newspapers, at public meetings, in correspondence with Ministers etc) usually require transport jurisdictions to make a quick and authoritative response. This entails either having a summary of the research findings at hand (which may or may not be dated) or a rushed review of the available literature (which may or may not be comprehensive).

The handbook aims to assist jurisdictions in the preparation of timely responses to key road safety issues, in the first instance by providing an up-to-date summary of the available empirical research on a given topic, ensuring that a balanced coverage is given to all viewpoints.

It also aims to present a consideration of the various political, economic and other factors that may influence any official response to the empirical evidence. In other words, for any given issue, it aims to complement empirical recommendations with comments on jurisdictions' real-world considerations. Whether these considerations are sufficient to impact upon the empirical recommendations has been left to each jurisdiction to assess.

Volume 1 of the handbook, consisting of 15 papers, has already been published. Volume 2 contains a further fourteen papers and will be followed by Volume 3 later in 2005.

It is intended that, once the first three volumes have been published, the handbook will be updated on a regular basis to include the latest research findings and any possible shift in emphasis warranted by research breakthroughs or other factors. It is further intended that the list of topics will be reviewed regularly and expanded or amended to reflect jurisdictions' changing priorities and concerns.

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ROAD IMPROVEMENTS AS A ROAD SAFETY COUNTERMEASURE

Prepared by: Jim Langford and Bruce Corben
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30 June 2003

1. A brief statement of the issue

It has been estimated that maintaining current road improvement programs in Australia will result in 453 lives saved per year by 2010.[1] This saving is equivalent to 25.6 per cent of the 1997 road fatality toll.

This paper aims to estimate the crash reductions and cost-benefits associated with specific types of road treatment used in black spot programs throughout Australasia, and to report on emerging approaches in road engineering.

2. An assessment of the road safety issue

2.1. The development of black spot programs in Australasia

Locations with abnormally high numbers of crashes have been defined as *black spot sites.*[2] Black spot treatments entail the application of engineering measures aimed explicitly at reducing crash numbers and/or crash severity.[3]

- at a specific site or section of road
- along a route with high crash numbers
- area-wide, encompassing a collection of roads and streets that collectively have high crash numbers
- through mass action, whereby a known remedy is applied to a wide spread of locations with common crash problems.

Victoria introduced Australia's first so-called black spot program in 1979 on a modest basis (about $0.4 million with four treatments implemented in the first year).[4] The funding and scale of operations increased substantially over the next two decades, such that Victoria currently has a State black spot program comprising $240 million for the period 2000/2001 to 2003/2004.

On 1 July 1990 the first national black spot program commenced as part of a 10-point package of road safety measures. Federal government support has continued, with the current four-year program having started in the 2002/2003 financial year.

State and Territory black spot programs are now commonplace throughout Australia and the terminology has also been widely applied to many road improvement programs at local government level.

New Zealand's crash reduction study programme was established in 1985. In 1989, the LTSA developed a monitoring system to collect data on the treated sites in order to analyse the effects of the programme. The monitoring system consists of both site data and information on works which are implemented at each site, which are then matched to crash data at each site for selected time periods.

2.2. On-going road improvement programs in Australasia

Capital works expenditure on roads in Australasia is given to general improvements and upgrades, particularly to improve vehicle mobility and to reduce congestion, to improve accessibility and to improve the efficiency of freight movement. While safety is usually not the prime priority, these improvements may produce safety benefits. For example the duplication of major routes to separate high-speed traffic travelling in opposing directions serves both mobility and safety functions. Safety improvements, although usually on a small scale, may also result from general maintenance programs.

2.3. The relative safety contributions of black spot vs. general road improvement programs in Australasia

It has been estimated that:

- for each $100 million spent, black spot programs will save at least 20 lives
- for each $100 million spent, general improvement programs will save at least 1.5 lives.[1]

The same authors have also estimated that, by 2010, the number of fatalities prevented per year in Australia as a result of road improvements will be 453:

- 144 saved from black spot expenditure
- 309 saved from general improvements expenditure.[1]

“If it is decided that, during the next decade or so, safety should be given more priority than mobility, then some expenditure could be reallocated from projects in the (general improvements) category to those in the (black spot programs). Such reallocation would also be likely to occur automatically if ‘willingness to pay’ were used to calculate the statistical value of a human life … rather than the present ‘human capital’ method. If such reallocation of expenditure did occur the number of fatalities saved per $100 million invested in all road construction would increase”.[1]

3. A review of the research

3.1. How effective are black spot programs?

From the very outset black spot programs have been rigorously evaluated, whether at jurisdictional or national level. To give three recent examples:

- The 1992-1996 program in Victoria showed a reduction of 26.4 per cent in casualty crash numbers and a reduced casualty crash cost of 29.6 per cent at treated sites.[4] Over its full life, the program will return benefits worth 4.1 times the program costs (rising to 5.1 times if seven high-cost treatments funded by the program for additional, non-safety reasons were excluded). These findings are in broad agreement with previous evaluations of earlier versions of the program.[5,6]
- The 1996/1997-2001/2002 Federal black spot program showed casualty crash reductions of 31.2 per cent and 48.2 per cent at metropolitan and other sites, respectively, during the first three years.[3] The overall benefit-cost ratio was 14:1. Again, these positive outcomes, at least in their general direction, were in accordance with earlier evaluations.[2]
- As at March 2003, NZ’s programme has been credited with achieving reductions of 34 per cent in injury crashes at the treated sites. This reduction corresponds to an estimated saving in social cost of approximately $3 billion (at June 2002 prices) using the willingness-to-pay values of statistical life and injury.

As might be expected, the specific measures of effectiveness vary from study to study according to the criteria used for selecting sites, the suitability of the treatments selected, the balance of treatments implemented, the pre-treatment crash levels, the duration of the post-treatment periods used in gathering 'after' crash data and so on. Again, considering the 1992-1996 program in Victoria and its sub-programs, it was found that sub-programs that were more systematically developed and based on proven treatment types had a greater impact on crashes and showed higher economic benefits per dollar invested, relative to sub-programs using less rigorous procedures.[4]

3.2. How effective are individual types of treatments in reducing crashes?

The two recent evaluations cited above[3,4] have also been used to indicate the possible impact of individual treatments on casualty crashes. Treatments that returned a significant change in casualty crashes, at least at either an urban or rural level, in at least one of the studies, are listed in Table 1 (over page).

At a total program level, both evaluations have shown reasonably consistent results, with the national results being somewhat higher for both urban and rural areas.

Looking just at the results of the Victorian program, intersection treatments (roundabouts, signal remodelling, new signals, etc.) and route treatments (pavement resealing, road delineation, shoulder sealing, etc.) had the biggest impact on crash levels. Equivalent grouped data were not available for the national study but it appears that the intersection treatments were the best performed.

Table 1 also suggests that general program benefits were greater in rural areas, compared to urban results:

- For Victoria, this difference in benefits was consistent at both program and most treatment-type levels – but in no instance was statistically significant. The only type of treatment that seemed more effective in urban areas was the collection of intersection treatments, but again, the differences were not statistically significant.
- The overall program benefits at a national level were also greater in rural areas. However, the differences were not tested for statistical significance.

Table 1: Casualty crash reductions attributable to the TAC Victorian or to the Federal black spot programs.

Treatment	Casualty crash reduction (per cent)			
	TAC program in Victoria, 1992-1996		Federal black spot program, 1996/1997-2001/2002	
	Urban	Rural	Urban	Rural
WHOLE PROGRAM	23.5	30.6	31.2	48.2
TYPE OF TREATMENT				
1. Intersection treatments	27.8	26.9		
2. Pedestrian facilities	8.8*	46.4*		
3. Route treatments	22.6	30.8		
4. Treat road features	3.5*	15.3*		
TREATMENTS				
Roundabout	72.3	67.4	69.9	75.1
Signal remodel – controlled right turn	25.8	5.7*	42.9	37.3
New signals	34.6	7.0*	47.1	76.0
Other intersection improvements	17.4	11.5*		
Pavement re-sealing (route)	56.2	30.4*	37.5	-26.7*
Roadway delineation	59.6	25.7	-7.0*	33.4
Curve realignment	-43.43*	74.9		
Shoulder sealing	15.6	38.4	12.8*	28.8
Pavement widening	30.9	37.0*		
Signs			15.8*	53.8
Lighting	11.2*		-26.9	63.2

NOTES: * indicates that a change was not statistically significant. Other changes were significant; The Victorian program used post-treatment casualty crash histories of between 2.5 and six years, depending on the implementation dates of individual treatments; the national program used a sample of 608 black spot treatments implemented during the first three years of the program. It was not possible from the report to determine the length(s) of the post-treatment crash histories. Specific treatment details and definitions may vary across the two studies.

The benefits of the individual treatments in reducing crash numbers varied across the two studies, in terms of exact measurement and sometimes in terms of direction of change. However, overall, there was reasonable consistency in the results:

- roundabouts – showed crash reductions at least at the 70 per cent level
- introduction of fully-controlled right-turn phases at intersection signals – in three of the four instances showed reductions in excess of 25 per cent
- new signals – which in three of the four instances showed reductions of 35 per cent or more
- pavement re-sealing in all four instances showed reductions exceeding 25 per cent (although in two instances the reductions were not significant)
- roadway delineation – in three of the four instances showed reductions of 25 per cent or more
- shoulder sealing – which in all instances showed reductions of 13 per cent or more (although in one instance the reduction was not significant).

3.3. Cost-effectiveness of individual types of treatments in reducing crashes

The various treatments implemented as part of the1992-1996 Victorian black spot program were analysed to estimate benefits and costs over the life of each treatment. Treatments that returned benefit cost ratios exceeding 1.0 at 95 per cent confidence levels, are listed in Table 2.

Table 2: Estimated benefit:cost ratios returned by the TAC black spot program.

Treatment	TAC program in Victoria, 1992-1996, Benefit:cost ratio		
	Point	Lower CL	Upper CL
WHOLE PROGRAM:	4.1 5.8	3.3 4.6	4.8 6.8
TYPE OF TREATMENT			
1. Intersection treatments	5.3	3.8	6.6
2. Pedestrian facilities*	1.9	-9.6	7.8
3. Route treatments	5.8	4.3	7.2
4. Treat road features*	7.9	-7.4	20.3
TREATMENTS			
Roundabout	5.2	4.1	5.8
Signal remodel – fully controlled right turn	12.6	5.6	17.7
Other intersection improvements	8.9	2.7	13.6
Pavement re-sealing (route)	18.3	1.9	24.4
Roadway delineation	32.8	21.7	42.5
Shoulder sealing	4.3	2.7	5.7

NOTE: * indicates that benefit cost ratios were not significantly above 1.0. Other changes were significant; the two sets of ratios for the whole program respectively include and exclude the 7 high-cost non-safety treatments.

Excluding the non-safety treatments, the total program yielded a benefit:cost ratio between 4.6 and 6.8, due particularly to the effectiveness of its intersection and route treatments. Specific treatments provided even more positive results, although the confidence levels were usually considerably wider.

3.4. The need to qualify the relative crash-reduction and economic comparisons

It needs to be stressed that the above comparisons need to be treated as indicative only. To repeat a previous point, specific measurements are likely to be influenced by at least the following considerations:

- the criteria used for selecting sites
- the severity of the initial problem, reflected in ‘before’ crash levels
- individual site circumstances
- the suitability of the treatments selected and the completeness of implementation
- the balance and number of treatments implemented
- the duration of the post-treatment periods used for collecting ‘after’ crash data.

Further, it is likely that, as successive black spot programs are implemented, there will be some diminution in the benefits as increasingly difficult sites and/or sites with lower 'before' crash levels find their way into the programs.

It needs also to be recognised that some individual treatments failed to show significant reductions in either study and were not included in Table 1 (examples included school-crossing warning signs and street lighting). These treatments may have failed to produce statistically significant benefits for a number of reasons, and in different circumstances may prove to be better performed.

3.5 New directions for improving roads

Specific treatments within black spot programs, or as part of more general road improvement programs, have resulted in road safety improvements throughout Australasia. At the same time, emerging priorities in this area will require road and traffic engineers to take more explicit account of:

- the limitations of humans in being able to survive the violent forces experienced in many road crashes
- the changing but still limited capability of vehicles to protect occupants in the event of crashes
- the inherent crashworthiness of the road infrastructure
- most importantly, the role of speed in crash and injury risk.

It is expected that, in the future, intrinsically safer road infrastructure will be created through attention to the overall crashworthiness of the system – be it through infrastructure design, systems operation or both. Well-designed barrier systems on high-speed roads represent one specific and current example of improved infrastructure design, enabling the separation of traffic moving in opposing directions and the prevention of impacts with roadside trees and poles.

4. Political, social and other factors

Formal road design standards exist to promote effective, efficient and safe movement on road networks. These standards need to address multiple objectives, including:

- providing adequate access and mobility
- ensuring that the system has adequate safety standards
- ensuring that the system does not have undue environmental impact
- efficiently moving people and goods to maximise society's economic performance.

In balancing these various objectives, safety standards are frequently compromised to ensure that, in particular, high standards of mobility and accessibility are met. To state it more abruptly, fatalities and serious injuries are often implicitly regarded as an inevitable price to be paid for mobility. Consider for example the title of the following presentation: "Why the road toll is no accident – we have designed it so".[7]

There is often a reluctance by engineers to implement safety changes that may compromise mobility, particularly if the road is in full compliance with existing design standards. However, the major difficulty in implementing safety improvements is undoubtedly due to financial considerations – and hence the importance of road safety auditing at the planning and design stages as a cost-saving measure.

Customarily, road treatments in a black spot program have been required to promise at least a 2:1 benefit:cost ratio. However, society's willingness to invest in safety-driven road improvements is ultimately a value judgement rather than an economic decision. Sweden's Vision Zero, for example, maintains that it is unethical to consider human life and health as tradeable: the system must place priority on preventing death and serious injury ahead of all other considerations, even if this entails radical changes to the current road and traffic system.[8]

5. Conclusions

Over the last 20 or so years in Australasia, there has been a growing awareness of the importance of the road infrastructure in determining safety outcomes. The existing road engineering standards are no longer entrusted to deliver the required levels of safety and, increasingly, targeted black spot programs are being implemented.

Accident black spot programs involve a systematic identification of high crash locations across the road network, followed by targeted engineering treatment of hazardous locations. Evaluations have consistently shown that these programs reduce casualty crashes by in the order of one quarter to one third, and that these gains are typically accompanied by reductions in the severity of injuries sustained when crashes do occur. Economic evaluations have shown that positive benefit:cost ratios (typically five to eight times the initial investment costs) are returned.

It also needs to be recognised that black spot programs, however effective, are essentially reactive: sites are selected for treatment only after experiencing high numbers of fatalities and serious injuries. Arguably, future improvements to the road network will be best achieved through a number of strategies, at least some of which need to be preventive – with high quality road safety auditing being foremost amongst these strategies.

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ROAD SAFETY IMPACT OF ROAD SAFETY AUDITS

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1. A brief statement of the issue

The road safety audit process is designed to pro-actively improve road safety through formal independent review of road and traffic plans, and through inspection of new and existing roads and traffic operation plans. Increasingly in recent years, road authorities in Australasia have recognised road safety audits as an effective means of either preventing crashes or reducing their severity.

2. An assessment of the road safety issue

2.1. What are road safety audits?

A road safety audit may be defined thus:

> A road safety audit is a formal examination of a future road or traffic project or an existing road, in which an independent, qualified team reports on the project's crash potential and safety performance (p. 9).[1]

There are several key factors in this definition:

- auditing is a formal process and not an informal check
- auditing is conducted by someone independent of the road designer and builder
- auditing is possible during design and also following construction of the road
- auditing is restricted to road safety considerations.

Checklists are used to underpin any assessment of accident potential and safety performance. The structure and content of audit checklists may vary from jurisdiction to jurisdiction, and from task to task. Six checklists are recommended by Austroads for use in Australia, for example, mainly to be used at various stages during road design and construction.

Road safety audits may be conducted from the perspective of different key road user groups (e.g. older people, pedestrians, cyclists).

2.2. The benefits of road safety audits

As road safety audits have developed in Australasia and overseas over the past decade, the process has been subject to monitoring and review. However, until recently there has been no evaluation of their expected safety benefits in Australasia. As safety practitioners seek to minimise road trauma, it is important to know what 'value for money' road safety audits can deliver. In order to identify and measure the benefits achieved by road safety audits in Australia, Austroads commissioned ARRB Transport Research to undertake a major investigation to determine their economic value.[2]

In evaluating the proposed actions emanating from road safety audits, a significant level of estimation has been required to predict the crash savings accrued. Individual audits also vary considerably in the number and crash cost reduction potential of the issues that are identified. As a result, the valuation of benefits identified in this project should be considered indicative and not definitive.

The evaluation of recommendations emanating from **design stage audits**, resulted in the following findings[2]:

- Of the nine design stage audits assessed, the overall benefit cost ratio (BCR) of implementing the recommendations from individual audits ranged from 3:1 to 242:1.
- Individual recommendations within the design audits exhibited BCRs between 0.06:1 and 2,600:1.
- This analysis indicates a wide range in BCRs for individual recommendations and considerable variation between design stage audits investigated.
- The high variance of audit results may be expected, with the outcome highly dependent on the number and type of deficiencies identified and the cost of associated recommendations in each audit.
- Over 90 per cent of all implemented recommendations had BCRs exceeding 1.0.
- Around 75 per cent of all implemented recommendations had BCRs exceeding 10.
- The majority of design audit findings required only very low-cost responses (65 per cent of recommendations had a cost of less than $1,000). Of these low-cost responses 85 per cent had BCRs exceeding 10.

The evaluation of the proposed actions emanating from **existing road audits** resulted in the following findings[2]:

- The analysis of a range of existing road safety audits indicated BCRs between 2.4:1 and 84:1, when considering the value of completing the proposed actions.
- The BCRs of individual proposed actions within the existing road audits ranged between 0.003:1 and 460:1.
- The analysis also indicated a wide range of potential safety benefits within an individual audit and between different audits. This result may again be expected with the deficiencies identified (and subsequent actions) specific to individual locations.
- Over 78 per cent of all proposed actions had BCRs exceeding 1.0.
- Approximately 47 per cent of all proposed actions had BCRs exceeding 5.0.
- Over 50 per cent of all proposed actions had a cost of less than $5,000. Eighty-seven per cent of these actions had BCRs exceeding 1.

The completion of design and existing road safety audits will also result in other qualitative benefits, including:

- identification of improved design, construction and maintenance standards that influence safety performance on an ongoing basis across the road network generally
- the role the audit plays in improving the general road safety awareness of operational staff
- the role the audit plays in providing the designer/asset owner with confidence in the safety performance of the proposed project or road network.

An audit with no deficiencies identified will still retain significant value in providing an assurance of safety.

3. Current practices in Australasian jurisdictions

Road safety audits have been implemented differently by each road authority.

- In New Zealand, Transit New Zealand requires audits for at least 20 per cent of new state highway projects annually. Despite the absence of formal requirements, a growing proportion of local authorities also undertake audits. Transfund undertakes high-level audits of the safety performance of the existing road network in Transit NZ regions and for local authority areas.
- Queensland (Queensland Department of Main Roads) has recently drafted a Road Safety Audit Selection Matrix. In summary, new projects exceeding $5 million are required to be audited at all stages. For projects of less than $5 million, audits are required at Stages 2 to 5. Traffic management, crash remedial and development projects all need to be audited at the detailed design and pre-opening stages. For existing roads, broad network-level safety audits are required in each District every five years, with patterns and priority areas identified and detailed audits undertaken and responded to, as needed.
- Transport SA has a corporate procedure and operational instruction relating to road safety audits, including a requirement for Project Managers to assess the number of audits required during a project as part of a risk management process. An audit at the detailed design stage is required for any project with changes in road alignment or the erection/alteration of roadside structures. For complex projects involving high volumes of traffic, audits are required at least twice during the project cycle. Network audits have been undertaken on all sealed Transport SA roads.
- In Victoria, VicRoads is required to conduct road safety audits at all stages for projects exceeding $5 million and at a minimum of one stage for 20 per cent of all other projects. In addition, existing route audits are required to be undertaken on the worst 30 per cent of the declared network, as part of the Road safety investigations program conducted by VicRoads.
- In New South Wales, the Road Transport Authority has a policy which sets out minimum requirements for road safety audits on road construction and reconstruction projects. Road safety audits of selected stages are required for various work types when project costs exceed the minimum level specified in the policy. For example, detailed design and pre-opening road safety audits are mandatory for road constructions and re-constructions of over $2 million. Additional audits are also undertaken at various stages of each project.
- Main Roads Western Australia generally requires that audits are conducted for all projects exceeding $100,000, for all new roads, at fatal crash sites (where warranted), at hazardous locations (being the worst 10 per cent by crash/injury type), and on 10 per cent of the existing road network.
- The Department of Infrastructure Energy and Resources (Tasmania) undertakes road safety audits on the designs of all major projects and blackspot projects. Audits on existing roads are now limited, with the main emphasis being to complete works recommended by earlier audits.
- The ACT (Department of Urban Services) does not currently have a formal policy regarding road safety audits but this is expected to change in the near future.
- The Northern Territory Department of Transport and Works has adopted the road safety auditing process in an informal manner. Currently, the Department is in the process of implementing road safety audits as part of its policies and practices.

4. A review of the research

A review of the available literature supports the Macaulay and McInerney[2] finding that road safety audits are, in most instances, cost effective. While a number of reports quote various qualitative benefits such as safer roads, better design practice and reduced whole-of-life project costs, only four studies were identified where the economic benefits of road safety audits have been quantified:

- Surrey County Council in the UK[3] undertook a study of 19 audited and 19 non-audited traffic schemes. Comparisons were made between the casualty crash reductions achieved as a result of the projects. For sites with audited schemes, the average number of casualties dropped by 1.25 per year (from 2.08 to 0.83) while the change in casualty crashes at the unaudited sites dropped by only 0.26 per year (from 2.60 to 2.34).
- The UK Highways Administration commissioned a study of 22 trunk road projects audited at the design stage. The evaluation consisted of comparing the costs of implementing safety recommendations made by the audit at the design stage, with the costs of making changes after the project was constructed. In effect, it investigated the potential disbenefits of not auditing a project, rather than the benefits of auditing a project. It was assumed that the cost of incorporating audit recommendations into the design was minimal, and they were excluded in the analysis of costs. The cost benefit calculated for the evaluation was the cost of implementation of works after the completion of the project (not allowing for traffic management costs), less the cost of conducting the audit. For the 22 audits, the total cost of the audits was £45,785 (A$115,000) and the total estimated cost of implementing works after project completion was £296,000 (A$740,000), giving a total estimated saving of £250,215 (A$625,000) or an average saving of £11,373 (A$28,000).
- In Denmark, a study was undertaken on 13 projects using crash prediction methods to estimate expected crash rates if road safety audit recommendations had not been implemented at the design stage. The results of the analysis showed that the total costs and estimated casualty savings for the 13 projects gave a first-year rate of return of 146 per cent. The rate varied considerably from one audit to another, but in all cases was above 105 per cent. Schelling[4] considered that the crash reduction might have been slightly over-estimated but that, even with a variation factor of two, the first-year rate of return would still be 137 per cent.
- A study in Jordan[5] focused on investigating newly-constructed sites with demonstrated crash problems. The study considered the potential benefits if the sites had been audited, assuming the audit would have identified the underlying safety problem and the changes made at the design stage. Based on these assumptions, the first-year rate of return of conducting design stage audits was estimated to be 120 per cent.

5. Political, social and other factors

The costs of responding to audit recommendations at the design stage are relatively modest: at least some of the changes require no more than altering a pencil line on a plan, compared to changing lengths of concrete or asphalt on the road. Further, the solution to a safety problem is more likely to be complete if tackled at the design stage, whereas post-construction solutions often need to be compromised by other factors. For economic as well as humanitarian reasons, therefore, road safety audits place the greatest emphasis upon ‘getting it right’ before, rather than after, road construction.

Because road safety audits at any stage aim to deliver positive safety benefits in a pro-active manner (as distinct from blackspot programs, for example, which are essentially reactive), the community is spared the personal trauma associated with road crashes by early identification and correction of safety problems.

To ensure that the limited monies spent on addressing safety issues identified through the road safety audit process deliver optimal safety benefits, it will be necessary to ensure that deficiencies to be corrected are prioritised so as to maximise crash risk.

6. Conclusions

Road safety audits represent a major, cost-effective engineering tool in preventing road trauma.

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MAXIMISING THE ROAD SAFETY IMPACT OF ADVERTISING

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30 June 2003

1. A brief statement of the issue

All jurisdictions have a longstanding involvement in public education (mass advertising) as a road safety countermeasure, and are frequently called upon to increase their involvement in response to emerging road safety issues. The effectiveness of advertising as a road safety countermeasure remains problematic, however.

The purpose of this paper is to draw together the available evidence about the effectiveness of mass advertising, particularly in reducing crash rates. It also deals with the following sub-issues:

- road safety issues amenable to advertising effort
- issues considered to be beyond the influence of advertising
- characteristics of an effective advertising campaign
- the additional support needed for effective advertising campaigns
- the means to evaluate the impact of advertising.

2. Current policies and practices in Australasian jurisdictions

In Australia and New Zealand, paid advertising is widely used as a component of road safety campaigns, particularly when attempting to reduce illegal behaviours such as drink driving, speeding and non-use of seat belts. A review found that these were also common themes of 265 evaluated road safety campaigns.[1]

Most of the mass-media budget for road safety advertising is spent on television, with other media in a supporting role. There is relatively greater use of radio and billboards for fatigue campaigns, however.

The responsibility for road safety advertising differs among the jurisdictions. In some, the road authority assumes the major responsibility for funding and implementation, in others the injury insurer has this responsibility (as in Victoria) and, in others, funding responsibilities are shared between the road authority and the injury insurer (as in New South Wales). The Australian Transport Safety Bureau (as the former Federal Office of Road Safety) has previously conducted national campaigns, often but not always related to rural road safety issues.

Road safety advertising campaigns have been regularly conducted and evaluated in all Australasian jurisdictions in the past. Arguably the Victorian Transport Accident Commission (TAC) has been the largest spender, having conducted over 60 separate campaigns since 1989, targeting speeding, drink driving, fatigue and the vulnerability of young/novice drivers – with other issues including seat belt wearing, pedestrians, motorcyclists and older driver safety. As is the case for many other jurisdictions' campaigns, TAC's advertising programs have included a strong evaluation strand, measuring program effectiveness in terms of both audience response and road trauma reduction.

3. A review of the research

Mass-media advertising campaigns require substantial resources that could otherwise be used for other road safety initiatives. Therefore it is crucial to know the extent to which they are effective and/or how they can be made more effective. Unfortunately, few programs are adequately evaluated[1,2,3,4] and when evaluated, the results are not always accessible for research.[1]

Advertising campaigns can aim to increase knowledge and/or awareness, change attitudes and/or change behaviour. To be meaningful, evaluations need to relate to the campaigns' stated aims. Many evaluations, even of campaigns that ostensibly aim to change behaviour, only measure audience response measures such as recall of the advertisement and its message. As well as relating to the stated aims, evaluations also need to assess road trauma reductions if benefit:cost ratios are to be calculated to allow comparisons with other road safety initiatives.

Most campaigns are more successful in conveying information and changing attitudes than in altering behaviour.[3,5] Campaigns that are undertaken in support of an enforcement program generally have a larger influence on behaviour than those which do not.[1,2,6]

It has been noted that, while education by itself has not generally resulted in significant changes in the behaviours targeted, education of the public and advocacy groups has often helped to enact necessary legislation, transmit knowledge about the provisions and penalties of laws in ways that increase their deterrent effect, and generate public support for law enforcement programs.[3]

3.1. Effects on crash rates

An early study presented a meta-analysis of 157 effect measures from 87 campaigns (mainly in English-speaking countries) over about 20 years.[2] The mean effect size across all campaign measures (awareness, knowledge, behaviour change etc.) was 7.6 per cent. This fell to 6.1 per cent when awareness improvements were excluded. The average effect was greater for awareness than attitudes and least for behavioural intentions.

In an international review of evaluated road safety media campaigns, it was reported that 31 international studies gave an average 8.5 per cent reduction in accidents during the campaign period and 12 international studies gave an average 14.8 per cent reduction measured after the campaign[1]. However, they stressed that these results should be attributed to all components of the road safety campaign (including any enforcement and legislation aspects) and not only to the media campaign itself. Larger effects were found for small campaigns on a local scale and in cities, compared with provincial and national campaigns.

The meta-analysis also indicated larger accident reductions for speed campaigns than for alcohol campaigns (16.9 per cent versus 6.9 per cent). However, this may reflect the finding that larger effects were observed when the baseline level of accidents was higher (a finding also reported elsewhere[2]). Further, larger percentage reductions may be expected in Australia – "the Australian evaluations are associated with very special long-term campaigns… Such campaigns are hardly typical of the campaigns in most European countries and the United States" (p.88).[1]

A series of analyses has been conducted considering the effects of different road safety initiatives, including TAC advertising, on casualty crashes in Victoria.[6] One study found that, for both drink driving and speeding, the number of casualty crashes reduced as a function of the monthly levels of TAC advertising related to those behaviours.[6]

Table 1 quantifies the contribution of the major factors influencing road trauma trends in Victoria, 1989-96. Speed and concentration publicity contributed five to seven per cent of the 26-41 per cent reduction in serious casualty crashes from 1989. The combination of drink-driving enforcement and publicity (which could not be separated) contributed nine to ten per cent to the reduction in serious casualty crashes.

Table 1. Estimated reductions in serious casualty crashes attributable to various sources, Victoria, 1990-96[7].

	Victorian road toll reductions (per cent)						
	1990	1991	1992	1993	1994	1995	1996
Contribution of speed camera traffic infringement notices	10	11	11	11	11	11	11
Contribution of speed and concentration publicity	5	7	7	7	6	7	6
Contribution of drink-driving program	9	9	10	10	10	10	10
Contribution of above road safety programs (1)	22	25	25	25	25	25	25
Contribution of increased unemployment	2	12	15	16	14	10	10
Contribution of reduced alcohol sales	3	6	7	9	8	9	10
Contribution of Accident Blackspot treatments	2	2	3	5	-	-	-
Reduction in serious casualty crashes from 1989	26	38	41	43	41	39	40

The analyses undertaken by Cameron and his colleagues in their series of studies[6,7,9] employed sophisticated mathematical modelling techniques. These techniques were needed to disentangle the effects of other concurrent initiatives and other changes that could also have affected casualty crashes. However, the resultant complexity means that the analyses are not straightforward, and some other researchers have questioned the appropriateness of the models used and conclusions drawn.[8,9]

3.2. Characteristics of effective campaigns

A meta-analysis of largely United States research concluded that more effective highway safety campaigns[3]:

- use multiple media
- combine mass media with community, small group, and individual activities, supported by an existing community structure
- carefully target or segment the audience that the campaign is intended to reach
- involve repetition of a single message
- emphasise the negative consequences of current behaviour, if aiming at developing preventative behaviour (arousing fear has been moderately successful in this regard, if coupled with mechanisms for reducing the anxiety that is created)
- emphasise current rewards rather than the avoidance of distant negative consequences
- involve in their design and operation, key power figures and groups in mass media organisations, in government and non-governmental bodies
- are timed appropriately (when introduced, what else is happening at the time, etc)

- use formative evaluation techniques to appraise and improve the campaigns during planning and while they are in operation
- set fairly modest, attainable goals in terms of behavioural change
- use commercial marketing and social marketing strategies
- use educational measures in entertainment contexts
- address the larger social-structural and environmental factors impinging on highway safety problems that the campaigns are attempting to counter
- are coordinated with direct service delivery components (e.g. hotline numbers for information or counselling), so that immediate follow-through can take place if behaviour change begins to occur
- segment the campaign audience by psychographic variables based on attitudes, values and beliefs, rather than demographics
- direct messages also to people linked to targeted individuals (e.g. peers and parents)
- choose their positive role models for social learning carefully, as these individuals may become negative role models through their personal actions (e.g. be found to drink drive)
- involve other campaign activities, rather than public service announcements alone
- use the news media as a means of increasing the prominence of the issue and message
- go in tandem with an aggressive enforcement strategy
- address the existing knowledge and beliefs of target audiences that are impeding adoption of desired behaviours
- communicate incentives or benefits for adopting desired behaviours that build on the existing motives, needs and values of target audiences
- focus target audiences' attention on immediate, high-probability consequences of safe driving behaviours
- use pre-testing to ensure that campaign messages have the expected effects on target audiences.

3.3. Role of medium, content and budget

3.3.1. Choice of medium

For a road safety advertising campaign to be effective, the type of medium should be matched to the duration of the required or expected effect. Television and brochures are suitable for long and intermediate term effects but not for immediate effects. For immediate effects, radio or billboard advertising seem to be the preferred options. Radio and billboards offer the opportunity to engage in the appropriate behaviour immediately, e.g. by moderating their speed or stopping to have a rest break. It has been claimed that "for seat-belt use, radio and billboards appear to serve the same saliency and reminder function as aisle displays for products in supermarkets" (p.50).[3]

3.3.2. Message content and production budget

Most road safety advertising in Australia and New Zealand uses threat appeals, where "non-compliance with the desired road behaviours is shown to result in or increase the likelihood of negative consequences occurring, or where compliance with the desired road behaviours averts or minimises the likelihood of negative consequences".[5] It has been noted that very few road safety advertisements use incentive appeals that depict positive consequences resulting from compliance with safe road behaviours.[5]

In a review of road safety and public health advertising, it was concluded that the effectiveness of different message contents would vary in response to the target audience, but that there was little evidence regarding the different executional approaches given the same message content.[10] However, it has been noted that the confounding of message content and executional factors (largely production budget) is a problem inherent in studies using real-world advertisements.[5]

The findings that the *level* of TAC advertising was related to the level of reduction in road trauma[5] have been (mis)interpreted as evidence that the *content* was effective.[11] It has been speculated that less costly advertisements might have produced a similar level of reduction in road trauma, if supported by the media budgets and levels of enforcement activities typical of Victoria.[4] Some research attempts notwithstanding, this issue remains open.

3.3.3. Amount of advertising

The amount of advertising exposure (or media weight or Target Audience Ratings Points) is a measure of the "dose" of an advertising campaign. It is likely that there is a minimum amount of exposure necessary to have some effect, but there is little clear information about what that dose should be. The work of Cameron and his colleagues[6] suggests that the crash reductions associated with advertising-plus-enforcement increase with the "dose", but many campaigns are currently conducted at far lower levels than those that were analysed by these authors. It may be that lower amounts of advertising are adequate to increase knowledge and awareness, with higher doses required to change attitudes or behaviour, but this has not yet been satisfactorily determined.

3.4. Whether all road safety issues are amenable to influence by advertising

Whether a given road safety issue is amenable to influence by advertising effort depends in part upon the aim of the advertising – whether to increase knowledge, change attitudes or change behaviour. For most road safety issues, well-designed and implemented advertising should be successful in increasing awareness or knowledge of that issue in a relatively short period of time. Depending on how firmly current attitudes are held, advertising should be able to change attitudes of at least some members of the community in the longer-term. Road safety issues involving behaviours for which enforcement of compliance is possible, are likely to benefit more from road safety advertising (combined with enforcement) than behaviours for which enforcement of compliance is not possible (e.g. fatigue or inattention.)[6]

3.5. Additional support needed for effective advertising campaigns

A United States review[3] identified the following types of support that make advertising campaigns more effective:

- combination with community, small group and individual activities, supported by an existing community structure
- coordination with direct service delivery components (e.g. hotline numbers for information or counselling), so that immediate follow-through can take place if behaviour change begins to occur

- involvement of other campaign activities, rather than public service announcements alone
- use of the news media as a means of increasing the prominence given to the issue
- partnership with an aggressive enforcement strategy.

In addition, websites are increasingly being used to provide supporting material, particularly for advertising campaigns that attempt to increase knowledge or public awareness.

Enforcement is an important support for advertising campaigns and, reciprocally, advertising can support enforcement activities. One school of thought maintains that mass-media support works primarily through increasing the perceived risk of detection and punishment. Another school of thought maintains that advertising produces behaviour change by changing beliefs and attitudes regarding the morality or social norms relating to the undesired behaviour.[10,12,13] It should be noted that, while linking road safety advertising with enforcement has mutual benefits, it makes it more difficult to separate the effects of advertising and enforcement.

It is common for jurisdictions to sponsor sporting, recreational and cultural organizations and activities to reinforce their advertising programs and key messages. The following statement from Victoria's TAC summarises this strategy: "sponsorship helps make key road safety and behavioural messages more highly visible and relevant in many areas of the community's social, sporting and cultural life" (p.4).[14]

4. Political, social and other factors

Institutional responsibilities within a jurisdiction may influence which agency has responsibility for road safety advertising, the extent of resources expended on this form of road safety initiative, and the types of road safety issues targeted.

Road safety advertising is presented within the context of other advertising that may contradict road safety messages (including car advertising promoting speed). There is concern about the extent to which these contradictory messages may be reducing the effectiveness of road safety advertising, but no empirical evidence has been collected.

The ability to practise the road safety behaviours promoted by advertising may be restricted by characteristics of the individual or of their community. For example, advertising to decrease drink driving may not be as effective in rural areas if there are no other transport alternatives to driving. Similarly, the success of educational programs to reduce driver fatigue is likely to be constrained by the limited ability of fatigued drivers to judge the level of risk at which they are operating and the incentives for (particularly professional) drivers to continue driving.[15] The same constraints may apply to campaigns to reduce speeding, when drivers are speeding as part of work-related driving. In order to maximise their effectiveness, advertising campaigns need to address and acknowledge the broader social framework within which they are to be implemented.

5. Conclusions

It is important to maximise the effectiveness of mass-media advertising campaigns because they are expensive and can take resources away from other road safety initiatives. Unfortunately, many evaluations only measure audience response and therefore do not allow benefit:cost ratios to be calculated and compared with those of other road safety initiatives. Most campaigns are more successful in conveying information and changing attitudes than in altering behaviour, with enforcement support being associated with larger behaviour changes. Education of the public and advocacy groups can help to enact necessary legislation, transmit knowledge about the provisions and penalties of laws in ways that increase their deterrent effect, and generate public support for law enforcement programs (provided enforcement is ongoing).

An international review of road safety media campaigns found average crash reductions of between eight per cent and 14 per cent, but these effects related to the campaign as a whole (including enforcement, where used), rather than the media campaign alone. Generally, measured crash reductions are smaller than measured improvements in awareness and attitudes.

The effects of threat appeal, production budget and media budget are difficult to separate in the Australian context. There is, however, a need for road safety advertising to be able to stand out from the background of programming and other, sometimes conflicting, messages.

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ROAD SAFETY IMPLICATIONS OF EXCESSIVE AND INAPPROPRIATE VEHICLE SPEED

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30 June 2003

1. A brief statement of the issue

Although the association between speed and crash risk is well established, jurisdictions are regularly called upon to defend policies aimed at producing lower travelling speeds. The purpose of this paper is to explain in detail the speed/crash association, including quantification of the relationship, and to present evidence that lower speeds result in lower numbers of deaths from road crashes. The primary reference covering these issues is that of Patterson et al.[1]

2. An assessment of the road safety problem

2.1. Definitions of excessive and inappropriate speed

"Excessive speed" refers to instances when vehicles travel in excess of the legally-declared speed limit. "Inappropriate speed" refers to instances when vehicles travel at speeds which are unsuitable for the road and traffic conditions prevailing at the time. As the European Transport Safety Council noted in its 1995 report: "the distinction is important because a speed limit…declares [only] higher speeds to be illegal, and it remains for each driver to decide what speed, within the limit, is appropriate".[2]

2.2. Mechanisms underlying the speed/crash relationship

The faster one travels on a road, the more likely one is to crash. This is because, the higher the travel speed:

- the more likely that the driver will lose control of the vehicle (e.g. by exceeding the critical speed on a curve)
- the more likely that the driver will miss important hazard cues
- the greater the distance that the driver will travel before applying the brakes in response to a hazard
- the greater the distance that the vehicle will travel, once the brakes are applied
- the greater the chance that other road users will misjudge the vehicle's speed and thus precipitate a crash.

The severity of injuries resulting from a crash is also directly related to the pre-crash speed of the vehicle. When a vehicle crashes, it undergoes a rapid change of speed. The occupants, however, keep moving at the pre-crash speed until stopped, either by being thrown from the vehicle and hitting an external object, by hitting the vehicle interior, or by being restrained by a safety belt or airbag. All else being equal, the higher the pre-crash speed, the greater the rate at which the human body must absorb the energy released in the crash and the greater the severity of the resulting injury.

2.3. Speeding as a factor in road trauma

The speed at which we drive on our roads is a major public safety and health issue, although the precise causal role of speed in road crashes is difficult to determine. For example, in New Zealand 126 deaths and 2,339 reported injuries on the road were attributed to speeding in the year 2002, based on police judgements. These numbers represented 31 per cent of all fatalities and 17 per cent of all serious injuries for that year. However, these levels are likely to understate the full impact of speed on crashes and crash severity, given that speed contributes to the severity of crash outcomes regardless of the cause.

However, as a broad estimate, if the average speed on New Zealand's rural roads was reduced by just 4 km/h, the total number of road crash deaths would decrease by about 15 per cent and the total number injured by about eight per cent – meaning that about 45 deaths and 480 reported injuries would be saved. Applying the same scenario to the Australian situation, each year around 255 deaths and 1,760 serious injuries (hospitalisations) would be saved (the difference between the fatal and serious injury proportions reflects the greater impact of any speed reduction on the most severe injuries).

3. A review of the research

3.1. The relationship between vehicle speed and crash risk

The speed/crash relationship has been demonstrated in the following studies.

- Between 1987 and 1988, 40 states in the United States of America raised the speed limit on interstate highways from 55mph (88 km/h) to 65 miles/hour (104 km/h). This resulted in an increase in average car speeds of about 3 miles/hour (5 km/h). Over the same period there was an increase in deaths on these roads of between 20 and 25 per cent.[3]
- During the 1973 fuel crisis, the New Zealand Government reduced rural speed limits from 55 miles/hour (88 km/h) to 50 miles/hour (80 km/h), leading to an 8-10 km/h reduction in average rural speeds. The drop in speed led to a significant drop in injuries, as compared with urban roads which were unaffected by the speed-limit change.[4] On main inter-city roads the number of deaths dropped by 37 per cent, serious injuries decreased by 24 per cent and minor injuries decreased by 22 per cent. The corresponding reductions for urban areas were 15 per cent, nine per cent and four per cent.
- In Australia the speed limit on Melbourne's rural and outer freeway network was increased from 100 km/h to 110 km/h in 1987 and then changed back to 100 km/h in 1989. Compared to a control area where the speed limit remained the same, the injury crash rate per kilometre travelled increased by 24.6 per cent when the speed limit increased, and decreased by 19.3 per cent when the speed limit decreased.[5]
- A review of the studies on speed-limit changes from several countries (South Africa, Belgium, Finland, France, Great Britain, Germany, USA, and New Zealand) where a speed limit was reduced or a new limit was introduced found a reduction in road crashes ranging from eight per cent to 40 per cent.[6]
- Patterson et al.[7] examined the effect of changes in speed limits on deaths on rural interstates in the USA. Road crash deaths in the groups of states that raised their speed limits to 75 miles/hour and 70 miles/hour rose by 38 per cent and 35 per cent, respectively, relative to fatality levels in the states that did not change their speed limits.

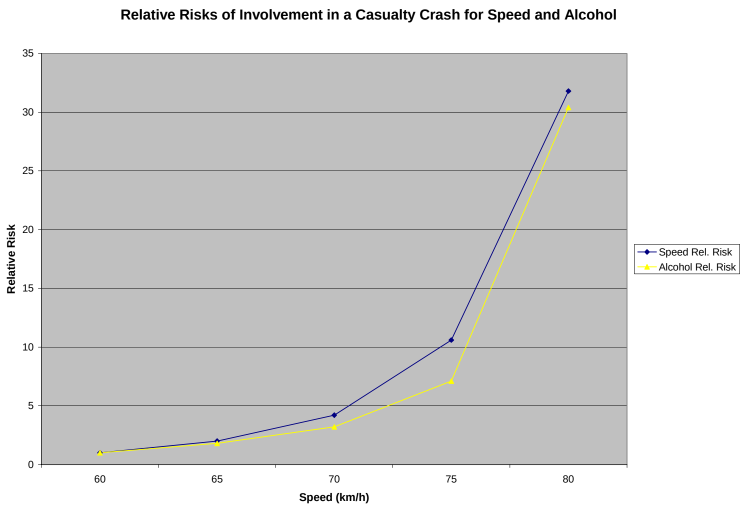
There is a consistent finding from the research that increasing the speed limit increases crash, injury, and fatality rates, and that decreasing the speed limit reduces these rates.

3.2. *Comparing speed and alcohol risks*

The role of speed in causing injury and death on our roads may be compared with the role played by alcohol. Most people understand that a driver affected by alcohol is more likely to be involved in an injury crash than a driver unaffected by alcohol. Similarly, a driver travelling at an excess or inappropriate speed is more likely to be involved in an injury crash than a driver travelling below the speed limit or at a speed that is appropriate for the conditions.

Research reported from Australia showed that, in a 60 km/h zone, there was an exponential increase in risk of casualty crash involvement with increasing travel speeds above 60 km/h, such that the risk approximately doubled with each 5 km/h increase. As shown in Figure 1, the consequent risk curve for speeding closely resembles that for drink driving.[8]

Figure 1: Relative risks of casualty crash involvement



The similarities in the two risk curves notwithstanding, alcohol and speed increase crash risk for quite different reasons:

- Alcohol-affected drivers are unable to perform multiple tasks, so they have difficulty in responding to hazards that appear in their path. They are also less risk averse and less able to withstand peer pressure. Furthermore, alcohol-affected drivers have slower reaction times, which affects both their risk of crashing and the consequences of a crash.
- Speeding means having reduced time available to detect and respond to hazards in the driving environment and also means increased stopping distances. Furthermore, if there is a small deviation in the direction of travel, the risk of leaving the road and crashing increases with increased speed. The consequences of a crash also increase with increasing speed.
- A further difference between alcohol and speed in terms of crash risk is the length of time that the increased risk exists. After a person drinks alcohol, the blood alcohol concentration remains elevated until the body is able to process the alcohol and remove it from the bloodstream (this process can take several hours). Thus, an alcohol-affected driver will present a higher crash risk over a sustained period of time – generally for the entire journey. By contrast, a speeding driver can increase the crash risk in a more transient manner. Through changing his or her speed over a journey, a driver can increase the crash risk significantly over short periods of time, and can maintain a relatively low level of risk at other times during the journey.

3.3. *The 'fourth power' and 'second power' principles*

One highly-reported piece of research comparing speeds and the risks of crash involvement was undertaken by Nilsson.[9] He combined a number of evaluations of increases and decreases in speed limits in Sweden, Denmark and the USA to validate a model for estimating the effect of changes in traffic speed on road safety.

The model used the law of physics relating to kinetic energy, such that:

kinetic energy = ½ *x* mass *x* (speed)^2

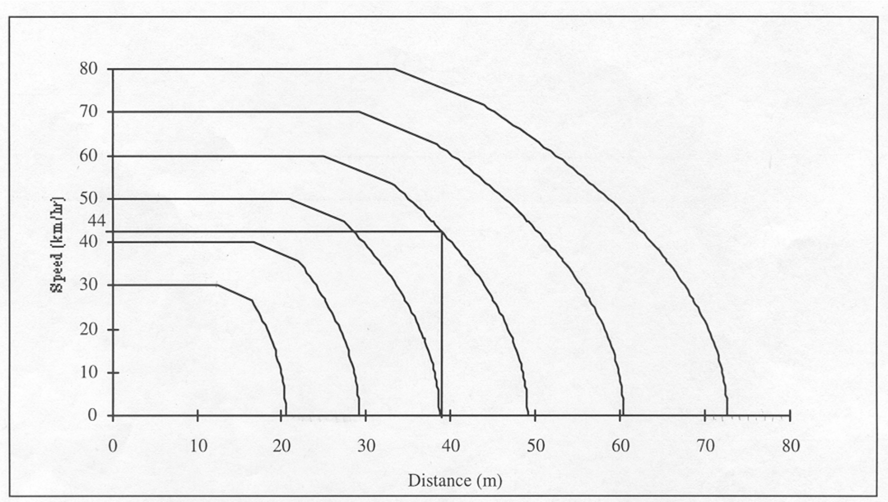
Nilsson's principles are based on the following probabilities:

- the probability of a personal injury accident in the road system reported by the police is proportional to the square of the speed (v^2)
- the probability of a fatal accident resulting from a personal injury accident is also proportional to the square of the speed (v^2), which means that the number of fatal accidents is proportional to the fourth power of the speed (v^4).[10]

The central factor in these relationships is stopping distance, which is critical in determining whether or not a crash occurs. There are two components to stopping distance – the distance travelled by the vehicle during the reaction time of the driver, and the distance travelled once the brakes are applied. The reaction time of the driver is generally the same, regardless of travelling speed – therefore, the greater the speed, the greater the distance travelled during the driver's reaction time. The stopping distance of a vehicle once the brakes are applied is roughly proportional to the square of the pre-braking speed[2], although in reality the formula is much more complicated.

Upon recognising the hazard at the faster speed, a driver will travel further before applying the brakes, and will travel further once the brakes are applied (see Figure 2).[11]

Figure 2: Speed versus distance for emergency braking from time=0



For example, assume that one car is travelling at 50 km/h and is being overtaken by a second car travelling at 60 km/h. If a child runs on to the road at a point just beyond the point at which the 50 km/h car can stop, the 60 km/h car will still be travelling at 44 km/h at the point of impact. A collision speed of 44 km/h means that a pedestrian has more than a 50 per cent probability of being killed or severely injured.

3.4. The ‘slow driver’ myth

It is sometimes claimed that drivers travelling at slow speeds have an inflated crash risk because of their proximity to the high-speed, overtaking vehicles. However, this interpretation ignores the fact that drivers involved in crashes at higher speeds are at greater risk of injury than those driving at lower speeds.

Further, slow drivers may choose to travel at a slower speed in at least some instances as a safety response – for example, older drivers may slow down to compensate for reduced vision and visual acuity or slower response times.

Another myth associated with slow driving relates to Solomon’s U-shaped curve.[12] Solomon examined the reports of 10,000 crashes that occurred on 35 sections of rural highway (a total of 600 miles) from 1955 to 1958. When deviation from mean speed was plotted against the crash involvement rate per hundred million vehicle-miles of travel, a U-shaped curve was found. That is, where speeds deviated greatly from the mean speed – either faster or slower – crash involvement rates were high relative to vehicles travelling at or near the mean speed.

The U-shaped curve has been interpreted by some to suggest that slow driving is as dangerous as speeding.

The counter to this interpretation is that the U-shaped curve is a design artefact of Solomon’s study. The highways on which the crashes occurred had a number of access points (including intersections and driveways) and were likely to experience congestion at times. The crashes at low speeds were generally due to the influence of congestion and a high number of access points, rather than to low speed. For example, 47 per cent of the low-speed daytime crashes were rear-end crashes (which are typical of congested conditions) and 38 per cent were angle crashes (which typically occur at intersections).

This problem with the interpretation of the data does not occur with the high-speed data. Solomon found, for example, that, as the speed of the crash-involved vehicles increased, particularly above 50 miles/hour (80 km/h), the number of single-vehicle crashes increased. Single-vehicle crashes typically occur at high speeds, when the driver loses control of the vehicle. Unlike many of the drivers travelling at low speeds, those travelling at high speeds are able to choose their speed of travel, as their choice of speed is not restricted by the traffic conditions. Thus, the high crash rate at speeds above the mean can be more appropriately interpreted as indicating that there is a high crash rate when drivers choose to travel at high speeds.

4. Political, social and other factors associated with the issue

4.1. Vehicle design

Modern vehicle design has created less noise, less vibration, less tilting when taking corners and more comfort. These design features tend to insulate drivers from the perception of speeding, and thereby contribute to speeding behaviour.

Vehicle safety initiatives have generally focused on reducing the severity of injuries arising from road crashes (secondary prevention), rather than on reducing the incidence of crashes through measures aimed at reducing vehicle speed (primary prevention). The advent of improved technology will in future allow for the greater use of speed-limiting devices and external controls on vehicle speeds.

4.2. The road environment

A driver's perception of the road is a critical factor in speed reduction. Roadside development tends to slow traffic down, so drivers will tend to travel faster on open rural roads and slower on built-up urban roads. Engineering measures such as speed humps, road narrowing and chicanes, as well as road markings, can help to reduce speeds.

To be effective, speed limits should be consistent with the design speed of the road and be backed up by enforcement. This, combined with the "Vision Zero" and Sustainable Safety approaches to safety management, requires less blame to be placed on the driver and a stronger focus on creating a safe travel environment in which driver errors can be better tolerated. A key strategy is to manage speed levels so that crash-impact forces do not exceed human tolerance (for more information see the paper entitled "Vision zero in road safety" in Volume 1 of the *Australasian Road Safety Handbook*). The likelihood that these approaches will become more widely adopted over time means that road environments will gradually become more forgiving in catering for the consequences of crashes, and this will eventually reduce their impact on road trauma.

4.3. Speed enforcement

Enforcement of speeding laws is based on the assumption that a driver chooses the speed at which to travel, and that the choice is made through a rational process of weighing the perceived advantages and disadvantages of exceeding the speed limit.[13] Perceived advantages may include time savings and thrill gains; perceived disadvantages may include the possibility of being caught by enforcement authorities and/or the increased chance of a crash.

The aim of enforcement is to deter some drivers from driving too quickly by increasing one of the disadvantages of speeding – the perceived likelihood of being caught. Enforcement is also used to detect and apprehend other speeding drivers for whom the increased risk of apprehension alone does not act as sufficient deterrent. Rigorous and effective enforcement thus represents a two-edged sword in the battle to reduce speeding.

Automated speed enforcement devices (e.g. speed cameras) have several advantages over traditional enforcement.[14] For example:

- They increase the probability of detection without overextending front-line police resources, since the police do not have to spend long periods of time detecting and apprehending speeders. This also means that the "enforcement pause" is eliminated – that is, the device does not need to temporarily cease operation while the speeding driver is apprehended.
- They increase road users' perceptions of the risk of getting caught, through direct observation, associated publicity and/or receiving a ticket when they were unaware they had been detected. Hence, the devices have a higher deterrence effect.
- They increase the fairness of enforcement by taking "officer discretion" out of the equation.
- They have been reported to lead to fewer disputes by motorists about their fines, thus providing a more efficient ticketing and payment process.
- They can be used in locations where patrol vehicles cannot be safely and effectively deployed.

4.4. Travel time, fuel efficiency and the environment

Reducing one's average speed from 90 to 85 km/h on a 10-km trip adds just 23 seconds to travel time.[2] Fuel efficiency starts to reduce noticeably at speeds above 90 km/h. At high speeds and acceleration, the emission of several major pollutants rises due to increased power demands on the engine. These decrements are hard to justify in terms of the time saved.

4.5. Public attitudes

When asked what factors make travelling on New Zealand roads unsafe, just over half of the respondents to an annual public attitudes survey spontaneously mentioned speeding.[15] One-fifth (21 per cent) identified speed as the main factor but, despite this recognition of speed as a major road safety issue, the speeding culture is still strong – for example, 40 per cent of male drivers and 36 per cent of female drivers say that they enjoy driving fast on the open road.

When nominating up to three crash causes, over one-half of Australians surveyed included speed (62 per cent).[16] At least one in three people (38 per cent) spontaneously mentioned speeding as the single most likely cause. This is three times the next most-often mentioned cause, which is drink driving.

The public survey results from both countries have shown a continuing and decreasing tolerance of speeding in the community over the years. However, despite this decreased tolerance, excessive and inappropriate speeds are still commonly practised in the community.

5. Conclusions

Excessive and inappropriate speed has a twofold effect on the safety of our roads – it increases the risk of involvement in an injury crash and it affects the severity of the consequences of a crash. It is essential for road safety that drivers travel at speeds which are not excessive in terms of well-set speed limits, nor inappropriate in relation to local conditions. Road and vehicle design, public education and enforcement all have a role in achieving these outcomes.

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ROAD SAFETY IMPACT OF FITTING SEAT BELTS TO SCHOOL BUSES

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30 June 2003.

1. A brief statement of the issue

The road safety benefits of fitting and using seat belts in private vehicles are well established. For many members of the public (and particularly concerned parents), it seems contradictory that children are allowed to travel in school buses, unrestrained.

2. An assessment of the road safety issue

In many countries including the US, a school bus is a specific type of vehicle with its own construction standards and patterns of use. In Australia, however, there is no exact definition, with many children carried to school in route service or transit buses used for carrying other types of passengers.[1] For the purposes of this report and in accordance with Australian Design Rule (ADR) 68/00, 'school bus' refers only to vehicles over 3.5 tonnes and used primarily, if not exclusively, for transporting students to and from school.[2]

There are two broad options for fitting seat belts to school buses:

- two-point seat belts which offer a lap belt only
- three-point seat belts which offer both a lap belt and a shoulder harness.

The latter option is strongly preferred, to the point that there is now widespread agreement that two-point seat belts do not have a meaningful safety role[1,3] and can increase rather than prevent injuries.

In Australasia, school buses over 3.5 tonnes are usually not fitted with seat belts and were not designed to have seat belts fitted. Retrospective fitting of seat belts to these buses is usually not possible for a number of reasons[4]:

- In the event of a crash, it is unlikely that the seats and flooring of many early model buses could withstand the additional loads exerted if seat belts were fitted.
- In some buses, it may be possible to strengthen the underfloor structure to allow at least two-point seat belt anchorages to be installed, albeit at considerable expense and with dubious safety outcomes.
- The optimum distance between seats equipped with seat belts needs to be approximately 85 centimetres or 35 inches. If seats are spaced closer, as is the case in many older buses, the possibility and severity of head, neck and spinal injuries are increased.

If seat belts on school buses were deemed mandatory in Australia, this could be achieved in some cases by retrofitting and in other cases through new vehicle purchases. The total cost of fitting seat belts to the current school bus fleet using both these options has been put at $697.4 million.[5] Based on the 1990-1997 road toll and Bureau of Transport Economics crash costings[6], the annual cost of deaths and serious injuries to on-board school bus passengers can be calculated to be $4.3 million.

3. Current practices in Australasian jurisdictions

Seat belts in school buses are not mandatory in any Australian jurisdiction, other than as determined by the ADRs, with ADR 68/00 defining the key provisions.[2] In summary, the rule requires that buses over 3.5 tonnes which seat more than 17 people and which have seat back heights exceeding one metre, require three-point seat belts to be fitted – provided that these buses were manufactured on or after 1 July 1995. ADR 68/00 also specifies some additional requirements for seat belt fitment, including strength of seats, seat anchorages and other occupant protection provisions.

However, very few of the buses used to transport children to and from school in Australia are directly affected by ADR 68/00.[2] In many instances, the seat backs are less than 1.0 metres, in other instances the buses are general route service vehicles and hence exempted from the requirements, in other instances the buses were manufactured before 1 July 1995.

In NZ mini-buses designed to seat up to nine people (including the driver) must be fitted with seatbelts for every seat. Elsewhere, ADR 4/01 requires light omnibuses up to 3.5 tonnes and up to twelve seats to have seat belts fitted if the vehicles were manufactured on or after 1 July 1991. If seatbelts are fitted to a mini-bus, whether or not the law requires them, the belts must be worn at all times when the vehicle is operated. However, most vehicles used as school buses are heavy vehicles and are not required to be fitted with seatbelts.

4. A review of the research

A decision on whether or not to fit seat belts to school buses rests on the following issues:

- the size of the road safety problem posed by school bus passengers
- the road safety benefits arising from widespread fitting of seat belts
- the benefits arising from other possible improvements in bus occupant safety.

4.1. Size of the road safety problem posed by school bus passengers

The crash epidemiology relating to school bus travel suggests that mandatory installation of seat belts is likely to have a very minor impact on the road toll.

Looking at school-aged children between five and 17 years and the Australian road toll over the period 1990-1997, six children were killed and 78 were seriously injured as bus passengers[2]. These numbers represent 0.04 per cent of all deaths and of all serious injuries for the period.

School bus travel is riskier than these very low passenger casualty levels might suggest. However, almost all of the risk is associated with alighting from the bus, as distinct from travelling in it. A detailed analysis of fatal crash records for the years 1992, 1994, 1996, 1997 and 1998 reveals that a total of 28 children aged between five and 17 years were killed during bus travel to and from school.[2] The deaths occurred thus:

As a pedestrian crossing the road:

- to board the bus	1
- after alighting from the bus	22

As a bus passenger:

-	alighting	2
-	within the bus/collision with another vehicle	2
-	other	1
TOTAL		**28**

In the same period five children were killed during school bus travel in NZ. Of these children, four were killed after alighting from the bus and one was within the bus at the time (note that these figures relate to dedicated school buses only).

The picture that emerges from crash data from both Australasia[2] and overseas[3] is consistent. The relatively small dangers associated with school bus travel in most cases occur only after the child has completed the bus trip and is alighting from the bus, usually on the way home.

As a general mode of travel to and from school, school buses represent the safest available option. An Australian study[2] has estimated that, relative to school bus travel, a child's risk of death or injury is:

- seven times greater, if travelling by private car
- 31 times greater, if walking
- 228 times greater, if cycling.

Any requirements imposed on school bus fleet owners that result in a reduced capacity to carry students, thereby forcing children into other travel modes, is therefore likely to have road safety disbenefits.[3]

4.2. Road safety benefits of seat belts in school buses

Notwithstanding the low death and injury rates directly associated with travelling as a passenger on a school bus, the possibility remains that fitment of seat belts may still have some safety benefits. The US National Transportation Safety Board (NTSB) has undertaken a series of studies[8] in an attempt to answer this issue. Its recommendations included:

- In large school buses, the use of lap belts would be likely to save only two of the thirteen deaths investigated and would have no net impact on injury levels, except to risk a possible increase. It therefore decided against lap seat belt requirements for large school buses, arguing that the crashworthiness of these vehicles rendered them an exceptionally safe form of transportation.
- In smaller (van-type) school buses in crashes, lap belted occupants were not at advantage relative to unrestrained occupants. However, the injury patterns sustained by front seat passengers suggested that three-point seat belts offering both a lap belt and a shoulder harness, could prevent some head and facial injuries by enabling greater torso restraint.

In both types of bus, it appeared that seating position rather than restraint status was the main determinant of injury outcome.

4.3. Other possible improvements in bus occupant safety

There may be a limited scope for seat belts that incorporate both lap and shoulder harnesses to reduce by a very small measure what is already a very small road safety issue. However, opinion is very much against seat belts on large school buses as a cost-effective countermeasure, particularly if considered against other competing options:

- An early review of school bus safety in New South Wales, while recommending against the fitment of seat belts to large buses, urged that priority be given to aspects of compartmentalisation plus pedestrian safety around buses.[1]
- The US Transport Research Board ranked nine possible school bus safety countermeasures in terms of value per dollar spent[9], with higher seat backs and pupil education programs emerging as the best-value options. The two options considered to be of least value were seat belts (lap belts only) and school monitors.

In its 2002 report to Congress[3] the National Highway Traffic Safety Administration (NHTSA) attributed the impressive record of school bus travel to requirements for compartmentalisation on large school buses and to three-point seat belts plus compartmentalisation on smaller van-type buses. Compartmentalisation centres upon strong, closely spaced seats with energy-absorbing seat backs that serve as protective envelopes around passengers, usually supplemented by improved body construction and stringent fuel system integrity requirements.

While compartmentalisation is generally regarded as the most effective countermeasure for frontal impact crashes, it offers less adequate protection for side-impact and rollover crashes. However, the latter categories of crashes are relatively rare: in Australia during the 1990s, side-impact and roll-over events accounted for only 15 per cent of all fatal crashes involving buses, whereas frontals accounted for 62 per cent of crashes.[10]

At least in regard to large buses, compartmentalisation and seat belts are regarded as mutually exclusive options.[4] To give two illustrations from the US:

- Compartmentalisation requires seat backs to bend at relatively low force levels (somewhere around 1000 pounds), thereby absorbing some of the crash forces. In contradistinction, three-point seat belts require anchorage hardware able to withstand 5000 pound forces.
- Compartmentalisation requires seat spacing at around 60 centimetres, whereas seat belts require seat spacing of around 85 centimetres if incidental injuries are to be avoided.

The extent to which this mutual exclusivity applies to Australian vehicles and standards needs further research.

NHTSA's 2002 report to Congress[3] included the results of a series of sled tests comparing two-point and three-point seat belts with compartmentalisation. The tests simulated a 30 miles/hour (approximately 50 km/h) frontal crash into a rigid barrier using dummies representing a six-year-old child, a 12-year-old child and a large high school student. Key results included:

- Compartmentalisation was effective in minimising the risk of head, chest and leg injuries, but produced high neck injury measures in half of the tests.
- Two-point belts kept dummies in their seats but produced the highest neck injury measures.
- Three-point seat belts provided the best form of occupant protection in regard to head and neck injuries, but only if worn properly. Improper wearing and any non-use produced a range of undesirable outcomes.

The report stopped short of recommending the fitment of three-point seat belts to large buses, arguing that other considerations - increased capital costs, reduced seating capacities, transfer to other less safe travel modes and the dangers of incorrect wearing - were insufficiently researched.

5. Political, social and other factors

Proponents of widespread fitting of seat belts to school buses frequently advance the following arguments:

- The life-saving and injury-reducing potential of safety belts in a moving vehicle cannot be denied. Seat belts in buses will keep children in their seats and thereby prevent them being thrown about within the vehicle or ejected from the vehicle.
- Teaching children to buckle up in motor vehicles is a sound strategy to reduce crash fatalities and injuries. Use of seat belts in school buses will reinforce the educational messages aimed at school-age youngsters and have a carryover effect.
- Proper use of seat belts will improve student behaviour on the bus, reduce driver distraction, and may thereby translate into accidents avoided.

The common counter-argument to these claims is that school buses consistently have a near-to-excellent safety record when their occupants are on board. The money required for either retrofitting seat belts or new vehicle purchases could be more effectively spent in other more problematic areas of school travel (especially pedestrian movements after alighting).

Other issues against the widespread fitting of seat belts to school buses include the likely opposition from bus fleet owners, many of whom may not be able to bear the initial costs incurred as a result of either retrofitting seat belts or purchasing a new vehicle. Widespread fitting would also be likely to result in reduced passenger capacity per bus, due to the likely ban on standing passengers and to the requirement of only two passengers per seat. Nor does providing seat belts ensure that they will be used: ensuring compliance may well prove to be a major disciplinary problem that could distract driver attention at critical times.

As a further factor to be considered, in Australia unlike other countries such as the US, many students travel to and from school by bus in general route service vehicles. A decision to make three-point seat belts mandatory in dedicated school buses but not other buses, would be difficult to defend, while a decision to make three-point seat belts mandatory in all buses could not be justified in terms of likely road safety benefits.

6. Conclusions

In the final analysis, and putting aside the considerable technical and financial issues, the telling argument against requiring seat belts on large school buses rests upon the intrinsic safety of their passengers: in other words, the number of children injured as passengers in school bus crashes each year represents a minute proportion of the total road toll. However, while the weight of opinion supports school bus safety countermeasures other than seat belts, there is widespread agreement that three-point seat belts need to remain mandatory for the smaller van-type buses.

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ROAD SAFETY IMPACT OF REHABILITATION PROGRAMS FOR TRAFFIC OFFENDERS

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30 June 2003.

1. A brief statement of the issue

The first line of punishment facing traffic offenders is usually a fine and possible loss of licence. Because these sanctions are not always effective[1], serious traffic offenders and/or recidivists may also be faced with rehabilitation options before being allowed back on the road. This chapter examines the range of rehabilitation programs in use in Australasian jurisdictions and provides a summary of the overall effectiveness of rehabilitation programs in a road safety context.

2. An assessment of the road safety issue

The published literature relating to driver rehabilitation program evaluation is largely restricted to drink-driving rehabilitation programs*. This restriction is therefore also true of this chapter.

2.1. The aim of rehabilitation programs targeting drink-driving behaviour

The evaluation evidence suggests that, while traditional sanctions (fines and loss of licence) offer the greatest overall road safety benefits, in isolation they often prove ineffective, especially for those who are alcohol dependent.[2] However, the effects of traditional sanctions can be intensified when used in combination with rehabilitation programs.[3,4]

Programs targeting drink-driving include inpatient and outpatient programs, education, psychotherapy, counselling, family therapy, relapse prevention, self-control training and contact probation[5,6], with education being the dominant intervention mode.[1] The variation in treatment approaches notwithstanding, programs have a common aim to reduce recidivism.[2,7]

2.2. The philosophy of rehabilitation programs targeting drink-driving

There are two major views underpinning the ‘processing’ of drink-drive offenders[5,8]:

- drink-driving is a criminal behaviour that requires punishment as a means to both deterrence and correction
- drink-driving is a health problem, with offenders needing formal treatment.

Increasingly, the second view has become paramount. This has seen drink-driving programs shift from a concern with reducing the individual’s drink-driving behaviours to a more strategic concern with minimising the harmful effects of alcohol on both individuals and on the wider community.[9,10,11]

[*] It is understood that VicRoads recently commissioned a review of unpublished non-drink-driving rehabilitation programs (and their evaluations) conducted in the USA. Subject to availability, the results of the review will be included in later versions of this chapter.

3. Current policies and practices in Australasian jurisdictions

In August 2002 details were sought from all Australasian transport jurisdictions regarding local driver rehabilitation programs. The details of these programs are summarised below.

Jurisdiction	Programs targeting drink drivers
Australian Capital Territory	Police run a conferencing scheme attended by the offender, family members and the victim(s) or their representatives, to allow offenders to express remorse for their actions and, so far as possible, to repair any harm caused by their offences. However, an evaluation conducted in the 1990s concluded that the scheme resulted in increases rather than reductions in drink-driving behaviour. Accordingly, this program is now rarely used; The Alcohol and Drugs Foundation of the ACT (ADFACT) runs a drink-driving rehabilitation course, consisting of group lectures and discussion.
New South Wales	No drink-driver rehabilitation programs in place.
Northern Territory	No response received.
Queensland	Two courses targeting drink-drivers are run by the Centre for Accident Research and Road Safety, Queensland University of Technology. Offenders can be sent to these courses by magistrates, on a user-pays basis (in lieu of a fine): • the “Under the Limit 1” is a 13-week course targeting convicted drink-drivers; • the “Under the Limit 2” is also a 13-week course, but it also requires drivers to have an alcohol interlock installed in their vehicle for a specified period. In addition, there may be other unofficial rehabilitation courses (e.g. defensive driving courses) to which magistrates may send traffic offenders.
South Australia	A driver intervention program that was initially developed for all novice drivers has become a *de facto* rehabilitation program for ‘L’ and ‘P’ plate offenders. This program has been running since 1994, and consists of small-group interactive workshops run by youth workers or individuals involved in the road safety, trauma or related areas.
Tasmania	The only formal program targets drivers with a provisional licence, detected drink-driving with any level of alcohol. The course has several structures (and can include a series of 2-hour workshops spread over several weeks) but most commonly consists of a half-hour presentation delivered by a road safety officer.
Victoria	Serious and recidivist drink/drug drivers are required (under the *Road Safety Act*) to attend a drug and alcohol service for assessment, education and other treatment if deemed necessary. The programs are delivered on a user-pays basis and are targeted towards individual offenders’ needs, with the key aim being to prevent recidivism.
Western Australia	No drink-driver rehabilitation programs in place.
New Zealand	Section 65 of the *Land Transport Act* 1998 provides a mechanism to encourage certain serious repeat drink-drive offenders to seek assessment and rehabilitation. Offenders qualify under these provisions if they have two drink-drive convictions within five years, one of which involves a very high blood or breath alcohol level, or a refusal to comply with the alcohol testing procedure. These offenders are disqualified indefinitely from holding or obtaining a driver licence and are ordered to attend an approved alcohol and drug assessment centre. While failure to attend the assessment centre is not in itself an offence the Director of Land Transport Safety has discretion to remove the indefinite disqualification only on the production of a satisfactory report from the assessment centre. Offenders must also serve at least two years of their indefinite disqualification and any other outstanding disqualification that may have been subsequently imposed.

4. A review of the research

4.1. Some difficulties in evaluating rehabilitation programs targeting drink-driving

There are a number of problems with comparing and combining results from different studies of program effectiveness.[9] Since many of the evaluations were conducted in the USA in different social and legal environments, the results may not be directly applicable to the Australasian context. In addition, there are problems relating to the general quality of research, differences in treatment, selection bias (e.g. how people are recruited to the programs), experimental design and outcome measures which may all impact on the findings.

Further, the evidence suggests that the speed of the system in imposing sentence, and the certainty of conviction, can both contribute to lower rates of recidivism, regardless of the intrinsic worth of any accompanying rehabilitation programs.[12]

4.2. Research results

A landmark meta-analysis published in 1995 examined the efficacy of remediation programs for drink-driving offenders.[5] While most of the 215 studies finally included in the meta-analysis were from the US, approximately thirty studies were from elsewhere, including seven from Australia and five from New Zealand. To be included, any study had to meet two principal criteria:

- subject samples had to include drink-drivers
- studies had to compare remediation groups to groups with no remediation, or had to compare two or more different forms of remediation.

The difficulties in comparing results across different studies notwithstanding, the following conclusions were reached:

- The combined results of studies 'with better methodology' suggested a robust and positive effect compared to no rehabilitation, with recidivism and alcohol-involved crashes being reduced by at least seven to nine per cent. This, despite the fact that, in practice, the control groups did receive a treatment of sorts in that they frequently experienced severe licence sanctions and on-going contact with various intervention personnel.
- The combination of rehabilitation with licensing sanctions (ranging from outright cancellation to restricted driving) appeared to be the most likely option to affect positively both alcohol-related traffic events and associated crashes (the latter presumably due to the reduction in driving).
- Combinations of psychotherapy/counselling, education and probation were more effective than single modality programs.[9] This is probably due to difficulties associated with identifying and meeting the full range of individual offenders' treatment needs[9]: multi-modal programs offering 'something for everyone' have a greater likelihood of addressing the complex needs of any diverse group.[6]

A 1997 Californian study has also looked at the effectiveness of rehabilitation, licence sanctions and jail terms in reducing drink-driving recidivism.[4] This study examined the effectiveness of three levels of outpatient alcohol education and treatment programs (targeted at first-, second-, third-(or more) time offenders) with other sanctions. The results suggested that the combination of treatment and licence suspension was associated with the lowest recidivism rate for first-time and multiple drink-drive offenders. This is consistent with previous studies.

A comprehensive Australian review of the options available for the management of drink drivers, confirmed licence actions as 'the only drink driving sanctions which have been consistently associated with reductions in community-wide drink driving behaviour'.[13] This result was attributed primarily to a reduction in exposure (either removing drink drivers from the road for specified periods or otherwise restricting their driving): the myriad factors contributing to drink driving were otherwise left largely untouched. Licence action run in combination with remedial programs – and especially multi-strategy programs – was again confirmed as an effective strategy in producing both general and alcohol-specific road safety benefits.

4.3. The way forward

It has been suggested that effective rehabilitation programs for drink-driving and other traffic offenders need to meet the following criteria.[6,14]

- referrals need to be based on thorough assessment using valid measurement tools
- the assessment results should guide the level of care and type of program
- programs should be multi-modal
- individualised treatment plans should be developed for each client
- counsellors should be trained to work with each specific group
- treatment and program goals should be clear and open to evaluation
- programs should include after-care plans and long-term follow-up.

4.4. Political, social and other factors associated with drink-driver rehabilitation

Many traffic offenders are ordered by the courts to undertake treatment. Coerced treatment raises ethical concerns, with there being more support for treatment referrals that allow at least some voluntary participation on the part of the individual.[15,16] It may also be that offenders who choose to participate in programs are more amenable to change.

In addition, coerced treatment raises questions regarding an offender's level of motivation for change.[17] It has been argued that, while some individuals may have little intrinsic motivation to attend rehabilitation programs (or change their behaviour), compulsory attendance at least ensures exposure to appropriate treatments.[18] However, it has also been argued that individuals with substance abuse problems undergo various stages in their motivation for rehabilitation or change (e.g. pre-contemplation, contemplation, preparation, action and maintenance), and that effective treatment requires appropriate targeting of treatment.[19,20]

Given the modest reductions of traffic offender rehabilitation programs, one author has raised the following questions[2]:

- how much should society spend on such programs?
- how effective are individual programs that offenders may be referred to?
- how well will the programs work with individual offenders?

These questions underscore the need for program implementation based on research and best practice, and the need for thorough program evaluation.

However, it must be noted that, although the seven to nine per cent impact of rehabilitation on drink-driving offences may seem low, it is similar to deterrent effects obtained in other areas such as licence revocation laws (six to nine per cent), graduated novice driver licensing (five to ten per cent), and seat belt use laws (six to nine per cent).[2]

5. Conclusions

Traffic rehabilitation programs offer an alternative to sanctions alone and aim to reduce recidivism of serious driving offences. Current programs in Australia and New Zealand are underpinned by a philosophy that aims to minimise the harmful effects of drugs such as alcohol on individuals and on society. Evidence suggests that well designed and conducted programs have the potential for modest reductions in the rate of alcohol-involved crashes (at least seven to nine per cent). It has been suggested that thorough assessments should be conducted to develop individualised multi-modal treatment programs based on best practice, to most effectively target the complex needs of the diverse drink-driving group.

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ROAD SAFETY IMPACT OF MEDICAL TESTING OF DRIVERS

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30 June 2003.

1. A brief statement of the issue

There are many medical conditions which can be at least intuitively associated with a decline in driving performance and thus crash risk. To this end, most countries have some form of medical assessment in place, usually as a pre-condition for either initial or renewed licensing.[1]

However, the extent to which these assessment programs are effective in identifying unsafe drivers is unknown.

2. An assessment of the road safety issue

Driving a motor vehicle is a complex task, requiring the successful integration of a range of functions including perception, attention, judgement, response time and reasonable physical endurance. Although comprehensive data linking medical conditions and crashes in Australia are unavailable, it would be reasonable to assume that medical conditions, and in some cases treatments, affecting functional capabilities (sensory, motor or cognitive functioning) would play a contributory role in crash risk.[2]

Data for New Zealand show that, between 1996 and 2000, medical-related factors were cited as contributing to 123 fatal crashes, 381 serious injury crashes and 1,208 minor injuries of drivers[3]. However, these figures are likely to underestimate the contribution of medical conditions, as it is difficult for the police to determine when a medical condition is present, and how or if this condition is related to the crash.[3]

Even if a medical condition does not directly ‘cause’ a crash, it may undermine the individual’s ability to react appropriately and effectively when faced with a hazardous situation[4]. Waller notes that, even when impairment is subclinical or minimal, the individual has less spare capacity to deal with challenges when an environmental task becomes unusually demanding.[5] He further estimates that medical conditions play a contributory role, either alone or in conjunction with other factors, in 15 to 25 per cent of all crashes.

There are therefore road safety benefits in identifying medically impaired and at-risk drivers, if the assessment process can be effectively implemented.

3. Current policies and practices in Australasian jurisdictions

While there are no uniform standards governing medical assessment as a pre-condition for licensing in Australia and New Zealand, there is some consistency across individual jurisdictions as a result of several factors.

Firstly, many jurisdictions have a self-assessment health section to be completed when renewing licences. Some individual differences notwithstanding, there is a substantial commonality in the data sought.

Secondly, the Austroads *Assessing Fitness to Drive* guidelines[2] have been recommended to all Australian jurisdictions as the basis for assessing medical fitness to drive. New Zealand has a closely related document, *Medical Aspects of Fitness to Drive*.[3]

Thirdly, the National Road Transport Commission has laid down the following administrative guidelines[6], with which all Australian jurisdictions must comply in particular:

- The holder of a driver licence must, as soon as practicable, notify the licensing authority of any permanent or long term injury or illness that may impair his or her ability to drive safely.
- Any applicant for a driver licence may be required to undergo a medical examination or attend a specified medical practitioner or allied professional practitioner for examination, or produce evidence of compliance with medical standards.

The following table outlines the different jurisdictions' policies concerning medical assessment.

Table 1: Medical assessment requirements in Australasian jurisdictions.

State	Is a medical assessment required prior to initial licensing?	Is a further medical report required during the period of licensing?	Are there additional road test requirements?
ACT	Vision test for all drivers on initial licence and on each renewal, then at ages 50, 60, 65, 70 and 75; thereafter annually.	Medical assessment for all licence classes at 75 years and annually thereafter.	No prescribed period or age.
NSW	Vision test for all drivers on initial application and on each renewal and replacement.	Medical assessment for all licence classes at 80 years of age and annually thereafter.	Annual road test required: • for all car drivers (Class C) from 85 years of age; • for drivers of motorcycles, light rigid vehicles (Classes R, LR) from 80 years of age. Road test may be required as a result of doctor's/police recommendations.
NT	Vision test for all drivers on initial application, then 5 yearly.	Medical assessment only when condition notified by Health Professional or driver.	Road test only when recommend by Health professional.
QLD	Vision test required if applicant declares a vision or eye disorder and if requested by the chief executive.	A person must obtain a current medical certificate if they have a medical or physical incapacity that may affect their driving; OR are 75 years of age or older. Currency of certificate is determined by the doctor.	Road test required only if a doctor determines a person medically fit to drive subject to passing a practical driving re–test.
SA	Vision test required yearly from 70 years of age or if declared or reported.	Medical assessment required yearly from 70 years of age for all licence holders.	Road test required annually from age 85 for licence classes other than C.
TAS	Vision test required on initial application then yearly from 75 years of age (as part of required medical assessment).	Medical assessment required yearly from 75 years of age.	Road test required yearly from 85 years of age.

State	Is a medical assessment required prior to initial licensing?	Is a further medical report required during the period of licensing?	Are there additional road test requirements?
VIC	Vision test required on initial application and subsequently if declared or reported.	No prescribed period or age, but may occur if a concern is declared or reported.	No prescribed period or age, but may occur if a concern is declared or reported.
WA	All drivers on application; then at 75, 78 and annually from 80 years of age.	At 75, 78 and annually from 80 years of age, unless medical condition requires earlier assessment.	At 85 years of age then annually.
NZ	Vision test required	When deemed necessary by GP or others. Medical Certificate (including vision test) required form those aged 75 and every second year from 80 years onwards.	When aged 80 years and every second year thereafter.

It may be seen that the onus of determining fitness to drive is most commonly placed upon the GP. However, the various guidelines notwithstanding, for most drivers determining fitness to drive remains essentially a subjective judgement.

4. A review of the research

4.1. Are medical conditions a road safety issue?

A comprehensive review of medical conditions and their possible association with crash risk, led to the conclusion that some conditions do significantly impair driving abilities and increase crash risk for at least some drivers.[7] A full listing of these 'red flag' conditions is given as an attachment to a previous Handbook paper, 'Older drivers and the greying of Australasia'.

Other recent research has also anchored home the role of medical conditions in crash involvement.[8] The state of Utah requires that, at licence renewal, each driver report whether he or she has a medical condition. During 1992-96, almost two million drivers renewed their licences, with almost 70,000 (four per cent) reporting at least one medical condition. Ninety-four per cent of drivers with a self-reported medical condition continued to hold a full, unrestricted driving licence.

Compared to control groups, fully licensed drivers with a single medical condition had significantly higher at-fault crash risk, as follows:

diabetes	relative risk = 1.46 (1.36-1.58)
pulmonary	relative risk = 1.26 (1.06-1.50)
neurological	relative risk = 2.20 (1.71-2.84)
epilepsy	relative risk = 2.02 (1.80-2.27)
learning, memory	relative risk = 3.32 (1.84-5.99)
psychiatric	relative risk = 1.85 (1.69-2.01)
alcohol and drugs	relative risk = 2.22 (1.25-3.94)
visual acuity	relative risk = 1.52 (1.38-1.68)
musculo-skeletal	relative risk = 1.84 (1.14-2.98)

The term ‘relative risk’ compares the crash risk for a driver with a given condition to the crash risk of a healthy driver. For example, a driver with epilepsy has just over double the crash risk of a healthy driver. The figures in parentheses indicate the lower and upper crash risks falling within a 95 per cent confidence range.

4.2. Is mandatory medical screening an effective countermeasure?

Most of the limited research undertaken in this area has occurred in relation to older drivers. For this population the evidence regarding the effectiveness of such screening is inconclusive.

An evaluation of mandatory older driver testing programs compared the Finnish and Swedish crash statistics for 1990.[9] Finland requires regular medical checks at age 70 for licence renewal, whereas Sweden has no age-related controls. The authors could find no evidence to conclude that Finland’s controls produced better safety than Sweden’s. However, there were considerable possible confounding factors which the study could not account for. The authors speculated that much higher older ‘unprotected road user’ (i.e. pedestrians, cyclists, mopedists) fatality rates in Finland might be due to transfer to such modes by drivers forced to retire once deemed unsuitable to drive through the medical screening process. However, fatality statistics from 2001 show that Finland has only a very slight difference in the overall death rate per 100,000 population for 80+ road users than Sweden, and has a much better rate than Sweden relative to those of its own middle-aged road users.[10] The latter situation was the reverse in 1990.

An Australian study conducted during the 1980s reached a similar conclusion. Despite having no age-based assessment program, Victoria had no worse older driver crash statistics relative to middle-aged drivers than states with established medical and/or on-road assessments.[11] An update of the study based on 1994-98 crash data found that Victorian drivers 80 years and older had lower serious casualty crash involvement relative to middle-aged drivers than drivers from all other states and, with one exception (Tasmania), the differences were statistically significant.[12]

The strongest evidence that could be found to support some form of mandatory assessment for older drivers, related to vision testing.[13] Visual examinations of over 12,000 drivers in Pennsylvania at the time of their licence renewal produced the following results:

- Individual measures of binocular static visual acuity, horizontal visual field scores and contrast sensitivity at varying spatial frequencies could not be related to increased crash involvement.
- However, combined measures covering all three variables were significantly related to increased crash involvement for drivers aged 65 years and above.

As noted by the two authors of the report, the direct causal role played by this set of visual conditions in crashes was still seriously questioned:

> *The drivers most likely to suffer (these) deficits, i.e. older persons, are also most likely to experience a variety of attentional problems; certainly the possibility exists that these diminished capabilities, rather than the (visual) deficits… offer the best explanation for the elevated risk indicated in the research for drivers aged 66-75 and 76+.* (p. 274).[13]

After weighing the limited evidence, a recent OECD Expert Group reported thus[14]:

> *Mandatory medical assessment of all drivers at a certain age to detect those who are unfit to drive, is neither cost-efficient nor beneficial. This is in part because a driver’s health does not necessarily equate to fitness to drive. When a health problem has been identified, the question of whether to continue driving depends not on a medical diagnosis but rather, on the functional consequences of the illness. And for different people, a given condition may affect fitness to drive in different ways and to different degrees.*

Notwithstanding this, some jurisdictions would argue that their medical screening is not just to detect those unfit to drive, but more to constructively pick up emergent problems with a view to maximising the chances of rehabilitation.

Whether these results pertaining to mandatory medical assessment for older drivers can be extended to mandatory medical testing as a pre-condition for licensing at younger ages, remains problematic. A search of the available literature failed to find any evidence regarding possible safety benefits arising from medical (including vision) testing immediately before, or at regular periods during, licensing.

5. Political, social and other factors

The problem of medical conditions and driver licensing is a difficult one to address. GP's are able to report drivers with identified impairments to licensing agencies, but there is often perceived ambiguity regarding patient confidentiality, patient-doctor relationships and legal liability. Ethical and legal guidelines place an extensive burden on health professionals to create a balance between a patient's rights and needs, and the safety of the community.[15]

- Individual jurisdictional legislation provides some indemnity by stating that a health professional does not incur civil or criminal liability for carrying out a test or examination and expressing to the licensing authority an opinion formed as a result of that test or examination.[6]
- Civil law in Australia also states that a health professional may be liable if a court decides that reasonable action has not been taken to ensure that impaired patients do not drive in circumstances that place the community at increased risk (further, patients who continue to drive while aware that they have a condition that impairs their ability to drive safely, may also be at risk of significant common law liability).[10]
- The ethics codes of the Australian Medical Association and the Australian Optometrical Association declare that information may be disclosed where it is necessary to protect the safety of others, or when ordered by a court.

To this end, it is suggested that health professionals should, as a bare minimum, advise patients of the risks associated with their medical conditions, and of their legal obligations pertaining to driving.[2]

However, there remain difficulties in this area. It was noted in the Utah study that it is unlawful under the Americans with Disabilities Act for any State or local government to discriminate against a qualified person with disabilities on the basis of those disabilities.[1] While this has not emerged as a problem in Australia, it would need to be considered carefully in the event of any amendments to licensing procedures for those with medical conditions or disabilities.

Further, anecdotal evidence from licensing authorities and from the medical profession suggests that many doctors are dissatisfied with their expected role in the licensing process. Legal and ethical issues aside, some doctors argue that any judgement about fitness to drive and the possible removal of a driver's licence is the business of the licensing authorities – with the maximum role that can be expected of doctors being to provide appropriate medical input.

In the meantime, while current attempts at identifying at-risk drivers through mass medical screening might lack research evidence of their effectiveness, licensing authorities still have a responsibility to continue to search for strategies for managing drivers with 'red flag'[*] medical conditions.[7] In this context, the approach recommended by the OECD Expert Group in assessing the association between a medical or health-related condition and crash risk, may well have relevance beyond just older drivers. This approach comprises the following decisions:

- determine whether the condition in each specific case has functional consequences that are relevant to driving
- if there are functional consequences, determine whether they necessarily lead to increased crash risk or whether the individual can compensate for them
- if there is substantial injury risk, identify and, as appropriate, implement countermeasures to reduce the risk
- if there are no effective countermeasures, balance the costs of crash risk against the cost of possible cessation of driving.

6. Conclusions

At present the research has not demonstrated a clear linkage between mandatory medical testing for any age group and crash-risk reduction.

[*] 'Red flag' conditions can be drawn from ten categories: visual impairments/illnesses; cardiovascular disease; cerebrovascular disease; diseases of the nervous system; respiratory diseases; metabolic diseases; renal disease; dementia; psychiatric disease; and medications (Dobbs, 2001).

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ROAD SAFETY IMPACT OF MOTORCYCLE TRAINING AND LICENSING SCHEMES

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30 June 2003.

1. A brief statement of the issue

Riding a motorcycle is hazardous.[1] The long-recognised need to improve motorcycle safety has recently been strengthened by a new factor: the increased prominence of motorcyclists aged forty years or more in the crash data.

As has been the case with novice and older car drivers, there has been a sustained call for improved training and licensing options to reduce motorcyclist casualties.

2. An assessment of the road safety issue

In Australia, motorcyclists are over 20 times more likely than other vehicle operators to be killed or seriously injured over the same travel distance.[2] In addition, during the last decade in Australia, fatalities among riders aged 40 years and more have doubled from 14 per cent of all motorcyclist fatalities in 1991 to 27 per cent in 2001.[3] (It remains, however, that older motorcyclists have the lowest fatality rates per distance driven, compared to younger age groups.[3])

Motorcyclists in New Zealand are also over-represented in the crash statistics. They account for nine per cent of all reported road injuries and 13 per cent of fatalities, despite accounting for less than two per cent of kilometres driven.[4]

High crash involvement cannot be totally attributed to the intrinsic risks of riding a motorcycle. An analysis of Australian fatalities for 1992 and 1994 showed that 'responsible' riders (those who were both licensed and sober at the time of the crash) had a fatality rate 53 per cent lower than the rate for the whole group (5.25 and 11.24 fatalities per 100 million kilometres travelled, respectively).[5]

Regardless of the specific source of the elevated crash risk, Australia has been relatively ineffective in reducing crash rates. For example:

- Motorcyclist fatalities decreased by six per cent between 1991 and 2001, whereas all road fatalities fell by 18 per cent.[3]
- In 2000, Australia had 5.7 motorcyclist fatalities per 10,000 registered motorcycles, compared to a median 5.1 fatalities for the OECD as a whole. In contrast, Australia ranks among the better-performed OECD nations when compared in terms of overall safety performance.[3]

And the situation in Australia threatens to worsen.[3] There is evidence that the fatality rates for some younger motorcyclist age groups are actually increasing per kilometre travelled, rather than decreasing. There is stronger evidence that motorcycling exposure for riders aged 40 years and over is also increasing, due to both the increasing popularity of motorcycling and an increase in the number of people of this age – while risk per kilometre ridden is also increasing beyond both these factors.

Improved training and licensing strategies are frequently seen as possible ways to improve the safety situation.

Despite the disappointing history of training in regard to novice car drivers, motorcycle training is now encouraged (and often subsidised) by authorities in most Australasian jurisdictions and overseas.[6] ‘Many believe that the unique handling characteristics of the motorcycle, and the rider's vulnerability to perceptual, aerodynamic and roadway disturbances require the acquisition of a high level of skill – most effectively obtained in a formal training situation’.[7]

Transport authorities have also looked to graduated licensing of motorcyclists as a solution. For example, many jurisdictions in both the US and Canada have implemented – or are about to implement – graduated licensing conditions for novice motorcyclists which closely parallel the systems for novice car drivers.[8]

3. Current policies and practices in Australasian jurisdictions

Pre-licence motorcycle training programs are compulsory in New South Wales, South Australia, Tasmania and the Australian Capital Territory, with voluntary programs offered in Victoria, Queensland and the Northern Territory. For details, see Attachment 1.

Licensing procedures vary across jurisdictions and are also detailed in Attachment 1.

4. A review of the research

4.1. The safety benefits of motorcycle training courses

Kloeden et al.[9] conducted a review of motorcycle training for the South Australian Office of Road Safety in 1993. They identified only twenty evaluation reports on rider training programs from around the world, notwithstanding the proliferation of these programs from the 1960s onwards. Twelve programs met minimum research standards and were included in the review:

- six of the studies found no evidence of any effect of training
- two showed that training was associated with an increase in crashes
- four showed that training was associated with a decrease in crashes – with the likelihood that this decrease arose from reduced licensing rates.

Using more stringent quality-of-research criteria, the reviewers expressed confidence in only three reports – two of which showed no effect, one a positive effect.

Kloeden and his colleagues also identified a series of obstacles to conducting definitive evaluations of rider training programs. Two key issues were:

- Sample sizes were often too small to allow a realistic chance of showing statistically-significant results. Because motorcyclists are a relatively small group, and because crashes are relatively rare events, an effective training scheme could require experimental and control groups each needing to contain up to 13,500 motorcyclists.
- It was often impossible to establish comparable training and control groups, especially if training was undertaken on a voluntary basis. Volunteers are likely to differ, at least in terms of age, gender, riding experience, road safety attitudes and risk taking –all of which could influence crash rates, regardless of the possible impact of training.

In a later review conducted for VicRoads, Haworth and Schulze[6] concluded that:

- Differences between trained and untrained riders were insignificant, after adjusting for differences in age, gender, riding history, exposure and education.[10]
- The amount and type of exposure were the most important determinants of crash risk, and there was no evidence that formal training altered the risk levels.[11]
- "Formal motorcycle training or enhanced skills testing programmes … are unlikely to lead to substantial or sustainable reductions in accidents or traffic violations arising through improvements in safe riding practices".[12]

As well as confirming the evaluation difficulties previously described, Haworth and Schulze added a further consideration. There are invariably substantial differences in training programs from jurisdiction to jurisdiction, from site to site and from presenter to presenter. These differences – which may be reflected in different objectives, agenda and training techniques – are rarely allowed for in overall summaries of training effectiveness.

In conclusion, the weight of current evidence fails to support motorcycle rider training as an effective road safety countermeasure. This is consistent with most of the evidence on the effectiveness of formal driver education at a broader level.[7]

However, promising alternatives to conventional training programs for young drivers and riders (for example, insight training which targets young car drivers' over-confidence) need to continue to be monitored. While providing behind-the-wheel training to develop basic vehicle control skills, the approach aims mainly to produce awareness of the individual's limitations in crash-threatening circumstances. The intended result is a driver (or rider) with greater safety margins than those produced by conventional training. Early evaluations have been both promising and less than enthusiastic.

4.2. The safety benefits of graduated licensing for motorcyclists

Graduated licensing schemes for novice car drivers have a proven history of effectiveness. The limited evidence available to date suggests that an equivalent strategy for novice motorcyclists will also prove effective.

The most recent and comprehensive review of graduated licensing for motorcyclists has been prepared by Mayhew and Simpson[8] and this section, unless otherwise indicated, has been based upon their report.

Graduated licensing for motorcyclists aims at a phased introduction to riding, whereby beginners gain their earliest controlled experience under conditions of low risk, with the restrictions to riding being increasingly removed as experience is accumulated. Graduated licensing for motorcyclists has mainly been implemented in North America, especially Canada.

In Canada six jurisdictions have implemented schemes and three have proposed them. As an overview:

- All jurisdictions require a test to be passed before a learner's permit is granted. This is generally a knowledge test, although a few jurisdictions include an off-road test of motorcycle handling and manoeuvring skills.
- The duration of the learner permit varies, from a minimum of 60 days to one year (with some jurisdictions allowing for a shortened period for graduates of approved training courses).

- Six of the nine jurisdictions require supervision at all times during the learner period by a supervised rider, who is usually required to follow closely behind on another motorcycle. Other options are permissible in some jurisdictions.
- In all jurisdictions, learners are not allowed to carry passengers and have a zero blood-alcohol limit.
- In all jurisdictions but one, learners are allowed to drive only during daylight hours.
- Several jurisdictions restrict learners from riding on freeways where the speed limit is above 80 km/h, with one jurisdiction restricting speed to under 60 km/h
- The duration of the next, intermediate, licensing phase varies from 12 to 24 months
- In all jurisdictions, entry to the intermediate phase requires passing an on-road test
- During the intermediate phase, most of the restrictions (including the prohibition against carrying passengers) are dropped. However:
  - all jurisdictions maintain a zero blood-alcohol limit
  - four jurisdictions maintain a night-time ban
- In addition, both learners and intermediate licence-holders are usually subject to a more stringent penalty point system, whereby fewer points are required for a loss of permit or licence.
- The requirement for graduation to full licensing varies. In some jurisdictions, it is simply a matter of serving time, in others it means completion of an approved training course, in others it means passing an advanced on-road test.

In evaluating the effectiveness of the North American graduated licensing schemes for motorcyclists, Mayhew and Simpson[8] recognised the absence of any formal evaluations. As a default, they were forced to examine ‘before’ and ‘after’ motorcycle crash levels in the three jurisdictions with long-standing schemes (Ontario, Nova Scotia and Quebec).

All three jurisdictions introduced the new licensing schemes during a period when the number of motorcycle crashes, and particularly those involving young riders, were falling dramatically. The authors failed to find evidence of any benefits of the licensing schemes in Ontario and Nova Scotia, and postulated that the strong pre-existent downwards crash trends may have had a masking role. In the case of Quebec, however, the decline in motorcycle crash rates was significantly greater for the youngest riders following the introduction of the scheme, thereby providing some indicative support for graduated licensing.

Mayhew and Simpson noted that the Quebec, Ontario and Nova Scotia schemes differed in two main regards:

- Only Quebec required supervision during the learner period.
- The minimum learner period in Quebec was considerably longer (12 months as compared to either 60 days or six months).

Mayhew and Simpson were forced to rely largely upon findings from evaluations involving novice car drivers, to assess the road safety benefits of the various restrictions associated with the motorcyclist graduated licensing schemes (see Attachment 2). While it makes intuitive sense that these findings should be applicable to novice motorcyclists, the extension of the benefits remains problematic.

Reeder et al.[4] investigated New Zealand's graduated licensing scheme for motorcyclists, and in so doing have provided the only formal evaluation in this area currently available.[8] Time-series analyses were used to show that the introduction of the new licensing scheme in 1987 was associated with a statistically-significant 22 per cent reduction in hospitalisations amongst 15-19 year-old motorcyclists. In explaining the reduction, the authors postulated two possible factors:

- reduced exposure to high-risk situations
- reduced exposure to motorcycling generally.

Given the observed decline in the uptake of motorcycling amongst young people at the time (as reflected in decreased numbers of licences issued and vehicles registered), the authors considered the latter factor as primarily responsible for the crash savings. The extent to which this decline was due directly to the new licensing scheme, or to other factors (for example, the increased importation of second-hand Japanese cars from early 1988 onwards), was not resolved.

4.3. Age vs. experience

The association between age and safety has long been recognised for motorcyclists, as it has for car drivers: the older the licence-holder, the less likely the chance of crash involvement (at least up to 60 years of age or thereabouts). Traditionally, this association has been partly attributed to the role of experience: while age is, in itself, a protective factor against crash involvement, so too is the accumulated driving/riding experience that usually comes with age.

A major case-control study from New Zealand[4] has largely dismissed the role of experience as a protective factor for motorcyclists. The study confirmed the role of age – riders aged 25 years or over had less than half the risk of those under 20 years – but found little evidence to support the benefits of experience, once age had been taken into account. The other major protective factor found related to familiarity with the specific motorcycle: riders who had used their current motorcycle for 10,000 km or more had 48 per cent less risk of crash involvement, after adjusting for other factors.

5. Political, social and other factors

It is likely that the high risk of motorcycle riding will continue to lead to a call for improved training of novice (and perhaps older) motorcyclists, despite research evidence indicating the lack of effectiveness of such training. The position faced by the 1998 Road Safety Committee of the Victorian Parliament can be readily understood:

- On the one hand, the Committee recognised that there was no evidence linking motorcycle training to any reduction in fatalities and injuries.

- On the other hand, it recommended that “the Minister for Roads and Ports strongly encourage motorcycle rider training for learner and probationary riders aged under 25 years”.[13]

At the very least, jurisdictions already having training schemes are unlikely to dismantle them, however dubious the road safety benefits. Given this scenario, it is a matter of importance that any continued implementation of motorcycle training be accompanied by evaluation which is as rigorous as the circumstances permit.

In the meantime, it appears that graduated licensing schemes for motorcyclists represent a promising way forward. The available evidence suggests that, as a general rule, the more stringent the early restrictions, the greater the eventual benefits. The extent to which this strategy generally, and the restrictions on mobility specifically, will be acceptable to riders themselves, remains unclear: motorcyclist lobby groups have a history of viewing improvements in motorcycle safety as needing to target motorists rather than motorcyclists.

6. Conclusions

Motorcyclists' high crash risk will ensure that there will always be a call for improved training and licensing options. The research evidence suggests that greater benefits are likely to result from new graduated licensing procedures, as distinct from training programs.

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Attachment 1

TRAINING AND LICENSING PROVISIONS IN AUSTRALASIAN JURISDICTIONS

Jurisdiction	Features of training and licensing programs
New South Wales	**Training** Two levels of training: pre-learner and pre-provisional. Compulsory pre-learner motorcycle training is being progressively introduced across NSW. As an area is declared and a training centre opened, would-be riders must satisfactorily complete pre-learner training before a learner licence will be issued. **Licensing** Must be 16 years and nine months old before obtaining a learner rider permit. To obtain a learner permit a rider must also complete a pre-learner course (if available). A learner rider licence is issued which is valid for six months. A rider must have a learner's permit for three months before applying for a provisional licence. To obtain a provisional licence a rider must pass the Motorcycle Operator Skill Test (MOST) – designed to measure a rider's ability to handle a motorcycle, including starting, accelerating, turning and braking. The MOST is undertaken at the end of the pre-provisional rider training course. The pre-provisional course is a seven-hour course held in one day. Learner and provisional riders are not permitted to ride a motorcycle with an engine capacity exceeding 260 ml, or with a power-to-weight ratio exceeding 150 kilowatts per tonne. A trial of a Learner Approved Motorcycle Scheme was introduced in September 2002, which allows novice riders (learner and provisional) to ride moderately-powered motor cycles up to 660 ml. A person 30 years of age or above who has held a post-provisional car licence for five consecutive years may proceed directly from a learner rider's licence to an unrestricted rider's licence after passing the provisional test.
Victoria	**Training** Training is not compulsory. However, approximately 90 per cent of new riders undertake courses provided by private companies accredited by VicRoads. **Licensing** Must be 18 years of age to obtain a learner rider permit. An applicant with no rider's licence or permit will need to satisfactorily complete a Motorcycle Learner Permit Skill Assessment (LPSA), a Motorcycle Knowledge Test (MCT/KT1), a Road Law Knowledge Test (LPT/KT2), and an eyesight test. An applicant who has held an Australian motorcycle licence current within the last five years, or who has held a motorcycle learner permit issued within the last two years, is not required to undertake any tests. An applicant with a current Australian car licence or learner permit, current within the last five years, must satisfactorily complete: a Motorcycle Learner Permit Skill Assessment (LPSA), a Motorcycle Knowledge Test (MCT/KT1) and an eyesight test. A Learner permit holder is subject to the following conditions: - must display "L" plate on the rear of the motorcycle. - must not carry a pillion passenger (a motorcycle and sidecar with a passenger is acceptable). - must not ride a motorcycle over 260cc. - zero blood alcohol content - must wear a helmet at all times when riding. A rider must hold a learner permit for at least three consecutive months and the permit is valid for 15 months. A probationary licence requires a rider to pass a Practical Riding test on a specifically designed off-street range, and a Knowledge Test. It runs for up to three years, depending on the previous driving experience of the rider (e.g. a car driver with a full licence will have a provisional period of 12 months).

	Conditions attached to a Probationary Permit for the entire probationary period include: - rider must wear an approved helmet - zero blood alcohol content - display “P” plate (unless rider is holder of a full car licence). Other conditions apply only for the first twelve months of the probationary period: - engine capacity not greater than 260cc - no pillion passengers. VicRoads recently introduced a Single Point Entry Test for older riders, involving a four-day course, after which the rider can move straight on to a provisional permit. The same restrictions apply for the first 12 months of the provisional period.
Western Australia	**Training** No details available on training requirements and provisions. **Licensing** Learner's permit at 16 years of age. Also the need to pass a standard Road Rules Test (as per car learner permit) and a further set of questions relating to motorcycles. There is no minimum period for a learner permit; however, the minimum age for attaining a first provisional licence is 16 years and six months of age. Several conditions (unspecified) are attached to a learner permit. There are two levels of a provisional licence: • a rider may attain a first provisional licence at 16 years and six months of age, after passing a practical riding assessment. A minimum of 25 hours’ riding (recorded via a log book) must be completed before applying for the second provisional licence; • to attain a second provisional licence a rider must pass both a practical test and a hazard perception test. Conditions attached to both categories of provisional licence include an engine capacity not greater than 250cc and a blood alcohol content not exceeding 0.02. The provisional period is for two years or until attaining the age of 19, whichever is greater. There are no measures in place that target older riders.
South Australia	**Training** Rider Safe is a pre-licence motorcycle rider training course that all new motorcyclists must complete, consisting of two levels: • Level One: Pre-Learner (Basic) • Level Two: Pre-provisional (Advanced) The Basic Training Course has two sessions of four hours each, dealing with straight riding, turning, gear changing and braking in a safe, off-road environment. When a rider has completed the Basic course, a Learner Permit is issued. The advanced training course includes a four-hour training session and practical assessment. **Licensing** A person must be 16 years old to attain a Learner Permit. It is also necessary to pass a written test and a Rider Safe training course (those without a current car licence) or only a Rider Safe training course (those with a licence). It is recommended that a Learner Permit be held for a minimum of four months. The minimum age for attaining a provisional licence is 16 years and six months, and passing the level two training course is required. A provisional rider who is under the age of 19 retains the Provisional rider conditions until he/she turns 19. A rider who attains a Provisional licence at 19 years of age may move straight to a full licence. A Provisional rider may ride any motor bike or motor trike, the engine capacity of which does not exceed 250 millilitres (cubic centimetres). There are no measures specific to mature age riders.

<table>
<tr><td>Queensland</td><td>Training

There are two methods of attaining a motorcycle licence in Queensland.

- Q-Ride
- Queensland Transport Practical Test

Q-Ride is a system based on obtaining a licence through training and building skills.

There is a list of Q-Ride registered service providers which provide training. They set their own fees and are subject to audits.

Licensing

To obtain a learner permit a person must be 16 years and six months old.

To obtain a learner licence a person must pass:

- a written road rules test that includes questions on road rules and questions specific to motorbikes
- an eyesight test.

A learner permit holder is subject to the following restrictions:

- a rider must ride under the direction of someone who holds, or has held for at least one year, an open licence for the size of motorcycle the rider is learning to ride.
- a person who is to be a pillion or sidecar passenger must hold, and have held for at least two years, the open motorcycle licence.

A learner licence is valid for 12 months.

Obtaining a provisional licence is different under Q-Ride from that via the Practical Motorcycle Test. To obtain a provisional licence a rider must be 17 years of age.

Under the Practical Motorcycle Test, a rider must pass a practical test with Queensland Transport to obtain a provisional licence. A rider must hold a learner permit for a minimum of six months before attempting the test.

Under the Q-Ride scheme, riders are assessed while they learn. The Practical Test does not have to be attempted. Riders may obtain their provisional licence without holding their learner licence for six months (provided that they are 17 years of age or more).

Under the Q-Ride scheme, a rider who has held a car licence for three years can move straight from a learner licence to a full licence.

Riders on a provisional licence are restricted to riding motorcycles with an engine capacity not exceeding 250 cc.

There are no measures specific to mature age riders.</td></tr>
<tr><td>Tasmania</td><td>Training

Two levels of training: pre-learner (level one) and pre-provisional (level two).

The level one course is a pre-requisite to obtaining a learner motorcycle permit. The duration of the course is 8 hours.

The level two course is a pre-requisite to obtaining a provisional motorcycle licence. The duration of this course is also eight hours.

Licensing

A rider must be 16 years old to hold a learner licence. Riders must complete the level one course before being issued with a learner licence. The level one course includes a knowledge test based on information contained in the Learner Driver Handbook.

A learner licence holder is subject to the following conditions:

- motorcycle limited to engine capacity not exceeding 250cc
- “L” plate fitted to rear of motorcycle
- must wear helmet
- must not ride at over the speed limit, or faster than 80 km/h at any time</td></tr>
</table>

	- zero blood alcohol content while riding - may only carry a pillion passenger if that person has held a motorcycle licence for at least 3 years, and is instructing the learner rider. A learner permit is valid for 12 months. A rider must be 17 years old to hold a provisional motorcycle licence. Riders must complete the level 2 training course before being issued with a provisional motorcycle licence. The length of the provisional period depends on the age of the rider at the time the licence is issued: - less than 22 years – three years - between 22 and 24 years – until the person turns 25 - 24 years and over when licence is issued – one year. Provisional riders are subject to the following conditions - “P” plate fitted to rear of motorcycle - motorcycle limited to engine capacity not exceeding 250cc. - zero blood alcohol content while riding. There are no measures specific to older riders.
Northern Territory	**Training** Training is not compulsory. However most riders undertake the Motorcyclist Education Training and Licensing (METAL) program. **Licensing** Riders must be at least 16 years and three months old to obtain a learner licence – and parental consent must be obtained for those less than 17 years of age. They must also complete either the METAL program or the Alternate Motorcycle Operator Skills Test (MOST) operated by the Motor Vehicle Registry. A written road law test is also given if riders are applying for their first licence. Conditions include: - must wear an approved motorcycle helmet - motorcycle limited to engine capacity not exceeding 260cc - zero blood alcohol content while riding - must not exceed 80 km/h - must not carry a pillion passenger - must display an “L” plate at the rear of the motorcycle. Riders must be at least 16 years and six months old to attain the next licensing stage of independent riding – or 16 years and three months old if they have passed the METAL test. They must then successfully complete an on-road riding test conducted by the MVR, or a METAL on-road course.
Australian Capital Territory	**Training** Two levels of training: Pre-learner Training Course and Pre-provisional Licence Training Course. Compulsory motorcycle rider training was implemented as a road safety initiative by the ACT Government in 1989. All learner motorcycle riders receive basic training before riding on the road with other road users. **Licensing** Applicants for a learner motorcycle licence must be at least 16 years and nine months of age. A learner motorcycle licence is valid for 24 months, and must be held for a minimum of three months before a practical riding test for a provisional motorcycle licence can be attempted. To obtain a learner motorcycle licence applicants must: - provide proof of identity, age and residency; - complete and pass a government-approved Pre-Learner Licence Training Course; - pass a knowledge test on ACT road rules and safe driving practices; and - pass an eyesight test.

	The Pre-Learner Licence Training Course provides nine hours of instruction, including both theory and practical components. To obtain a provisional motorcycle licence, a rider must pass the Alternate Motorcycle Operator Skill Test (MOST), which is designed to measure a rider's ability to handle a motorcycle, including starting, accelerating, turning and braking. A Pre-Provisional Licence Training Course only becomes compulsory when riders fail their first rider assessment for a provisional motorcycle licence. The Pre-Provisional course includes seven hours of theoretical and practical instruction in motorcycle riding techniques. The ACT Government subsidises the cost of this compulsory course. ACT learner and provisional riders are not permitted to ride a motorcycle with a power-to-weight ratio exceeding 150 kilowatts per tonne, or to carry pillion passengers. The holder of a normal car driver licence may have a motorcycle condition endorsed as an additional class if the person has held a provisional motorcycle licence for at least one year, or is otherwise exempt from the requirements under the regulations.
New Zealand	**Training** Details of any training course pending. **Licensing** In 1987 New Zealand introduced a graduated licensing scheme for novice motorcyclists. Features of the learner period include: minimum entry age of 15 years; the need to pass a theory and vision test to get the permit, as well as an off-road vehicle handling skills test; duration of a minimum of either six months or three months (with approved rider education); restrictions consist of a blood alcohol limit below 0.03; no riding between 10pm and 5am; a maximum speed of 70 km/h; no passengers, and a maximum 250cc engine capacity allowed. Features of the second, restricted phase include: the need to pass a practical on-road test for entry; a minimum duration of either 18 months or nine months (with an approved course); restrictions consist of a blood alcohol limit below 0.03; no riding between 10pm and 5am; a maximum speed of 70 km/h; passengers allowed in a side-car only, and a maximum 250cc engine capacity allowed. There are no formal exit requirements.

Attachment 2

GRADUATED LICENSING FOR NOVICE MOTORCYCLISTS:

A POSSIBLE MODEL

1. Background

> "Current and planned graduated licensing systems for novice motorcyclist riders can and do vary substantially in their operational features … This flexibility is an attractive feature of graduated licensing, because it can be tailored to the particular needs of a jurisdiction. However, in designing a graduated licensing system, it is critical that its features are true to the basic prevention principle of providing opportunities for obtaining driving experience under conditions that minimize exposure to risk. In addition, the elements of the system should be based, to the extent possible, on scientific evidence and proven effectiveness.
>
> Until further evaluations and studies are undertaken and completed, it is difficult to identify the optimal requirements and features of a graduated driver licensing program for novice motorcyclists. However, reviews of programs, both in place and planned, as well as of the scientific evidence on key features, provide at least some guidance for structuring an optimal program".[1]

Based on these sets of evidence, Mayhew and Simpson have recommended the following model.

2. A recommended graduated licensing model for novice motorcyclists

As a minimum, the model would involve three stages.

Stage 1:
- an extended learner stage with a specified minimum number of riding hours;
- riding to be under the supervision of another motorcyclist, following closely on another motorcycle or in a car;
- riding to be restricted to daylight hours and maybe on certain types of roads;
- speed restrictions;
- zero alcohol provisions;
- no passengers.

Stage 2:
- unsupervised riding but only during daylight hours and under less risky conditions;
- supervised riding permitted during night hours and on higher speed roads (the supervisor being on the same motorcycle);
- passengers permitted during unsupervised riding periods but only towards the end of this stage.

Stage 3:
- a full privilege licence would be permitted after expiry of the second stage, provided that (a) there has been a crash-free record and (b) an appropriate off-road and/or on-road test(s) has been passed.

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ROAD SAFETY IMPLICATIONS OF DAYTIME RUNNING LIGHTS

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30 June 2003.

1. A brief statement of the issue

Daytime running lights (DRL) increase the visual contrast between the vehicle and its background, thereby making the vehicle more visible to other road users. The increase in visibility results in a decrease in most types of daytime multi-vehicle accidents.

DRL are now mandatory in many countries but have yet to be accepted in Australasia as a mandatory road safety countermeasure.

2. An assessment of the road safety issue

2.1. The origins of DRL

The concept of encouraging drivers to use their vehicles' lights during daytime as a road safety countermeasure can be traced to the United States.[1] In the early 1960's the State of Texas launched a 'Light Up and Live' campaign as a means to reduce the high road tolls expected during peak holiday times, an idea which was quickly adopted by several other states over the following years. At around the same time, a number of fleet operators, especially the Greyhound Bus Company, used early versions of DRL on their vehicles as an explicit accident reduction measure. Further, a series of individual States passed compulsory motorcycle lights-on legislation, again as a means to increase vehicle conspicuity.

The use of DRL for vehicles, however, soon fell by the wayside in the US. The concept met with a more enthusiastic response in Europe, particularly in Scandinavia[1], to the point that they are now universal in that region. Increasingly, other countries around the world are also introducing DRL requirements, at least for new vehicles.

2.2. The rationale for DRL

Laboratory-based studies have shown that, the greater the brightness contrast between an object and its background, the greater the probability of the object being detected. Further, the lower the ambient illumination, the greater the contrast ratio between object and background needs to be if detection is to occur[2]. Hence the role of DRL:

> "Visual contrast is the essential characteristic that enables vehicles to be perceived and monitored by other drivers. The purpose of daytime running lights is to increase visual contrast: i.e. make the vehicle more visible to other road users, and thereby reduce collisions".[3]

Although many factors are likely to influence the effectiveness of DRL as an accident-reduction measure, ambient illumination levels are particularly pertinent. The lower the ambient illumination, the greater the tendency for contrast ratios to be reduced, and the greater the risk of non-detection of a given object. Ambient illumination is itself the function of numerous variables, foremost amongst them the altitude of the sun (and hence the latitude) and the season of the year. The closer countries are to the North or South Poles, the longer are the twilight periods and the periods generally with lower sunlight – and the greater the benefits of DRL.[2]

2.3. Options for DRL

Conventional options for DRL include:

- headlights on full-intensity low beam
- headlights on reduced-intensity low beam
- headlights on reduced-intensity high beam
- indicators
- increased-intensity parking lights
- separate DRL.

These conventional options generally entail the lights automatically switching on with the ignition, and being doused whenever the ignition is turned off. However, given that the benefits of DRL are most evident when ambient illumination falls below certain levels (for example, at dawn and dusk), there is an increasing interest in 'smart' DRL: that is, lights that automatically come on when the ambient light drops below a certain threshold.

3. Current policies and practices in Australasian jurisdictions

As early as 1991, it was argued that[4]:

- failure to see vehicles is demonstrably a substantial factor in vehicle-vehicle and vehicle-pedestrian crashes in Australia
- DRL are an effective means to improve vehicle conspicuity
- there is ample evidence that DRL are effective in reducing accidents
- based on the Swedish experience, DRL could have saved Australia between 80 and 170 fatalities, between 700 and 1,300 serious injuries, and between 1,400 and 2,200 other injuries in 1988 – a saving of between $132 million and $297 million.

During the early 1990s, many of the Australasian jurisdictions expressed an interest in DRL, either as a measure to be implemented more or less immediately at jurisdictional level, or to be further investigated as a possible national road safety countermeasure. However, this growing momentum was largely stopped by the Australian national government's decision in 1996 to rescind ADR 19/01, which had mandated DRL for motorcycles sold after 1 March 1992.

Currently DRL are not mandatory in any Australasian jurisdiction, although individual jurisdictions continue to show some interest.

4. A review of the research

4.1. Fleet studies

The best-known fleet study relates to the US Greyhound Bus Company[5], which for one year in the early 1960s ran all its buses with headlights constantly on – and subsequently reported a 12 per cent drop in accidents. Since then, there have been numerous analyses of the relationship between the use of DRL and changes in fleet accident rates, the results varying between around 10 per cent and 40 per cent.

More recently, the results of five fleet studies conducted in Austria, Israel and Canada were reported.[6]

- Two of the studies employed a control-group method, whereby a group of cars equipped with DRL was compared to a control group. The first control-group study, conducted in Israel, found a 13 per cent decrease in crashes in the DRL group, the second study conducted in Canada found a 15 per cent reduction in crashes in the DRL group.
- A study in Austria used a similar design but looked at the crash histories of the cars before and after the DRL intervention, and found a 21 per cent decline in crashes in the DRL group compared to the control group.
- The remaining two fleet studies were also conducted in Austria. Both studies involved a before/after design whereby the crash history of the fleet before introducing DRL was compared with the crash history of the fleet after DRL had been introduced. In one study a two per cent reduction in multi-vehicle crashes was found, in the other no change in crash rates was found.

Overall, the findings from fleet studies generally indicate that introducing DRL has a positive impact on crashes. These findings have been reinforced by the results of a meta-analysis of seven fleet studies.[7] This analysis revealed a 10-15 per cent reduction in multi-vehicle daytime crashes when DRL were introduced to fleets.

The effect on crashes of DRL introduced into specific vehicle fleets is likely to be much higher than the effect of DRL introduced into a country's entire vehicle population. Vehicle fleets with DRL will be more conspicuous than the remainder of the vehicle population without DRL, thus giving them a safety advantage. However, if the entire vehicle population uses DRL, all vehicles will have a similar level of conspicuity, and thus the safety effect of DRL will be smaller.

4.2. Whole-of-country studies

An early study, based upon Finnish data for the years 1968-74[2], set the pattern for later efforts. The researchers reasoned that DRL should have the greatest impact upon multi-vehicle accidents occurring during daylight hours, and hence devised an impact measurement based upon an interaction between four subsets of accidents: daytime multi-vehicle, daytime single-vehicle, night-time multi-vehicle, and night-time single-vehicle accidents. These subsets of crash data were used to show that the movement towards DRL, which had strengthened over the period and achieved a compliance of almost 100 per cent by 1974, was primarily responsible for the following changes:

- overall, a 21 per cent reduction in daytime multi-vehicle accidents
- more specifically – a 28 per cent reduction in head-on accidents, a 17 per cent reduction in accidents involving vehicles crossing paths, a 24 per cent reduction in daytime pedestrian accidents, and a nine per cent increase in rear-end accidents.

An equivalent method was used to evaluate the situation in Norway.[8] Norway legislated installation of DRL for new vehicles in January 1985, and then in April 1988 required all vehicles not equipped with DRL to use headlights during the day. No overall reduction in multi-vehicle daylight crashes was found when a 'before' period of 1980-81 was compared to the two 'after' periods, 1984-85 and 1989-90. However, when crashes were separated into seasons, there was an approximately 15 per cent decrease in all summer-time multi-vehicle daylight crashes. The analysis also revealed that rear-end crashes increased by approximately 20 per cent, 'before' and 'after'.

Denmark mandated DRL use for all motor vehicles in October 1990. Fifteen months after the change, multi-vehicle crashes had decreased by seven per cent, and crashes involving left-turn across oncoming vehicles had decreased by 37 per cent.[9] After thirty-three months there was a six per cent reduction in daytime multiple vehicle crashes, a 34 per cent reduction in left-turn crashes, a four per cent reduction in motor vehicle-cyclist collisions, and a statistically-significant increase of 16 per cent in motor vehicle-pedestrian collisions.

Canada mandated that DRL be installed on all new passenger cars, multi-purpose vehicles, buses and trucks manufactured in Canada after 1 December 1989. Comparing the changes between successive years over the period 1988 to 1991, it was found that the only significant year-to-year reduction in multi-vehicle daytime crashes occurred between 1989 and 1990.[10] All other successive year comparisons yielded no difference. The reductions in multi-vehicle crashes between 1989 and 1990 were:

- for daylight and twilight crashes combined, 9.2 per cent
- for daylight crashes only, 8.3 per cent
- for twilight crashes only, 16.5 per cent.

The author also examined the year-to-year changes for three types of multi-vehicle crash: head-on, left-turn conflict and right-turn conflict collisions. Significant reductions were found between 1989 and 1990 for head-on and left-turn conflict collisions when daylight and twilight were combined, and there was also a significant reduction in head-on collisions during daylight alone. No reduction was found for right-turn conflict collisions.

The finding that DRL are effective in reducing daytime multi-vehicle crashes, when introduced for all vehicles, has been reinforced by the results of a meta-analysis[7], entailing 10 national studies that examined accidents in countries having either a DRL law or a campaign designed to promote the use of DRL. The weighted mean effect of DRL laws or campaigns was found to be a two to 12 per cent reduction in multi-vehicle accidents, and a three to 20 per cent increase in the number of rear-end collisions.

4.3. An overview of the research

One study reviewed 24 independent empirical studies of DRL – eight were national studies examining the effect of DRL legislation, two examined the effect of a DRL recommendation, and 14 were fleet studies.[11] The results suggested the following conclusions:

- There is undoubtedly a positive road safety benefit arising from the introduction or increased use of DRL.
- The effect of DRL on rear-end accidents is less than the effect on other crash types.
- DRL have an even greater impact on casualties than on crashes. This probably comes about because the collision speeds in crashes involving motor vehicles with DRL are lower, due to earlier perception of the vehicles. While some crashes could not be avoided, the injuries were less severe.

- When DRL were introduced for individual fleets, crash reduction rates were considerably higher than the rates obtained for national whole-of-fleet conversion to DRL
- The benefits of DRL are also determined by latitude, such that the closer to the South or North Poles, the greater the crash reductions. This is due particularly to the longer periods of reduced ambient illumination, leading to greater benefits if a strong background/ vehicle contrast can be established via DRL. This led to the development of formulae for predicting the DRL effect for a given country. These formulae are:
  - percentage decrease in fatalities = $0.00331(\text{degrees})^{2.329}$
  - percentage decrease in casualties = $0.00279(\text{degrees})^{2.329}$
  - percentage decrease in all multi-vehicle daytime crashes = $0.00166(\text{degrees})^{2.329}$
- A comparison of the eight evaluations that assessed the impact of DRL on non-motorised road users revealed that, on balance, these groups were not disadvantaged by DRL
- Data from Norway and Denmark showed that motorcyclists specifically were not disadvantaged by DRL.
- Three studies examined the long-term effects of DRL, and thus allowed an evaluation of the possibility that DRL had an initial impact only due to a novelty value which would wear off over time. It was concluded that the DRL effect does not diminish over time.
- Another conclusion was that there was no evidence of any substantial impact of DRL on single-vehicle and night-time accidents.

5. Political, social and other factors

The Australian national government's decision in 1996 to rescind mandatory DRL for motorcycles has two major implications for Australian jurisdictions. In the event of any introduction of DRL for cars, the logical need to reverse the 1996 decision affecting motorcycles would require considerable political commitment to the concept. This in turn would be likely to revive opposition from some motorcycle groups, which may or may not spill over into motorists' groups.

Motorists who would bear the additional direct costs of DRL if they were mandated in Australasia (i.e. increased fuel usage and installation if retrofitting were required), might vary in their willingness to accept these costs, depending particularly upon their geographic location. Motorists in Darwin, for example, would receive minimal benefits relative to motorists in Hobart.

At least some opposition may also come from non-transport groups. The use of DRL entails increased fuel usage and, thus, increased CO_2 emissions. A recent New Zealand analysis, for example, estimated that DRL fitted to a vehicle fleet of around 2.6 million vehicles would produce almost 400,000 tons of additional CO_2 annually.[12]

Most road safety countermeasures come at some cost, either directly or otherwise. By and large, if the benefits sufficiently outweigh the costs, the countermeasures are likely to be accepted by the general public. The benefit:cost ratios for DRL remain problematic and are usually below 2:1.[11] A recent New Zealand analysis suggested that the benefits of requiring special-purpose DRL on new vehicles would not outweigh the costs for the life of a vehicle (assumed to be 15 years).[12] Because most of Australia is at a considerably higher latitude than New Zealand, the recouping of costs is likely to take even longer on this side of the Tasman.

'Smart' DRL, which automatically switch on only in low-light conditions, may represent a more acceptable option, given their lower running costs and lower emission levels.

6. Conclusions

DRL have definite, albeit modest, road safety benefits and usually return positive cost:benefit ratios. They have a greater impact on casualties than on crashes, probably because of the lower collision speeds in crashes involving vehicles with DRL, due to the earlier perception of the vehicles.

It is considered that there are two immediate avenues for their promotion:

- Through targeting owners whose vehicles feature warning devices for lights left on/automatic dousing of lights when the ignition is turned off.
- Through encouraging the installation and use of 'smart' DRL on all vehicles.

Both options will impact on only a part of the vehicle fleet, and are thus likely to produce only very modest crash reductions.

It is further considered that fleet-wide installation of DRL can only be achieved through changes to Australian Design Rules, whereby DRL become a mandatory feature for all new vehicles. This is achievable only at a national level and will require substantial political commitment.

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IMPROVING CHILD SAFETY RESTRAINT SYSTEMS

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30 June 2003

1. A brief statement of the issue

This paper describes the features that comprise an effective restraint system for young passengers, including an overview of some relevant social and political issues.

2. An assessment of the road safety issue

2.1. Deaths and serious injuries among child passengers

Motor vehicle crashes are one of the leading causes of death and acquired disability for children in Australia and New Zealand.[1]

Figure 1 shows the death and serious injury rates for child passengers in motor vehicles in Australia 1980-1996.

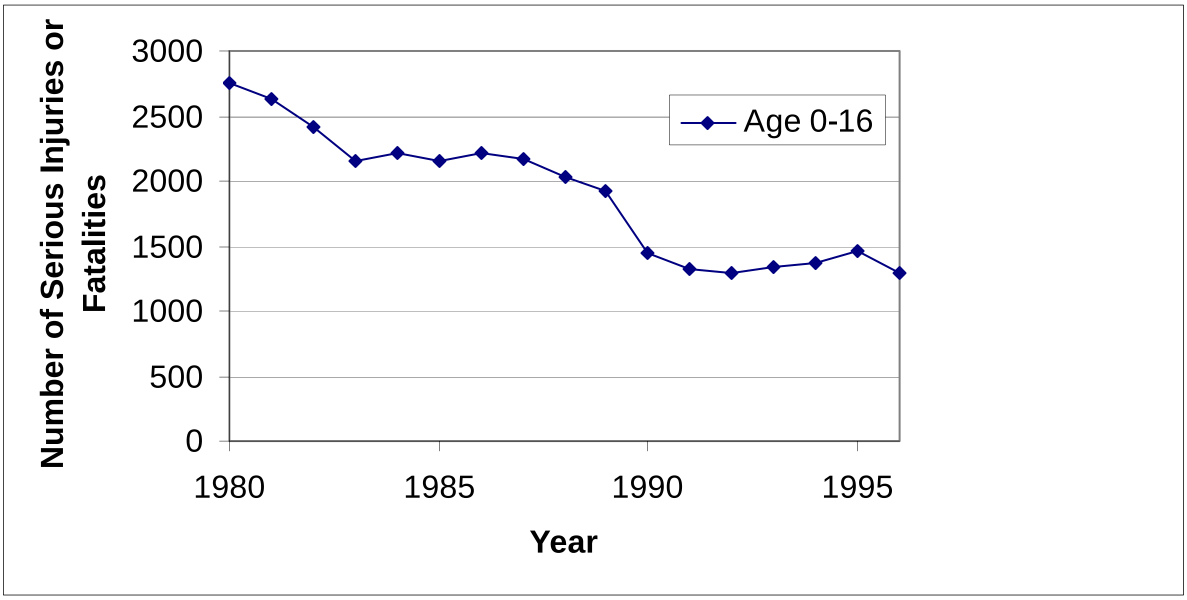

Figure 1 Number of child passenger deaths and serious injuries in motor vehicle crashes in Australia, 1980-1996.[2]

Figure 1 shows that the number of deaths and serious injuries for child passengers more than halved between 1980 and 1996.

Figure 2 shows the numbers of deaths and serious injuries sustained by children in motor vehicle crashes in New Zealand, 1970-2001.

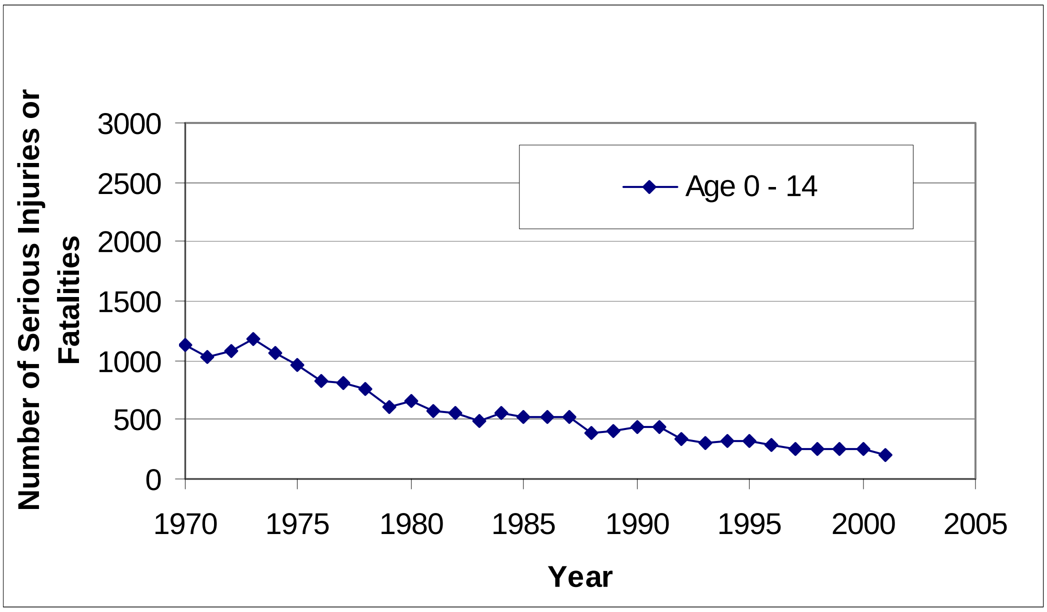

Figure 2 Number of child passenger deaths and serious injuries in motor vehicle crashes in New Zealand, 1970-2001.[3]

As was the case in Australia, the number of deaths and serious injuries sustained by children in motor vehicles in New Zealand has reduced since the 1970s.

2.2. Restraint effectiveness

There are no Australian or New Zealand studies estimating the effectiveness of child restraints. However, international studies suggest that child restraints may reduce all injuries by approximately 70 per cent and severe injuries by 90 per cent compared with injuries sustained by unrestrained children.[4,5,6,7,8,9,10,11]

It is probable that Australian and New Zealand child restraint systems are at least as effective as their overseas counterparts and have been a major factor in the overall decline in deaths and serious injuries indicated in Figures 1 and 2.

Children in child restraints are also less likely to be injured than children wearing adult seat belts[6,12], and some injuries may in fact be caused by inappropriate restraint usage.[13] While children wearing adult seatbelts are 53 per cent less likely to be seriously injured than children who are unrestrained, children in child restraints or booster seats are 60 per cent less likely to be seriously injured than children wearing adult seat belts.[6]

2.3. Injuries sustained by restrained children

Most injuries sustained by restrained child passengers are minor in nature[7,10,14,15,16,17,18,19,20,21]. One study reported that approximately seven per cent of all reported injuries to unrestrained children were at MAIS 2 (using the Abbreviated Injury Severity scale, where zero = uninjured and six = unsurvivable or fatal injury), compared with just over three per cent for those wearing a seat belt (only), less than two per cent for those restrained using a booster seat and less than one per cent for those restrained in a rear-facing child restraint.[21] It is worth noting that a limitation of a number of child injury studies is that unrestrained children are not included in the study sample. Thus, comparisons between injuries of restrained and unrestrained children are not possible.

Most serious and fatal injuries in restrained children occur to the head[18], mainly due to contact with the vehicle interior.[15] In side-impact crashes, head injuries most commonly occur from either contact with the vehicle interior and/or contact with some part of the restraint.[22] Limiting head excursion in frontal impacts and preventing head contact and minimising head loads in side impacts remains a challenge for good child restraint performance.

There is also some risk of injury to other regions of the body, depending on the type of restraint being used:

- it has been found that non-head injuries have the lowest risk in rearward facing restraints, with minor injuries to the extremities being relatively common in forward-facing restraints.[12]
- injuries to the chest and abdomen are also associated with the use of booster seats in conjunction with adult seat belts.[12,13]

Abdominal and chest injuries are also common in children using adult seat belts.[23]

3. Current policies and practices in Australasian jurisdictions

3.1. Legislation

In Australia, children less than one year old must be restrained in an approved child restraint which is properly fitted and adjusted. Children over one year old must either be in an appropriate child restraint (that is properly fitted and adjusted) or must occupy a seating position fitted with a suitable seat belt, and use that seat belt.[24]

In New Zealand, children younger than five years old must wear an approved (and properly fitted and adjusted) child restraint, which includes suitable booster seats. Children aged five to seven years must use a suitable child restraint or booster seat if there is one available, otherwise they must use a seat belt if available. If neither a child restraint, a booster seat, nor a seat belt is available, they must travel in the back seat. Children aged eight to fourteen years must use a seat belt if there is one available[25].

3.2. Standards

In Australia, approved child restraints must comply with Australian Standard AS1754. In addition, two Australian Design Rules relate specifically to child restraints:

- ADR 34 specifies the requirements for child restraint anchorage and child restraint anchor fittings;
- ADR 3/00 relates to seat anchorages and their attachments. Since 1975 this Rule has included requirements aimed at ensuring seat back and seat anchorage strengths are adequate when loaded with a child restraint in place.

Child restraints sold or used in New Zealand must meet either the Australian/New Zealand Standard 1754, the European Standard ECE 44 or the United States Standard FMVSS 213. New Zealand is currently considering the recognition of the Japanese standard for built-in child restraints.

AS/NZS 1754, ADR 34/01 and ADR 3/00 have collectively resulted in some significant benefits in Australasia compared with the current situation in North America and Europe.[26] These include:

- mandatory top tether strap (in New Zealand, however, restraints that comply with ECE 44 or FMVSS 213 do not require this)
- single point of adjustment of the harness
- six-point harness with double crotch straps
- careful specification of the location of mounting points for top tether straps in vehicles, to assist accessibility and optimise performance (again, in New Zealand, not all restraints may require this)
- a specially developed infant dummy for testing child restraints, with greater body flexibility (which gives it characteristics closer to those of a real infant).

It is important to note that, although the Standard sets a minimum level of performance for all Australian child restraints, there are large differences in how well approved restraints perform under standardised conditions.[27,28] Further, improvements to the design of child restraints are ongoing[29], with specifications for the Standard needing to match the newest developments.

3.3. Child restraint usage

Legislation, supported by education campaigns, has resulted in relatively high usage of restraints by children in Australasia. For example, an observational study conducted in Australia in 1994 estimated usage rates exceeding 95 per cent.[30] An observational study undertaken in 2001 in New Zealand identified that overall child restraint usage was 82 per cent, with compliance in some regions as low as 69 per cent.[25]

However, observational studies do not necessarily identify whether child restraints are being used correctly[31] and evidence presented later in this paper shows widespread incorrect usage, or even non-usage. Some authors[34] have identified a number of factors to explain this, including lack of authoritative information, ergonomic barriers (for example, highly-contoured vehicle seats leading to difficulties with installation), or socio-economic barriers (primarily, costs associated with purchasing child restraints).

4. A review of the research

A number of important variables influence the absolute effectiveness of child restraint systems, including design features, installation and appropriate usage.

4.1. Design features

Different types of child restraint systems have been developed to cater for the changing anthropometric and biomechanical characteristics of children:

- Infant capsules cater for infants aged up to approximately six months (less than 9 kg or 70 cm). Important design features of infant restraints are:
  - ability to provide support for the head
  - ability to distribute crash forces uniformly over the whole of the infant's torso and head
  - ability to prevent unwanted motion between the head and the torso, and prevention of contact between the internal harness system and the 'soft' parts of the infant

  - ability to protect the head, in terms of both excessive motion in frontal impact towards the vehicle's seat back, and contact with the vehicle interior in side impact.

- Forward-facing child seats cater for children aged approximately six months to four years (8-18 kg, 70-100 cm)*. Important restraint design features include:
  - ability to provide support for the head
  - ability to limit forward excursion of the head in frontal impact
  - ability to protect the head in side impact
  - ability to prevent unwanted motion between the head and the torso, and prevention of contact between the internal harness system and the 'soft' parts of the infant.
- Booster seats provide the transition between dedicated child restraint systems and adult seat belts and are designed for use by pre-adolescent children (100-145 cm in height). A child's height is a more important indicator of the need for a booster seat than age or weight. Important restraint design features include:
  - raising the child up to a sitting height that allows correct positioning of the lap/shoulder seat belt
  - allowing close fit of the seat belt
  - constructed of material not too easily compressed
  - providing lateral support for a sleeping child
  - ability to provide some head protection in side impact.

In Australia and New Zealand, the need for a top tether for restraint systems that comply with AS/NZS 1754 has meant that children are usually carried in the rear seat, whereas in other countries children are commonly carried in the front passenger seats. The result is that Australia and New Zealand have not experienced the problem of children in front seats being injured by deploying front passenger airbags.

4.2. Installation

The level of protection provided by child restraints depends heavily on how well the restraint is fixed to the vehicle to which it is fitted. A study conducted in Australia by the Royal Automobile Club of Victoria (RACV) found that approximately 70 per cent of child restraints were incorrectly fitted.[32,33] Of these errors, 25 per cent were described as potentially serious[33] and included loose seat belts, loose anchor bolts and incorrectly fitted seatbelts. Other studies suggest these figures may over-estimate misuse rates. For example, a study conducted in New South Wales found that approximately 20 per cent of infant capsules and 19 per cent of child seats had safety-related installation problems.[34]

* Children in this age group can also use harness-only restraint systems. However, the inherent design of these restraints is of concern there is the potential for the lap portion of the restraint to be 'pulled up' and come into contact with the soft abdomen, if the shoulder straps are tightened excessively.[23]

4.3. Appropriate usage

Incorrect use of child restraints may reduce or nullify safety benefits.[20,15] A New Zealand pilot study of child restraint usage found that, while approximately 64 per cent of drivers believed that it was easy to use a child restraint correctly, 75 per cent were failing to do so.[35] Around 60 per cent had made at least one error installing the restraint, while 65 per cent made at least one error fitting the child into the restraint. Further, the most common errors were serious breaches of correct usage guidelines, including tether straps not fitted or secured to an anchor point, seatbelt incorrectly routed, or seatbelts fitted too loosely.[35] The RACV study mentioned above found similar results.[33] A mix of child restraints with and without top tethers complicates the situation in New Zealand.

Further, it is important that, as children grow, they use a restraint system that is appropriate for their size (particularly height and weight).[30,36] There are a relatively high proportion of children who grow out of a child restraint suitable for young children, and then use either an adult seat belt or no restraint at all, rather than using a child booster seat.[36,37,38] For example, one US study found that more than one-third of pre-school aged children (two to five years old) were inappropriately restrained by vehicle seat belts.[36]

5. Political, social and other factors associated with child safety in cars

The high rates of incorrect child restraint installation and use in Australia and New Zealand suggest the need for further public education and awareness programs focussing on the importance of correct installation and usage of child restraints – notwithstanding the current efforts of many organizations, including community health centres and automobile associations.

Some recent initiatives by the automotive industry, in specifying suitable child restraints for their models of vehicle and providing advice at dealerships, may assist in improving community awareness about correct fitment and usage. In addition, various state government authorities and automobile associations have established a wide network of restraint fitting stations to assist people to install child restraints correctly. However, not all people choose to use these facilities. Moreover, some families and carers have a need to move restraints regularly between multiple vehicles.

Further, a number of children move directly from a child restraint suitable for younger children to an adult seat belt (or no restraint at all), thus increasing the chance of injury. The extent of the problem, and the underlying explanations for the inappropriate use of adult restraints, particularly by the “booster seat age group”, are not well researched in Australasia. Nevertheless, strategies such as media campaigns, improved laws and extending the use of booster seats to older children may help to increase the use of booster seats.

As discussed above, currently in New Zealand child restraints must comply with the Australian/New Zealand Standard 1754, the European Standard ECE 44 or the United States Standard FMVSS 213. The acceptance of these multiple standards allows restraints on the New Zealand market that do not use a tether strap.

6. Conclusions

Recent estimates suggest that, overall, child restraints reduce the risk of injury by up to 70 per cent. Most injuries sustained by restrained children are minor in nature, and children wearing appropriate child restraints are less likely to be injured than those wearing adult seat belts.

Legal requirements in relation to child restraints have changed over the years, but currently in Australia children travelling in motor vehicles must be suitably restrained. In New Zealand, children under 5 years old travelling in motor vehicles must be suitably restrained. In both countries there are relatively high rates of child restraint usage, although this may vary dramatically between regional areas. In both countries, however, there is evidence that, while restraints are being used, in many instances they are being used incorrectly.

There are three main types of child restraints: infant capsules, forward-facing child seats, and booster seats used in conjunction with seat belts. It is important that children are seated in a child restraint appropriate for their size and weight. While many parents and carers report that they believe that child restraints are easy to install and use, a number of studies have found high rates of errors in installation that could potentially nullify the safety benefits.

More educational/awareness campaigns may help to combat many of the installation and usage problems.

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Acknowledgements:

Thanks to John Wren and Michael Paine for helpful comments on earlier drafts of this chapter and to Mike Keall, Land Transport Safety Authority, for assistance with NZ injury data.

ROAD SAFETY EDUCATION IN SCHOOLS

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1. Brief statement of the issue

Most Australasian jurisdictions remain committed to school-based road safety education (RSE) programs in both the primary and secondary sectors. Despite the absence of outcome evaluations demonstrating that these programs are responsible for reductions in road trauma, they continue to occupy substantial amounts of valuable curriculum time, and new programs continue to be developed.

This section briefly reviews what is known from past research about the program attributes that maximise the chances of a school RSE program reducing involvement in traffic accidents for its target audience, both while they are still at school and later in life. It also offers some criteria that can be used to assess the road safety content and the educational delivery processes of current RSE programs and those planned or under development.

2. Assessment of the road safety issue

Table 1 shows the number of school-aged children killed in traffic accidents in Australia in 2001 as a proportion of all fatalities. The percentage of fatalities aged five to 16 years is highest for pedal cyclists, followed by passengers and pedestrians. The situation is similar in New Zealand, where 30 per cent of cyclists killed, 17 per cent of pedestrians killed and seven per cent of passengers killed in 2001 were aged five to 14 years (LTSA, 2003).[1] These three road-user groups are the focus of RSE programs at primary school level. They receive reduced coverage at secondary level, where driver-related issues become more prominent.

Table 1: Fatalities of school-aged children in Australia, 2001, by sex and road user group

Types of road user	Gender	5-16 years	All ages	Percentage (5-16 years)
Drivers, motorcyclists and pillion passengers	Males	11	589	1.9 per cent
	Females	3	187	1.6 per cent
	Total	14	776	1.8 per cent
Passengers	Males	28	225	12.4 per cent
	Females	20	181	11.0 per cent
	Total	48	407	11.8 per cent
Pedestrians	Males	21	201	10.4 per cent
	Females	8	88	9.1 per cent
	Total	29	289	10.0 per cent
Pedal cyclists	Males	12	40	30.0 per cent
	Females	0	6	0.0 per cent
	Total	12	46	26.1 per cent
TOTAL	Males	72	1,265	5.7 per cent
	Females	32	470	6.8 per cent
	Total	104	1,736	6.0 per cent

Source: adapted from Australian Transport Safety Bureau fatality data for 2001.[2]

3. Review of the research literature

3.1. Effectiveness of school road safety education programs

There has traditionally been a view in road safety education that children aged less than about nine years or so have not reached a stage of psychological development at which they are capable of learning to be safe pedestrians. However, recent work has demonstrated that children as young as six years, and possibly younger, can be trained to cross roads more safely.[3] It is important that training for young children be practical, and be carried out at the roadside or a close approximation of it.[4] Young children's learning proceeds from the concrete to the abstract, and they tend not to transfer learning from the classroom to the real world.[5]

Bicycle education for primary school children is often successful in improving riding knowledge and riding performance.[6] However, a study of the road safety outcomes of Victoria's *Bike Ed* program by Carlin et al.[7] found that program participation appeared to *increase* the chance of the child presenting at hospital with a bicycle-related injury. On the other hand, a UK study[8] found that children who received bicycle training were three times less likely to become casualties than those who did not. In view of the conflicting evidence, the value of bicycle education as an injury countermeasure remains unproven.

Programs to teach primary school children how to use public transport safely operate in Victoria, the ACT and Perth. The Victorian program is very highly regarded by primary school teachers.[9] However, no evaluation of the road safety benefits of these programs has been performed.

Pre-driver education programs operate at or around Year 10 level in schools in several Australasian jurisdictions, including the ACT *Road Ready* program, Tasmania's *Pre-driver Education*, Victoria's *Keys Please* seminars and several local programs in New Zealand. *Road Ready* and *Keys Please* have been very favourably received by participants.[10,11] Two evaluations have been undertaken to examine the impact of Tasmania's *Pre-driver Education* on accident involvement.[12] The first of these found students who took the full course were less likely than those who took no school pre-driver education to be involved in a crash in the first year after acquiring a licence. However, the second evaluation, using a larger sample of students, failed to confirm the benefit of the program.

The Victorian and ACT Year 10 programs have the specific aim of increasing the amount of driving practice that learners accumulate before they graduate to a solo licence; as such, they are likely to encourage many students to acquire the learner permit earlier than they otherwise would have. A recent Swedish finding suggests that earlier acquisition of the learner permit, unlike earlier acquisition of a solo licence, does not lead to increased accident involvement. Gregersen et al.[13] found that lowering the age at which a learner permit can be obtained in Sweden led to a reduction in accident risk for novice drivers.

Reviews of school-based driver training programs (e.g. Woolley[14]; Christie[15]) have consistently concluded that there is little or no evidence of reduced accident involvement as a result of participation in secondary school driver training. Indeed, there is evidence that some programs have led to earlier licensing for many students, and hence to increased exposure for the most at-risk group and increased accident involvement.

3.2. Road safety content of educational programs

In the light of the available research on road safety generally, and on the effectiveness of school RSE programs in particular, seven general principles for minimising road trauma have been identified as having relevance to school RSE. These principles and their implications for school-based programs are as follows:

RSE should not result in increased exposure in high-risk categories.

- Programs for pre-drivers should not encourage or facilitate earlier acquisition of a solo (provisional, probationary, restricted or full) licence. School-based programs should not result in the award of a solo driver licence; nor should they lead to any reduction in the age at which a licence can be obtained.
- School-based programs should not encourage or facilitate acquisition of a motorcycle learner permit or licence.
- Programs for child cyclists, roller-bladers and scooter-users should not encourage on-road travel.
- Programs for children up to the age of about nine years should not encourage increased pedestrian exposure when not accompanied by adults or older adolescents.
- Programs for students at all levels should not encourage use of any form of motorcycle, motorised bicycle or motorised scooter.
- Programs for secondary students should encourage the use of safer motorised transport modes (such as buses and trains) in preference to less safe modes (such as private car and motorcycle use) whenever possible, subject to personal safety and mobility considerations.
- Education on walking and cycling should be conducted in a manner which encourages risk-averse use of those modes, and should be implemented in conjunction with measures to provide a safer environment for these modes.

RSE should promote injury reduction countermeasures that are known to be effective.

- Programs for students of all ages should promote the use of seat belts, bicycle helmets and other protective equipment, such as knee and wrist pads for roller-bladers.
- Programs for early primary students should promote the use of booster seats for younger/smaller children.
- Programs for pre-drivers should encourage or facilitate earlier acquisition of the motor car learner permit.
- Programs for learner drivers should encourage or facilitate acquisition of increased amounts of supervised driving experience.

RSE should provide students at each age with the skills and knowledge required to safely perform the road-related activities in which they are likely to be engaged.

- Programs for students of all ages should address safe behaviours for travelling as passengers.
- Programs for primary students should address safe behaviours for walking along, across or near roads, and playing near roads.
- Programs for early primary students should build an understanding of traffic management devices, including signals, signs, road markings and crossing supervisors.
- Programs for late primary students should address safe behaviour for cycling on footpaths and near roads.
- Programs for late primary students should lead to an understanding of safe behaviour for independent travel and use of public transport, including choice of the safest route for each journey.

Scarce RSE resources (money, curriculum time, teacher professional development) should not be devoted to programs that are known to be ineffective in reducing accidents and casualties.

- Driver training in vehicle control skills should not be provided at specialised off-road facilities.
- In communities where most learner drivers have the opportunity to be trained by fully-licensed family members, friends or commercial instructors, driver training in vehicle control skills should not be provided through schools.
- Students should not be encouraged to undertake traditional defensive/advanced driver training before or after they acquire a licence.

RSE should not lead students to become overconfident about their ability to cope safely with hazardous driving situations.

- Students should not be given training in advanced driving skills such as skid control.
- If driver training is provided to late secondary students, it should form one component of a broader RSE program.
- If driver training is provided to late secondary students, it should focus on avoidance of hazardous situations rather than skills to cope with them.
- Programs for learners should be promoted as a supplement to, not a substitute for, on-road experience supervised by a fully-licensed family member, friend or commercial instructor.

RSE should provide students, not only with the knowledge and skills required to be able to behave safely but also with the motivation to do so.

- Programs for late primary students should lead to an understanding of the causes and consequences of traffic accidents.
- Programs for secondary students should lead to an understanding of the costs and impacts of road trauma for its victims and the community.
- Programs for late secondary students should lead to an understanding of the penalties associated with illegal driving behaviours.

RSE should provide students with knowledge that will help them to make sense of their experiences once they leave the school system, and help to make them safer road users throughout their lives.

Programs for late secondary students should build an understanding of:

- the types and causes of traffic accidents, especially those involving young and/or inexperienced drivers
- the physiological and motivational factors that can increase the risk of a traffic accident
- the dangers associated with high-risk driving/riding/walking behaviours
- alternatives to high-risk road user behaviours and strategies to help implement those alternatives
- hazards in the traffic environment and how to identify them
- peer and media influences that encourage risky behaviour and how to recognise and manage them
- road rules
- the responsibilities associated with car ownership, including licensing, registration and insurance requirements.

3.3. Educational methods for delivery of school road safety education programs

One reason for children and young people being killed or injured in road accidents is that they do not have the necessary knowledge and skills to allow them to deal with the hostile traffic environment.[16] Receiving RSE as part of their normal school curriculum is recognised as being one of the most effective ways of providing children with this type of knowledge. However, as we have seen, it is difficult to demonstrate that improved knowledge results in reduced road trauma.

A school RSE program that is solely classroom-based will be ineffective. Learning to be a safer road user involves acquiring a range of practical skills, and it is unlikely to be effective unless it occurs in a real-world environment.[17] New knowledge and new skills need to be rehearsed and applied in the environment in which they will ultimately be used, or in an environment closely resembling the real traffic environment. By learning the skills in an actual, but safe, road environment, children and young people will not only learn from their errors but also become skilled in recognising high-risk situations when they do occur. The most effective programs occur where schools work in partnership with parents, carers and other key stakeholders to inform and empower young people.

Effective programs also have a clear structure within a recognised curriculum with a planned, sustained and coherent program of learning. They are outcomes-based[18], and achievement of the planned outcomes is assessed.

It should not be assumed that ‘one size fits all’. It is important that RSE programs cater for the characteristics of the particular age group being targeted. To be developmentally appropriate, programs must take account of the enormous diversity of physical, social, emotional and intellectual development among young people at each stage of schooling. This diversity is reflected in variable learning rates, abilities and styles. Programs should also be culturally appropriate, taking into account the social and cultural norms and patterns of the target group.[16] In developing programs, the usual learning patterns and stages (not ages) should be considered in relation to factors such as the usual or available form of travel, the associated morbidity and mortality data, and the current understanding of risk and preventative factors.

An effective program provides students with small, frequent and purposeful inputs of RSE throughout their school careers. The content and processes within an effective program need to develop:

- knowledge and understanding of road traffic and the environment in which it is found
- behavioural skills necessary to survive in the presence of road traffic
- an understanding of their own responsibilities for keeping themselves and others safe
- knowledge of the causes and consequences of road accidents
- a responsible attitude to their own safety and to the safety of others.

In the absence of a distinct curriculum space in which to deliver RSE, the suggestion from key educational bodies is to take a cross-curriculum approach to RSE rather than struggle for a separate, identifiable space in an already crowded curriculum.[19] One disadvantage of the cross-curriculum approach is that RSE belongs to no single learning area or teaching body. This makes it difficult to raise issues in decision-making bodies and influential committees in the school community, and to defend the subject when necessary or promote it when an opportunity presents. It may mean that RSE has no budget for professional development and the acquisition of resources and materials. Further, a cross-curriculum approach will mean that the program probably has no distinct goals, learning outcomes or associated assessment tasks, and may lack planned sequentiality.

Learning opportunities should be provided through existing learning activities. However, it cannot be assumed that, just by using road-use/trauma data in mathematics or deconstructing a road safety advertisement in English, this constitutes an RSE program. The focus will most probably be on, for example, how to calculate percentages, and not on what the data mean and what the individual or community can do about it.

Program developers need to be mindful that taking a cross-curriculum approach can lead to an RSE program being topic/knowledge-driven rather than skills-based. The interpretation of skills here means, not only the physical skills required to ride a bike or cross a road, but also the diverse skills required to be a safer road user – such as decision-making, problem solving, effective communication, negotiation, conflict resolution, hazard recognition and hazard management, managing difficult emotions and internal and external pressures, multi-tasking and taking responsibility for self and others.

3.4. Requirements for sound delivery practice

School RSE programs are more likely to be effective if they comply with the criteria listed below.

3.4.1. Context

The program should:

- reflect the values, processes and content outlined in the curriculum document for the jurisdiction
- be outcomes-based, with outcomes that are achievable and measurable
- have content and skills that allow for progression of achievement within outcomes
- be integrated across key learning areas, while still retaining a clear road safety identity
- reflect the core values of the social and education systems
- challenge beliefs and attitudes that can lead to unsafe behaviour
- have a clear, research-based rationale, relying on data that are current and reputable.

3.4.2. Content

The program should:

- clearly define the road safety area, issue or behaviour to be addressed
- be developmentally appropriate for the target group
- have activities that lead to the achievement of stated goals of the program
- relate new information to prior knowledge, continuously building upon current and earlier learning and understandings to ensure positive and safe future behaviours
- focus on learning for understanding rather than requiring correct responses
- be interpretive, problem-based and solution-focused
- provide consistent and implementable knowledge and strategies
- employ planned, coherent, strategic and sequential content and processes
- be generally developmentally appropriate, but allow for individual and community differences
- be strategic, establishing a purpose and then providing matching strategies
- be culturally sensitive
- be gender inclusive

- not be rules- or mantra-based
- take into account geographic and environmental differences
- have a greater emphasis on skills than on knowledge.

3.4.3. Processes

The program should:

- focus on the processes of thinking and problem solving
- employ a variety of teaching methods to cater for individual differences in learning styles and abilities
- cater for a range of ways of organising the class, such as individual tasks, small group work and large group work
- be student-centred
- allow an opportunity to understand how self and others think and operate
- allow an opportunity to evaluate own behaviours and to consider the consequences of holding a particular value position
- include key questions of a higher order
- take place both in and outside of the classroom
- involve significant others and/or key road safety stakeholders
- have an assessment component that is linked to learning outcomes.

3.4.4. Resources

The resources used in the program should:

- not assume teacher knowledge of the area
- be supported by teacher professional development or comprehensive teacher advice
- draw upon or utilise contemporary stimulus materials and information that is less than five years old
- not include any bias, deception or product persuasion
- not be reliant on delivery by outside experts
- not rely on fear or shock
- have respectable and reputable authorship or source
- be visually attractive and appealing to the targeted age group.

4. Political, social and other factors relating to school road safety education

RSE in schools requires considerable investment to develop suitable programs and resources, and a large investment of student and teacher time in the delivery of these programs. Despite the difficulty of demonstrating that road safety education reduces deaths and injuries, there is a firm expectation amongst most parents and the wider community that road safety should be taught in schools. The magnitude of the investment in such programs implies a responsibility to ensure, at the very least, that program content is based on sound road safety principles and that the delivery methods used are based on sound educational principles and practices.

5. Conclusions

The difficulties of conducting outcome evaluations to resolve the many questions and issues associated with school RSE programs are daunting. However, a review of past research into school road safety education, and into the broader road safety and education fields, has revealed many well-established principles and requirements that can and should be applied when assessing the strengths and weaknesses of current programs. These same principles and requirements can also be used to guide the development of new programs to maximise the beneficial effects of the program on the behaviour of road users, and to reduce their involvement in traffic accidents.

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ROAD SAFETY IMPLICATIONS OF DRIVER DISTRACTION

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1. A brief statement of the issue

Any activity that distracts the driver from the primary driving task has the potential to compromise safety. Distraction can derive from objects or events occurring within the vehicle or external to the vehicle. Those from within the vehicle, which are the focus of this paper, include the performance of everyday activities (e.g. eating, smoking) and distractions arising from driver interaction with an ever-expanding range of communication (e.g. mobile telephone, internet), entertainment (e.g. radio, compact disk player, video) and advanced driver assistance systems (e.g. in-vehicle navigation systems). There is converging evidence that these in-vehicle sources of distraction are, to varying degrees, a contributing factor in road crashes.

2. An assessment of the road safety issue

2.1. What is driver distraction?

Driver distraction forms part of the broader category of driver inattention. The American Automobile Association Foundation for Traffic Safety defines driver distraction as occurring "when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object or person within or outside the vehicle compelled or tended to induce the driver's shifting attention away from the driving task".[1] The presence of a triggering event or activity distinguishes driver distraction from the broader category of driver inattention.[2]

According to the National Highway Traffic Safety Administration (NHTSA) there are four distinct, although not mutually exclusive, types of driver distraction: visual, auditory, biomechanical (physical) and cognitive distraction. Visual distraction occurs when drivers neglect to look at the road and instead focuses their attention on another visual target, such as an in-car navigation system, for an extended period of time. Auditory distraction occurs when drivers momentarily or continually focus their attention on auditory signals rather than the road environment. Biomechanical distraction occurs when drivers remove one or both hands from the steering wheel to physically manipulate an object, instead of focusing on the physical tasks required to drive safely such as steering or changing gears.[3] Cognitive distraction includes any thoughts that absorb drivers' attention to the point where they are unable to navigate through the road network safely.[4]

2.2. The role of in-vehicle driver distraction in crashes

The extent to which distraction is a road safety problem in Australia is a function of both the increased risk associated with distraction and the prevalence of distraction while driving. Currently there is no published Australian research in this context. However, overseas research does provide an indication of the increased crash risk associated with using certain devices while driving. Research conducted in Canada has found that using a mobile phone while driving can increase the risk of having a crash by up to four times[5], while interacting with an email system can lead to a 3.5 per cent to 38.5 per cent increase in crashes.[6]

While there has been no systematic investigation of the prevalence of distraction while driving in Australia, limited survey evidence shows that around one-third of mobile phone users regularly use hand-held phones while driving, and one in six drivers send text messages while driving.[7] A recent observational study has also found that two per cent of Melbourne drivers were observed using a hand-held phone while driving[8]. However, no information is available regarding the prevalence of other forms of distraction. Prevalence data from overseas studies suggest that, of the drivers involved in a distraction-related crash, 11.4 per cent indicated that they were distracted by adjusting the radio, CD or cassette, 1.7 per cent were distracted by eating or drinking, and 1.5 per cent were distracted by using a mobile phone.[1]

The number of crashes in Australia for which distraction is a contributing factor is not currently known. Not all Police crash report forms have provision for recording the presence of distraction. Even where this provision exists, however, it can be unclear whether distraction played a role in the crash or was merely present. Where the presence of distraction can be noted but is not, this is not equivalent to recording the absence of distraction. Given the increased crash risks and high prevalence of crashes associated with distraction demonstrated by overseas studies (see below), and given that the effects of distraction on driving performance can be expected to be universal across jurisdictional boundaries, there is every reason to believe that distraction is a significant contributing factor to crashes in Australia. As a first step in quantifying the role of distraction in crashes in Australia, it is recommended that a carefully designed study of the prevalence of driver involvement in distracting activities be undertaken. This information, combined with information derived from the epidemiological research already being undertaken, will enable an initial estimate of the magnitude of the problem. If it is shown to be a significant problem, better recording by Police of the role of distraction in crashes will be needed.

3. Current policies and practices in Australasian jurisdictions

The current Australian Road Rules contain a number of rules regarding the use of in-vehicle devices and technologies by drivers while driving.

- Rule 300: Use of hand-held mobile phones states that: “The driver of a vehicle (except for emergency or police vehicles) must not use a hand-held mobile phone while the vehicle is moving, or is stationary but not parked, unless the driver is exempt from this rule under another law of this jurisdiction”. A failure to obey this rule can result in a loss of demerit points (three points in Victoria and NSW and one point in WA) and a fine ($135 in Victoria, $220 in NSW and $100 in WA).
- Rule 299: Television receivers and visual display units in motor vehicles states that: “A driver must not drive a motor vehicle that has a television receiver or visual display unit in or on the vehicle operating while the vehicle is moving, or is stationary but not parked, if any part of the image on the screen is visible to the driver from the normal driving position or is likely to distract another driver. This rule does not apply if the visual display unit is, or is part of, a driver’s aid (e.g. closed-circuit television security cameras, dispatch system, navigational or intelligent highway and vehicle system equipment, rear-view screens, ticket-issuing machines, or a vehicle monitoring device).

While there is currently no law in Australia prohibiting the use of advanced driver assistance systems (e.g. in-vehicle navigation systems) while the vehicle is moving, many vehicle manufacturers recognise the dangers associated with using these devices while driving. In the case of in-vehicle navigation systems, some vehicle manufacturers ‘lock-out’ some navigation functions, particularly the destination entry function, when the vehicle is in motion.[9]

4. A review of the driver distraction research

4.1. Mobile phones

There is a vast body of literature examining the impact of mobile phone usage on driving performance.[4,10,11,12] The results of these studies are reviewed in more detail in another paper in this handbook.

4.2. Text messaging

Very little research has been conducted on the distracting effects of sending or receiving text messages while driving. An Australian survey, conducted by the University of Sydney, found that 30 percent of people surveyed had sent text messages while driving.[13] Such a high prevalence of text messaging while driving is disturbing, given that the physical, visual and cognitive distraction associated with text messaging while driving is likely to be far greater than that associated with simply talking on a hand-held phone.[4]

4.3. In-vehicle navigation systems

In-vehicle navigation systems are now available in Australia in some luxury vehicles and rental cars. Drivers program a required destination into the system, and it then automatically plots the fastest or shortest route to that destination and issues turn-by-turn instructions (computer-generated voice instructions and/or instructions presented on a visual display screen) on how to reach the destination.[9] One major concern with the use of route guidance systems while driving is the task of entering destination information. Various methods exist for doing so: selecting the required destination from a scrolling list of suburb and street names; manually typing in the number, street and suburb of the destination letter by letter; or using voice input to enter the destination details.[14] Research by Tijerina and colleagues[15] has revealed that visual-manual destination entry is associated with longer completion times, longer eyes-off-road times, more frequent glances at the device, and a greater number of lane exceedences compared to voice activated input systems. On the basis of these results, the authors conclude that route guidance systems with voice recognition technology are a more viable and safer option than systems that require visual-manual entry.

Once a driver has entered the destination information and is en route, the route guidance system will issue instructions to the driver as to the best course to take. This information can be presented using a visual display, computer-generated voice messages, or both. In the case of visual displays, information can be presented either as an electronic route map (similar to a conventional map), or as a turn-by-turn display (usually left and right arrows at each turn point). Systems which provide turn-by turn instructions, rather than presenting complex map displays, are less distracting to the driver and present the most useable means of navigation, especially when they are accompanied by voice guidance.[16] Using voice-guided, turn-by-turn systems to navigate to a destination has also been shown to be less cognitively demanding than using a conventional paper map, resulting in less abrupt braking manoeuvres and lower workload ratings.[16]

4.4. In-vehicle email and Internet facilities

These systems are not yet available in production vehicles in Australia. However, they are predicted to become an important element of so-called car 'infotainment' systems. These will enable the driver to download traffic updates and weather reports to improve traffic flow, obtain information on parking availability, and access emails and web information.[17] However, the distraction associated with the use of such systems while driving is a concern for researchers, car manufacturers and designers. Lee and colleagues[6] used a driving simulator to examine the effects of a speech-based email system (in which email messages were accessed, read and replied to using only voice commands) on drivers' attention to the roadway and their reaction time to a braking lead vehicle. When interacting with the speech-based email system, regardless of the complexity of the system, drivers' reaction time to the braking lead vehicle was 30 per cent longer than when not interacting with the system. Moreover, this 30 per cent increase in reaction time translated into a 3.5 to 38.5 per cent increase in collisions and a 27.3 to 80.7 per cent increase in collision velocity. Interaction with the speech-based email system also increased drivers' workload levels and this was highest for the complex email system.

4.5. Radios and Compact Disk (CD) players

Despite being equipped to almost every car on the road in Australia, surprisingly little research has directly examined the distracting effects of interacting with, or listening to, a car radio. Overseas research suggests that simply listening to radio broadcasts while driving can impair driving performance, resulting in more lane deviations, particularly under complex driving conditions.[18] Also, while several studies have found that tuning the radio is less distracting than dialling or talking on a mobile phone[19,20,21], or operating an in-vehicle navigation system[21], numerous other studies have found that tuning a radio degrades driving performance more than holding a simple conversation on a mobile phone, particularly when driving in adverse conditions (e.g. in wet, slippery conditions).[22, 23]

An on-road study conducted by Wikman and colleagues[23] examined the allocation of visual attention of experienced and inexperienced drivers as they tuned the radio, changed a cassette and dialled a mobile phone, while driving along rural and city roads. The results revealed that drivers spent greater lengths of time glancing away from the road when tuning the radio than when dialling the mobile phone. Changing the cassette resulted in the shortest glance durations away from the road. Compared to the experienced drivers, the novice drivers made more short (less than 0.5 seconds) and long (more than three seconds) glances away from the road, which were associated with large deviations in lane position. These results suggest that tuning a radio while driving appears to have a detrimental effect on driving performance, particularly for inexperienced drivers.

In-car CD players are also a common feature in many Australian cars, yet few studies have examined the distracting effects of using these systems while driving. In a study by Jenness et al.[24], 26 participants completed five driving conditions, while eating a cheeseburger, reading directions, using a voice-activated or manual-dial system to place calls on a mobile phone, or continuously operating a CD player (selecting a CD, inserting it, selecting a track, removing the CD and placing it in its case). The results indicated that participants made more lane deviations and glances away from the road, and took the longest amount of time to complete the trials when operating the CD player, than when eating or dialling numbers on a mobile phone. However, recent evidence suggests that the use of voice-activation may minimise the distraction associated with using CD players while driving.[25]

4.6. Television, Video and DVD

Rear-seat television/video/DVD systems are currently among the best-selling in-car devices on the market in the United States.[26] These systems are now also available in some Australian cars. No research, to the knowledge of the authors, has examined the influence of these systems on driver performance. Although legislation already in place in Australia prohibits television and video/DVD systems being mounted in the vehicle where they can be viewed by the driver while they are driving, it is likely that televisions and video/DVD systems could create an auditory and cognitive distraction as drivers try to 'listen in' to programs.

4.7. Non-technology-based distraction

Drivers often engage in a number of non-technology-based activities, such as eating, drinking, smoking and interacting with passengers, which have the potential to distract them from the driving task and increase their crash risk. Eating and drinking are deemed acceptable activities while driving. However, they can create a physical and visual distraction. A recent study by the American Automobile Association (AAA) revealed that a greater proportion of drivers involved in traffic accidents are distracted by eating or drinking (1.7 per cent) than by talking on a mobile phone (1.5 per cent).[1] Another study[24] found that eating a cheeseburger was as distracting as using a voice-activated dialling system, but less distracting than continuously operating a CD player. Several studies have also found that smoking while driving increases the risk of being involved in a crash.[27,28,29] The association between smoking and increased crash risk could be the result of three factors: distraction caused by smoking, behavioural differences between smokers and non-smokers, and carbon-monoxide toxicity.

The distracting effects of passengers are less well understood due to a lack of direct research. However, anecdotal evidence suggests that passengers can indeed be a distraction under certain circumstances. Research on teenage passengers has revealed that the presence of passengers increases crash risk, particularly for younger drivers, and this is believed to result largely from distraction and risk-taking.[30] A study by Regan and Mitsopoulos[31] also provides evidence that passengers can distract drivers. Their results revealed that some of the participants found the presence of passengers distracting to the point where they were less likely to detect traffic light changes or road signs. Overseas research has found that passengers were the source of distraction in 10.9 per cent of distraction-related crashes.[1]

5. Political, social and other factors associated with driver distraction

Traditionally, vehicles have been built for mobility, pleasure and safety. Increased time and work pressures mean, however, that more drivers are now using their car for work-related purposes – as a mobile office.

A worrying trend is the provision of services to the driver through portable devices such as the mobile phone or pocket PC. In Europe, for example, it is possible to access real-time traffic information, the Internet, navigation assistance and entertainment information through a pocket PC or mobile telephone. These services can be expected to be available in Australia shortly. Currently, there are no regulations in Australia governing the use of portable devices used for these purposes while driving.

6. Conclusion and recommendations

In summary, there is converging evidence that driver distraction contributes to road trauma, and that the prevalence of distraction as a risk factor will increase as new technologies proliferate in the market. It is important, therefore, that policies and programs are developed and implemented in Australia to manage existing and emerging risks associated with driver distraction.

For a more detailed treatment of this topic, the reader is referred to a Monash University Accident Research Centre Report in press.[32]

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ROAD SAFETY IMPLICATIONS OF USING HANDS-FREE MOBILE TELEPHONES WHILE DRIVING

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1. A brief statement of the issue

The heightened crash risk associated with mobile phone use has led many jurisdictions in Australasia and around the world to ban the use of hand-held mobiles while driving. Typically, however, the legislation stops short of banning the use of hands-free mobiles, implying that it is acceptable to use them while driving.

2. An assessment of the road safety issue

Using a mobile telephone while driving can cause distraction at a number of levels.[1] There is physical distraction, with the driver usually being required to drive one-handed, either for the total duration of the call if using a hand-held phone or for some part of the call if using a hands-free device. Using either form of phone also involves visual distraction, particularly when starting and completing calls. Mental distraction seems to be the key factor, with the phone serving to divert a driver's attention from the driving task and the road environment. Auditory distraction is arguably the least dangerous form of distraction, perhaps because auditory cues have a minimal association with safe driving.

These forms of distraction arising from phone use can result in various decrements in driving performance and lead to a marked increase in crash involvement, with the weight of evidence suggesting approximately a four-fold increase in crash risk.[2]

While it appears logical that hand-held mobiles cause the most distraction and pose the greater crash risk, it does not follow that hands-free devices are thus safe to use while driving. The exclusion of the latter from legislation does, however, imply the contrary.

3. Current policies and practices in Australian jurisdictions

Rule 300 of the *Australian Road Rules* states that a driver of a vehicle (except an emergency vehicle or police vehicle) must not use a hand-held mobile phone while the vehicle is moving, or is otherwise stationary (unless parked). Transgressing this rule can result in the loss of demerit points (e.g. three in Victoria and New South Wales, two in Tasmania and one in Western Australia) and a fine (e.g. a $135 on-the-spot fine in Victoria, $220 in NSW, $110 in Tasmania and $100 in WA).

National and local legislation, however, permits the use of hands-free telephones.

Currently in New Zealand there is no legal requirement banning the use of mobile phones while driving, although this is being reviewed. The Land Transport Safety Authority recommends that drivers not make or receive phone calls while driving.

4. A review of the research – do hands-free mobile phones have a safety advantage?

4.1 Impact on driving performance

A key study in this context was conducted in the UK.[1] Twenty experienced drivers were tested on a simulator on two separate occasions, with the independent variables being normal driving, alcohol-impaired driving and driving while talking on a hands-free or hand-held mobile phone. Results included:

- the best driving performances (based on a number of constituent measures) were obtained from those driving under normal conditions i.e. alcohol-free and not using a mobile phone
- driving under the influence of alcohol (at around a 0.08 BAC level) was significantly worse than normal driving but significantly better than driving when using either form of phone
- driving while using a hands-free mobile was generally safer than using a hand-held device but conversation remained a major cause of distraction.

As an example of the results, the distances travelled before making a braking response are shown below:

Drivers unaffected by alcohol and not using phones responded to a presented stimulus after 31 metres. Drivers using hands-free phones responded after a further eight metres, while those using hand-held phones responded 14 metres after the control group.

More recently, a New Zealand research team extended the analysis to cover usage of three types of mobile phone: hand-held, hands-free with an external loudspeaker and microphone, and hands-free with a personal single earphone.[3] The subjective driving workload of 13 experienced drivers was measured across a range of scales (including mental demand, physical demand, temporal demand, effort and frustration) while driving on a rural highway under each of the three phone conditions and also without phone use.

The results showed that all three forms of phone use were associated with increased subjective workload when compared to the control condition (no use of phone). There were also significant differences across the phone types, such that the hands-free phone with personal earphone had the lowest extra workload, followed by the hand-held phone, with the hands-free phone with external loudspeaker/microphone surprisingly having the highest workload. The research team suggested that the latter finding was probably due to the distance of the microphone and speaker from the user. This distance within a reasonably noisy environment was more likely to lead to frustration and difficulties in hearing, and subsequently to increased workload overall.

As a broad overview of the published literature:

- studies consistently show that hands-free telephone use while driving leads to significant performance impairment[4,5,6,7]
- some studies, while confirming this association, are unable to show any differences between hand-held and hands-free phones[8,9,.10,11]
- some studies show that hands-free phones have advantages over hand-held phones but are still associated with driver impairment[1,12,13]
- at least one study shows that hand-held phones have advantages over hands-free phones with external speakers and microphones.[3]

The following statement summarises the current state of play:

> … the use of cellular phones disrupts performance by diverting attention (from) the external environment immediately associated with driving. …legislative initiatives that restrict handheld devices but permit hands-free devices are not likely to eliminate the problems associated with using cell phones while driving because these problems are attributed in large part to the distracting effects of the phone conversations themselves …. [14]

4.2 The crash association

Although a driving decrement can be associated with hand-held and/or hands-free phone use while driving, it does not necessarily follow that there will be a commensurate increase in crash risk. The number of research studies that have tied phone use to crash involvement is small and only two studies that have compared the crash implications of hand-held versus hands-free devices have been identified.

In the first study[15], 699 drivers involved in non-casualty crashes in Toronto, who owned cellular phones, were identified. Each driver's phone use during the day of the collision and during the previous week was analysed through detailed billing records. The researchers used a case-crossover analysis, whereby each driver's extent of telephone use around the time of collision was compared with telephone use during an appropriate 'before' time interval. This method allowed each driver to serve as his or her own control, thereby eliminating some of the major confounding factors.

For calls made or received within ten minutes before the collision, the relative risk of being in a crash was 4.3 times (95 per cent CI 3.0-6.5) greater. This heightened risk was robust across a range of variables, including driver age, experience, social background and gender.

The researchers found that both hand-held and hands-free phones were associated with this extra crash risk and "found no safety advantages to hands-free as compared with hand-held telephones … One [possible explanation] is that motor vehicle collisions result from a driver's limitations with regard to attention rather than dexterity … our data do not support the policy followed in some countries of restricting hand-held cellular telephones but not those that leave the hands free" (p.456).

In the second study[16], about 9,000 Norwegian drivers recently involved in crashes responded to a postal questionnaire about mobile phone use around the time of their accidents. After the drivers were allocated to either an 'innocent' (judged by their insurance company as not responsible for the crash) or 'guilty' (judged as responsible) group, their respective use of mobile phones at the time of the crash was examined.

Fifty per cent of all drivers reported that they used a mobile phone while driving, with 29 per cent of all drivers using a hand-held device. Of the at-fault drivers, 0.66 per cent reported that they were using a phone at the time of the crash, compared to 0.3 per cent of innocent drivers – meaning a statistically significant overall relative risk of 2.2. Despite the very small numbers of drivers involved in crashes, the 3.6 times increase in relative risk for hand-held phone users was significant. The relative risk for hands-free phones was lower at 1.8, and was just short of statistical significance. The difference between the two relative risks was also not statistically significant.

5. Political, social and other factors

There are at least two criteria for judging whether a given issue represents a road safety concern:

- the extent to which the issue can be associated with an increased crash risk
- the proportion of the road toll which can be associated with the issue.

Using a mobile phone while driving is associated with a significantly heightened crash risk, with the risk being more or less common to both hand-held and hands-free devices. In different contexts (e.g. speeding and drink driving) the extent of extra risk has been judged unacceptable and has been targeted through legislation. This additional risk has also been used as the justification for the widespread ban on the use of hand-held mobiles while driving.

However, the available evidence also suggests that using a mobile phone while driving can be associated with only a very small proportion of the road toll:

- 0.047 per cent of all drivers killed or injured in NSW in 1996-2000 were explicitly linked to mobile phone use[17]
- 0.24 per cent of road fatalities per year in the US died as a consequence of collisions identified as related to mobile phone use[18]
- in the Norwegian study previously cited, 0.66 per cent of at-fault drivers in crashes were using their mobile phones at the time of crash, with mobile phones having been used in an estimated 0.86 per cent of all crashes.[16]

In at least some instances, the available studies almost certainly under-report the true incidence of phone use while driving, with the incidence likely to increase dramatically as the numbers of phone users grow. It remains, however, that a total cessation of mobile phone use while driving would have no immediate, discernible impact on the road toll.

Extending the ban on mobile phone use while driving to include hands-free devices has an additional disadvantage at the level of enforcement. Enforcing the ban on hand-held devices is, in principle at least, straightforward, given offenders' relative visibilities. The only major indicator when using a hands-free device, however, is lip movement, an action which could arise from any number of legitimate causes.

A further difficulty in extending the ban on mobiles to include hands-free devices, relates to impending technological developments. It is likely that, in the immediate future, the equivalents of today's mobile phones will be integrated so thoroughly with in-vehicle communications and entertainment systems that they will be beyond the scope of current legislation programs governing mobile phone use.

These difficulties notwithstanding, it remains that the ban on hand-held devices is already in place. There is an apparent inconsistency in banning one device while allowing the use of another, when both are known to be associated with a more or less comparable increase in crash risk. Further, unless carefully managed, a failure to ban hands-free mobiles may be/has been interpreted as implying that their use is safe – a perception that could have further disbenefits if it results in increased mobile phone use while driving.

As a possible compromise for these conflicting issues, it seems that the only practical way forward is to continue the ban on using hand-held devices while driving – with the exclusion of hands-free devices from the ban being justified (if required) in terms of enforcement practicalities. It is also recommended that all phone use while driving be strongly discouraged e.g. through public education programs and Occupational Health and Safety policies.

The extent to which the installation of in-vehicle hands-free phone facilities should be encouraged remains problematic. On the one hand, failure by employers, fleet managers and others to provide these facilities may result in increased illegal use of hand-held devices; on the other hand, the provision of facilities will inevitably be perceived as permission to use hands-free mobiles while driving, and may well counter other attempts to discourage such phone use.

6. Conclusions

On the one hand, use of mobile phones while driving is not a major road safety issue, contributing to under one per cent of all casualties, so far as can be judged from the available research. On the other hand, the individual driver’s risk of being involved in a crash while using a phone is increased approximately four- fold.

Completely banning mobile phone use while driving is presently problematic, if only from an enforcement point of view. In the meantime, it remains that the most viable option open to jurisdictions which wish to regulate phone use while driving, is to continue to target hand-held units through enforcement, backed by appropriate public education campaigns to discourage all mobile phone use while driving.

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PROMOTING VEHICLE CRASHWORTHINESS

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30 June 2003.

1. A brief statement of the issue

Australia's national road safety strategy assumes that continuing improvements in vehicle crashworthiness will result in a 10 per cent reduction in fatalities per 100,000 population by 2010, provided that current levels of commitment are maintained.[1]

The purpose of this paper is to demonstrate that improved vehicle design standards have led to improved crash performance under both controlled conditions and on the road.

2. An assessment of the road safety issue

During the early to mid 1970s in particular, a series of Australian Design Rules (ADRs) was introduced in Australia to improve vehicle occupant protection[2]. Examples during 1969-1972 included:

- ADR 4 (seat belts fitted to front seats)
- ADR 2 ('anti-burst' door latches and hinges)
- ADR 10A (energy-absorbing steering columns)
- ADR 22 (head restraints).

Examples during 1975-1977 included:

- ADR 5B (improved location of seat anchorages)
- ADR 4C (dual-sensing locking retractor inertia reel seat belts)
- ADR 29 (improved side door strength).

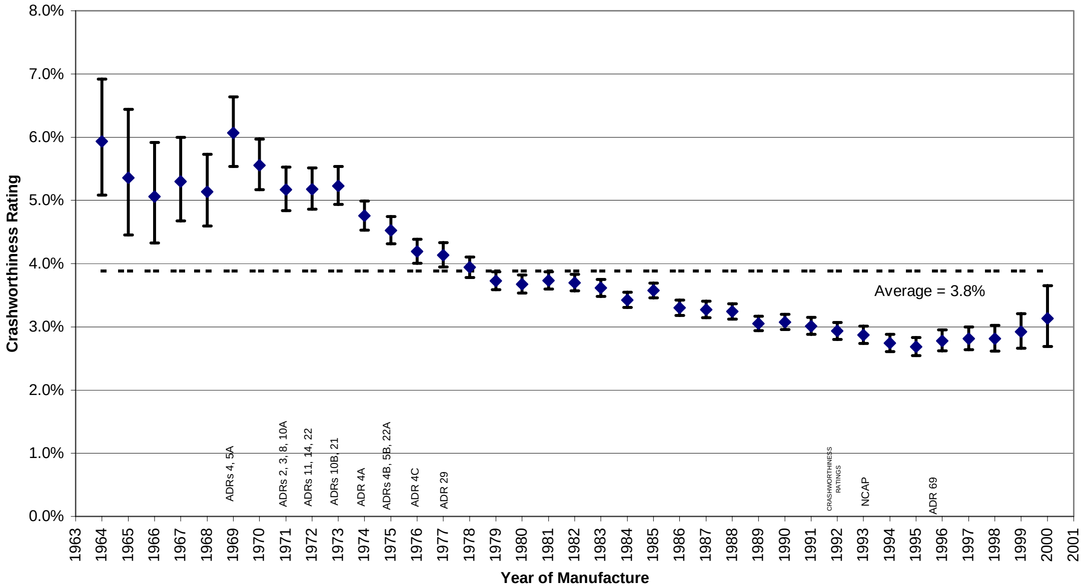
The safety emiles/hourasis in the manufacture of vehicles has continued through two developments in particular[2]:

- The introduction of programs to advise consumers of relative vehicle safety. The Australian New Car Assessment Program (ANCAP) assesses relative vehicle safety through a program of crash barrier testing. A series of studies, based on vehicles' performance in real crashes reported to Police, is conducted by the Monash University Accident Research Centre (MUARC) and marketed as Used Car Safety Ratings (UCSR). Both programs commenced in 1992 and continue to be conducted.
- The development and implementation of ADR 69 in 1995, ADR 72 in 1999 and ADR 73 in 2000 have also been important, in that they have produced major improvements in standards for frontal and side impact occupant protection.

The finding that improved design standards have indeed led to improved crashworthiness, under both controlled conditions and on the road, needs to be vigorously promoted if the maximum road safety returns are to be made from these developments. (Throughout this report, 'crashworthiness' relates to the protection against injury offered by the vehicle to its occupants, most often the driver, in the event of a crash.)

Figure 1 shows the relationship between vehicle crashworthiness (the risk of death or serious injury given involvement in a crash where at least one vehicle was towed away) and year of vehicle manufacture, from 1964 to 2000. It also shows the dates of introduction of major Australian Design Rules concerned with safety for passenger vehicles. Figure 1 shows a clear association between the introduction of key safety-based ADRs and improvements in vehicle crashworthiness, particularly during the 1970s.

Figure 1: Crashworthiness by year of vehicle manufacture (with 95 per cent confidence limits)
(From Newstead, Cameron, Watson & Delaney, 2003)



3. Current policies and practices in Australasian jurisdictions

All new vehicles sold in Australia must comply with all appropriate ADRs.

The implementation and promotion of ANCAP assessment is supported by the following transport authorities and automobile clubs:

- NSW Roads & Traffic Authority
- Transport South Australia
- Land Transport Safety Authority of New Zealand
- Queensland Transport
- Western Australia Department for Planning and Infrastructure
- Tasmanian Department of Infrastructure, Energy and Resources
- Federal Department of Transport and Regional Services
- RACV

- NRMA
- RACWA
- RACQ
- RAA South Australia
- Northern Territory Automobile Association
- RACT
- New Zealand Automobile Association.

Estimation of the Used Car Safety Ratings is carried out as part of a research program undertaken by the Monash University Accident Research Centre. The research program is sponsored by:

- RACV
- VicRoads
- NRMA
- RTA
- RACWA
- ATSB
- TAC
- Land Transport Safety Authority of New Zealand.

4. A review of the research

4.1 ANCAP

ANCAP is a program that tests the crashworthiness of most major current car models by conducting barrier crash tests under laboratory-controlled conditions. The primary purpose of the program is to provide consumer information on relative vehicle safety in crashes. In providing consumer information, the ANCAP program also hoped to emulate US experience of similar consumer crash test programs which led to informed consumer pressure on manufacturers to rapidly improve safety in their vehicles. Because a vehicle can be tested as soon as it is released for sale, ANCAP primarily targets consumers of new vehicles, with the program claiming to cover 70-80 per cent of the new vehicle market.

The testing procedures have varied since ANCAP was first implemented in 1992, when performance during a full frontal impact crash only was assessed.[3] Now ANCAP uses the testing procedures and rating system developed for Euro-NCAP, whereby each vehicle model is subjected to at least two crashes[4]:

- An off-set frontal impact test, whereby the car is driven at 64 km/h into a barrier with a crushable aluminium face. The crash forces are concentrated on the driver's side of the vehicle and the use of a deformable barrier simulates the effect of crashing into another vehicle.[3]
- A side impact crash, whereby the driver's side of the stationary vehicle is struck by a trolley travelling at 50 km/h.

Where vehicles have side airbags or the equivalent, their manufacturers can elect to have a third test performed to gain extra safety credit.[4] The vehicle is crashed side-on at 29 km/h into the equivalent of a round power pole, at a position in line with the head of the dummy – with any extra safety credit being for low risk of head injury.

Vehicle crashworthiness ratings derived from crash barrier testing depend heavily upon the forces experienced by dummies in the driver and front-passenger positions, restrained by the vehicle's seat belts. The dummies are fitted with sensors to detect dummy kinematics, forces and other data which would be experienced by an average male in the event of a crash, from which head injury outcomes, chest deformation, chest loading and upper and lower leg loadings can be determined.

In addition, infant (18 months) and toddler (three years) dummies are placed in child restraints in the rear seat for both crash tests. Results of these tests are, however, not considered relevant to Australia and are not published as part of ANCAP, nor are they replicated on locally-tested vehicle models. A separate child restraint evaluation program is run in Australia by the New South Wales RTA, NRMA and RACV in association with the Australian Consumers Association, with results published periodically in the form of a brochure titled 'Buyers Guide to Child Restraints'. Tests under this program are based on the Australian Standards but involve higher crash forces and additional test procedures.

Each of four body regions (head, chest and upper and lower legs) is scored up to four points, whereby a severe injury would be scored zero while a minimal injury would earn the maximum four points. Where more than one injury measurement applies for a given body region, the score for the most severe injury is used. In the offset crash test, passenger injuries also contribute to the scoring. The worst four injury outcomes on either the driver or passenger dummy for each test are combined to produce a maximum score of 32 points.

With the offset test the injury scores can be modified: for example, excessive rearward movement of the steering wheel might result in an additional penalty point, reducing a given head score of four to three. Other modifiers include airbag stability, steering column movement, A-pillar movement, structural integrity, hazardous structures in the knee impact area, and brake pedal movement.

If a pole test is conducted and the vehicle shows good head protection, two extra points are added, giving a score out of 34 points.

There is also a star rating system based on the overall score – the greater the number of stars (up to four[1]), the higher the safety rating. In addition to an overall points score and star rating, ANCAP also provides detailed summaries of each model's test performances. A full description of the ANCAP test protocols and scoring procedures can be found at www.euroncap.com.

As well as assessing the safety of vehicle occupants, ANCAP also undertakes pedestrian protection testing, which rates the protection a vehicle model offers to pedestrians in a frontal impact. The pedestrian test procedure has three components assessing different parts of the vehicle structure, using test dummy parts rather than a whole dummy. The tests aim to replicate accidents involving child and adult pedestrians in which impacts occur at 40 km/h. The component tests of the pedestrian protection assessment are:

- a legform to bumper test in which a dummy leg form is impacted into the front bumper of the vehicle
- an upper legform to bonnet leading-edge test
- headform to bonnet top in which both child and adult head forms are impacted into various areas of the top of the vehicle bonnet.

[1] Since the preparation of this paper, and the addition of further points for a seat belt reminder system, it is now possible to achieve a five-star rating.

Force measurements from the dummy components in the tests are translated into injury parameters from which a pedestrian protection star rating out of a possible four is calculated. EuroNCAP has changed the pedestrian protection test to make it more stringent, meaning that results published from January 2002 are not comparable with previous test results.

As ANCAP is fully harmonised with EuroNCAP, many of the ratings published by ANCAP are based on tests carried out in Europe by EuroNCAP. For vehicles tested in Australia, the offset frontal, side impact and pole testing is carried out by Crashlab in Sydney while the pedestrian protection testing is carried out by the Adelaide University Centre for Automotive Safety Research.

There are acknowledged limitations to the ANCAP ratings. Firstly, ANCAP does not – and does not claim to – represent the full range of crash circumstances. It has been estimated that, when the test procedures involved full and off-set frontal crashes, some 60 per cent of real-world crashes were represented[3]. Secondly, in a multi-vehicle collision, occupants of the lighter vehicle are invariably at greater risk of injury, regardless of the crashworthiness of the individual vehicles. ANCAP has therefore categorised vehicles by size and type (small, medium, large, luxury, utilities and four-wheel drives) and has recommended that comparisons are most meaningful only when made within categories. Notwithstanding this, it is generally acceptable to compare vehicles' point scores or star ratings with regard to crashes into fixed objects, regardless of the size or category of the vehicle.

Australia is not the only country to rate relative vehicle crashworthiness using a crash barrier test program. As noted, ANCAP uses the same test protocol and shares results from the Euro-NCAP test program operated in Europe. Similar programs also operate in the USA, Japan and Korea, although the test protocols and scoring procedures used in these programs differ in their detail.

4.2 Assessing crashworthiness from data on real crashes reported to police[5]

Vehicle safety ratings based on police records of real-world crashes and injury outcomes, commenced independently in Victoria and NSW in 1990. These early efforts were soon combined into a single research program, carried out by the Monash University Accident Research Centre (MUARC), which now prepares vehicle safety assessments at regular intervals. These ratings are published as Used Car Safety Ratings (UCSR) by the organisations that sponsor the research. The used car marketing focus is used primarily to differentiate the real crash-based ratings from those derived from the crash barrier tests discussed above which generally focus on new vehicle model releases.

Incomplete reporting of the injury outcomes for vehicle occupants other than the driver in police crash reports means that the ratings only cover injury outcomes for vehicle drivers. In the MUARC reports, the UCSRs, referred to as crashworthiness ratings, are calculated as the product of two factors:

- The injury rate of drivers involved in tow-away crashes (injury risk).
- The serious injury (death or hospital admission) rate of injured drivers (injury severity).

A vehicle's crashworthiness rating is therefore an estimate of a driver's risk of being killed or admitted to hospital once involved in a crash where at least one person is injured and/or requiring at least one vehicle to be towed away. A rating of 3.93 (the current average of all vehicles with 'useable' crashworthiness ratings) means 3.93 drivers killed or admitted to hospital per 100 tow-away crash involvements.

The most recent report[5] has been based on crash data from Victoria and NSW for 1987-2000 and from Queensland and Western Australia for 1991-2000 – in total, involving 1,007,045 drivers in determining injury risk and 199,676 drivers in determining injury severity. After controlling for a number of influences (driver sex and age, speed limit at the crash location, year of occurrence, State of occurrence and number of vehicles in the crash), statistically-reliable crashworthiness ratings have been obtained for 213 vehicle models manufactured between 1982 and 2000. ('Statistically reliable' means that the confidence intervals associated with the ratings fell within specified limits.)

Further, 51 models of passenger cars, four-wheel drive vehicles, passenger vans and light commercial vehicles have been identified as significantly superior, and 44 models as significantly inferior, compared to the average crashworthiness across all vehicles in the analysis. Looking at this spread of results in more detail (and without considering the confidence intervals):

- The safest model had less than half the risk of death or serious injury in a tow-away crash, compared to vehicles with average crashworthiness.
- The least safe model had more than double the risk of death or serious injury in a tow-away crash, compared to vehicles with average crashworthiness.
- The least safe model had more than five times the risk of death or serious injury in a tow-away crash, compared to the safest model.

The same report[5] has looked at changes in vehicle crashworthiness over the years. Taking vehicles manufactured between 1964 and 1969 as the base measure, it was found that the risk of death or serious injury in tow-away crashes had halved for drivers of vehicles manufactured between 1991 and 1998. Put another way, current vehicles are, as a group, twice as safe (as measured by crashworthiness) than vehicles manufactured some thirty years earlier.

This measure of improvement was not, however, evenly spread across all vehicle categories. While large, luxury, medium and 4WD categories have shown general improvement with each year of manufacture, the small, sports and commercial categories have tended towards reduced crashworthiness from 1993 onwards. Two reasons have been suggested for this decline[5]:

- A consumer trend towards purchasing the cheapest but least safe vehicles.
- Polarisation of the Australian vehicle fleet in terms of size, whereby the mid-1990s onwards experienced a sales shift from medium to either small or large car sales. The increased number of larger cars is most likely to impact on the crashworthiness ratings of smaller, lighter vehicles.

4.3 Do the two sets of crashworthiness ratings agree?

Both the Used Car Safety Rating and ANCAP programs purport to measure relative vehicle occupant protection in a crash. In examining the detail of each rating system, however, it is clear that each is measuring a different aspect of vehicle safety. Injury assessment in the ANCAP program is based primarily on the Abbreviated Injury Scale (AIS), which measures the risk of death. As described, ANCAP tests cover a fixed set of crash configurations, impact speeds and occupant characteristics. They do not reflect the role of vehicle mass in crash outcomes. In contrast, the UCSRs measure the risk of death or hospitalisation in a crash severe enough for at least one person to be injured or a vehicle to be towed away. They cover all crash configurations, impact speeds and driver characteristics, albeit with the profile of these standardised across vehicle models compared through use of advanced statistical analysis methods. They also reflect the role of vehicle mass in real crash outcomes. Because of these key differences, it is not necessarily expected that each rating system will lead to the same assessment of relative safety within a group of rated vehicle models.

MUARC investigators have undertaken a number of studies to assess the extent of agreement between the two rating systems. These studies have compared barrier test results with real crash data from Australia, the USA and Europe. A paper summarising the key findings from these studies[6] drew the following conclusions:

- On *average*, there appears to be consistency between the ratings based on real crash outcomes and the barrier test-based ratings.
- This general consistency appears to stem from a strong relationship on average between the barrier test ratings and the injury severity component of the real crash-based ratings (the risk of death or hospitalisation given that some level of injury was sustained). There seems to be little relationship between real crash injury risk (the risk of any injury given involvement in a crash) and the barrier test outcomes.
- The removal of vehicle mass effects from the UCSR crashworthiness measure generally increased the strength of the association with the barrier test measures, as did the consideration of real crash configurations similar to the barrier test configurations (for example frontal impact crashes).
- Although on average overall, barrier test measures appear to be consistent with the real crash measures of vehicle safety, there is not necessarily consistency when comparing ratings for a specific vehicle model. There is a possibility that individual vehicles predicted to have the same safety level by barrier testing will have significantly different estimates of safety based on analysis of real crash outcomes. The converse is also true.

It is encouraging that the conclusions above indicate an overall consistency between the two rating systems (for example, the average real crash safety of vehicles in the ANCAP 4-star category is better than that in the lower-star categories). This is illustrated in Table 1, which is taken from Newstead and Cameron (2002) and which shows average injury risk, severity and UCSR calculated from British crash data for vehicles in each EuroNCAP star category. It shows clearly that, when injury severity and UCSR ratings decrease, the EuroNCAP star rating increases.

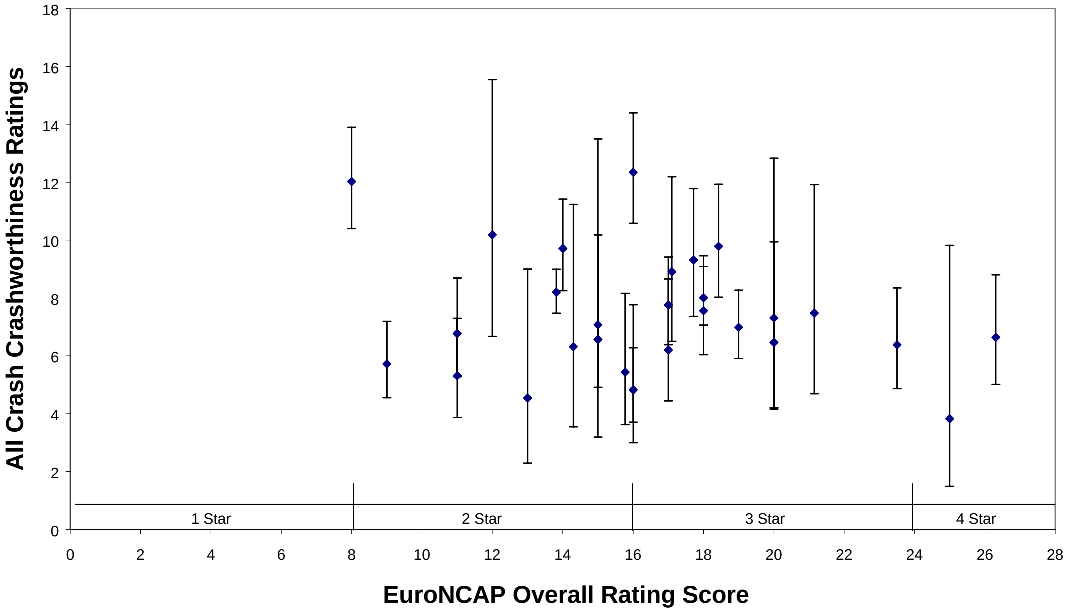
Table 1: Average UCSR estimated from UK data vs. overall EuroNCAP Star Rating

		Crashworthiness estimated from police reported crashes in Great Britain		
		Injury risk	**Injury severity**	**Used car safety rating**
Overall	**1**	75.03	16.02	12.02
EuroNCAP	**2**	65.39	12.23	8.08
Star	**3**	65.40	11.92	7.81
Rating	**4**	66.61	9.39	6.27

N.B.: The lower the UCSR score, the greater the crashworthiness.

However, this consistency frequently did not hold up at the level of individual models, as shown in Figure 2 taken from Newstead and Cameron (2002). For example, Model A with a 4-star ANCAP rating may or may not have better real crash performance than Model B with a lower-star rating.[6]

Figure 2: UCSR estimated from UK data vs. overall EuroNCAP star rating for individual vehicle models.



To some extent, this less-than-complete association can only be expected, given in particular the markedly different approaches used in collecting injury information[7], along with the differences in crash configurations and circumstances represented by the two rating systems. However, it has been demonstrated that it is possible, without changing the current basic measurement procedures for either rating system, to develop weighted rating systems that will potentially provide even more consistency between the two measures of crashworthiness, particularly on a model-by-model comparison basis[7].

5. Political, social and other factors

There can be no doubt that the new vehicles coming on to the roads in Australasia are safer on average than their predecessors, despite the minor role that safety seems to play in most vehicle promotion campaigns.

The existence of two sets of crashworthiness ratings promoting safety ratings as a key factor in vehicle selection could potentially lead to some consumer confusion when comparing the relative performance of individual vehicle models. For the present, promotional campaigns have minimised the potential for confusion by adopting the following strategy:

- promoting ANCAP ratings for new vehicle purchases
- promoting real crash performance for older (used) vehicles.

This strategy may become difficult to sustain, however, as the number of models with both sets of ratings grows. To some degree, this problem is alleviated by constant changes to the ANCAP test protocol and scoring system, which means that the number of vehicle test results that are directly comparable within that rating system alone are limited. In contrast, ratings for each vehicle model in the Used Car Safety Ratings are re-estimated at each ratings update and are always internally compared. Clearly, the consumer considering the use of both rating systems needs to be fully informed about the content and interpretation of the information presented in each, and to be steered towards the system that offers the best information in the context of their impending vehicle purchase.

An ultimate goal would be to somehow harmonise the information presented by ANCAP and the UCSR into a consistent format. Ongoing research aiming to resolve differences between the ratings, and to develop a single safety system, is to be both welcomed and, where appropriate, supported. This may require willingness amongst barrier-test developers to consider changes to their scoring procedures to make them more consistent with real crash outcomes. Early promise has been offered in this area by research to date.[6] Alternately, or simultaneously, changes to the UCSR system may also be possible to help to achieve this aim.

Differences aside, both rating systems fulfil the role of raising the profile of vehicle safety in the community consciousness. They also both provide a mechanism for monitoring the progress of the vehicle manufacturing industry and vehicle standards regulators in improving vehicle safety standards, through which impetus is provided to make further gains.

As a final consideration, the distinction between vehicle crashworthiness and aggressivity needs to be established. Whereas the former refers to a vehicle’s capacity to protect its occupants in the event of a crash, aggressivity refers to the risk of injury that a given vehicle model represents to other road users – either occupants of other cars or unprotected road users (pedestrians, bicyclists and motorcyclists). Any vehicle safety purchase policy that fails to consider aggressivity could well find itself, for example, promoting the proliferation of large four-wheel-drive vehicles, thereby substantially increasing the overall risk on the roads.[2]

Certainly the early evidence suggests that vehicle aggressivity is a characteristic of vehicle safety performance that is quite independent of crashworthiness.[7] In other words, how well a vehicle protects its own occupants in a crash does not necessarily have a bearing on how it protects other road users with which it collides. This suggests that vehicles can be designed to perform well in relation to both crashworthiness and aggressivity. Indeed, there are examples of vehicles currently available that perform well in both dimensions.

To date, the measures of aggressivity that have been developed by researchers in Australia [2,5] pertain only to 96 individual vehicle models – only 23 of which have ratings either significantly better or significantly worse than average. As this situation improves and the amount of data increases, it will be essential that aggressivity ratings also be considered in future vehicle safety campaigns. In this context, it is also worth noting that the Australian Transport Safety Bureau is undertaking a research program to develop an assessment of vehicle compatibility based on crash testing.

6. Conclusions

Substantial improvements in vehicle occupant protection mean that modern vehicles are overall twice as safe as those manufactured some three decades ago. However, the level of crashworthiness is not evenly spread across all vehicle makes and models, with the least safe model having more than five times the risk of death or serious injury when involved in a crash, relative to the safest model.

Stronger promotion of vehicle crashworthiness as a key factor in purchasing a vehicle represents a meaningful road safety countermeasure that has been far from fully exploited. However, programs in this area must also consider the issue of aggressivity (i.e. the risk of injury that a given vehicle model represents to other road users) in promoting particular makes and models.

7. References

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INFORMATION RETRIEVAL

Austroads (2005) **Australasian Road Safety Handbook: Volume 2**, Sydney,, A4, 125pp, AP-R268/05

KEYWORDS:

Road improvements; black spots; road safety audits; road safety advertising; speed; speed limits; seatbelts; school buses; rehabilitation; drink driving; daytime running lights; medical tests; driver testing; motorcycles; driver licensing; child restraints; road safety education; driver distraction; cell phones; crashworthiness

ABSTRACT:

Volume 2 of the Australasian Road Safety Handbook aims to provide an up-to-date summary of research and other considerations in regard to the following key topics:

- Road improvements as a road safety measure
- Road safety impact of road safety audits
- Maximising the road safety impact of advertising
- Road safety implications of excessive and inappropriate vehicle speed
- Road safety impact of fitting seat belts to school buses
- Road safety impact of rehabilitation programs for traffic offenders
- Road safety impact of medical testing of drivers
- Road safety impact of motorcycle training and licensing schemes
- Road safety implications of daytime running lights
- Improving child safety restraint systems
- Road safety education in schools
- Road safety implications of driver distraction
- Road safety implications of using hands-free mobile telephones while driving
- Promoting vehicle crashworthiness.

The overview for each topic generally consists of the following components:

- a statement of the key road safety issue(s)
- a description of current practices and policies in Australasian jurisdictions
- a summary of the research findings
- the identification of the various political, economic and other factors that may influence any official response
- the conclusions to be drawn.