

Centre for  
Automotive Safety Research



THE UNIVERSITY  
OF ADELAIDE  
AUSTRALIA

# 2006 Annual Report



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# Director's report



The Centre for Automotive Safety Research (CASR) at the University of Adelaide is the oldest road safety research group in Australia. Established 33 years ago as the Road Accident Research Unit, we conduct high quality research in a range of areas related to crash and injury causation. While there are many topics that could be investigated under the heading of "road safety research", our emphasis on at-scene crash investigation enables us to readily identify the more worthwhile topics to study.

A large proportion of our budget continued to be allocated to at-scene crash investigation during 2006. We now have a well-established regular reporting routine where presentations are made to engineers from the South Australian Department for Transport, Energy and Infrastructure on relevant features of crashes which we have investigated. These features range from site-specific concerns through to more general aspects of the road infrastructure and traffic control practices.

In 2005, we described the benefits arising from in-depth crash investigation at the seminar we convened in Bangkok in collaboration with Khon Kaen University. This led to the Thai Government Office of Transport Planning (OTP) decision to fund crash investigation teams at five universities in Thailand and to a request for CASR to conduct a one week training course in Adelaide in March 2006. This course was attended by 18 engineers from these universities and Thai government agencies. An expenses-paid invitation was later extended by OTP to Jack McLean to present a keynote address at the third annual national road safety conference which was held in Khon Kaen, Thailand in November 2006.

CASR was approached by the Australian National Transport Commission (NTC) to conduct a heavy vehicle speed and crash involvement case-control study, similar to the two studies we have conducted on passenger cars. As we were not

confident that we would be able to investigate enough heavy vehicle crashes and obtain the data needed to estimate the travelling speed of the heavy vehicle before the crash, the focus of the study has been changed to an investigation of existing information in Australia that is relevant to heavy vehicle travelling speed and crash involvement.

CASR commenced a major study of the offence and crash experience of more than 50,000 young drivers over a five year period during 2006. The main aim is to search for patterns or trends which may lead to the development of measures to reduce the crash risk of this group of drivers. Based on police accident reports and driver licensing data, this project is being conducted by Craig Kloeden and is funded by Austroads.

The CASR Impact Laboratory continued its long-standing participation in the Australian New Car Assessment Program (ANCAP) by

conducting tests of the level of protection afforded by a car to a pedestrian in the event of a collision. Additionally, we also completed work on a collaborative study on pedestrian safety and vehicle design with Mitsubishi Motors Corporation (Japan). That study involved at-scene crash investigation, computer modelling, and physical reconstruction of the pedestrian's head impact with the vehicle.

A comparison of the relative safety for a pedestrian of the front of a selection of 4WD vehicles with and without a bull bar fitted was completed in 2006 for the Motor Accident Commission in collaboration with ANCAP. With one exception, the addition of a bull bar substantially degraded the predicted level of pedestrian safety.

CASR continued to contribute to the activities of the International Harmonised Research Activities Pedestrian Safety Expert Group, particularly in the area of



computer modelling of the pedestrian-car collision where we coordinate the work of members of the Expert Group. In an unrelated development, agreement was reached with INRETS, the French Government Transport Safety Research Institute, to set up a collaborative research program on computer modelling. CASR's participation will be funded by Vehicle Safety Standards of the Federal Department of Transport and Regional Development, which continues to support our work on computer modelling. INRETS has committed 25,000 Euros to this project.

A new one-semester course on Automotive Safety was presented by CASR as part of the Automotive Engineering Degree Program in the Department of Mechanical Engineering at the University of Adelaide. Guest lecturers included two engineers from Ford Motor Company, one from Bosch, and one from Autoliv. The course is run by Robert Anderson.

Two engineering graduates commenced their PhD candidatures with CASR in 2006. Their fields of research are brain injury models, in one case, and the relevance of electronic stability control to crashes included in our at-scene crash investigation program in the other. They are the first doctoral candidates to have enrolled solely under the supervision of CASR's staff, rather than under a co-supervisory arrangement with another department of the University.

Staff members continued to respond to media inquiries and to contribute to the work of the South Australian Road Safety Advisory Council and its associated Sub-Committees and Task Forces. CASR was also invited by the Combined Emergency Services of South Australia to participate in a demonstration and training exercise which involved rolling a transit bus down a cliff face. Jeremy Woolley advised the organisers on the installation of three point seat belts in the bus and on other matters relating to the exercise, including the placement of video cameras to ensure that the motions of the restrained dummy

could be compared with those which were unrestrained as the bus rolled down a quarry face.

CASR published reports and papers on a wide range of topics during 2006. A comprehensive review of whiplash associated disorders and a report on factors associated with the causation of rear end collisions addressed one of the major areas of concern in road safety in general and for the Motor Accident Commission in particular. Self-regulation of driving in relation to older drivers' functional abilities, the role of medical conditions in crash causation, and advice on the choice of type of child restraint by age of child were other topics. The role of travelling speed and speed limits in crash and injury

causation was addressed in reports on the reduction of the speed limit from 110 to 100 km in a rural area and as a factor in rollover crashes.

Although a substantial proportion of our research program is conducted under contract with outside bodies, both in Australia and overseas, we gratefully acknowledge the continuing support from the Department for Transport, Energy and Infrastructure and the Motor Accident Commission, which gives us the freedom to conduct independent research and, in particular, encourages younger staff members to plan for a career in road safety research.

*Jack McLean*  
Director





# Research highlights



## Crash investigation

CASR's program of at-scene crash investigation distinguishes it from other road safety research groups in Australia and from many overseas. CASR crash investigators attend the scene of a road crash when an ambulance is called. One member of the team photographs the crash scene and marks the final positions of the vehicles, while another investigator identifies the people involved in the crash, including those transported to hospital by ambulance, and attempts to speak with any witnesses to the crash.

Detailed photographs and measurements are taken of relevant damage to the vehicles, and the site is surveyed and a scale plan prepared. Later, information is obtained on the injuries sustained, and interviews conducted with those crash participants and witnesses who are willing to be interviewed.

The crash and the resulting injuries are reviewed at regular CASR meetings, and relevant factors are identified. The crash history of the site is examined and compared with findings from the case review. About 100 casualty road crashes are investigated in this manner each year and the Centre is currently investigating rural crashes that occur outside the metropolitan area and up to 100 km from Adelaide.

Regular presentations are made to regional managers and senior engineers at the South Australian Department for Transport,

CASR's research program covers a number of areas of road and vehicle safety. From injury biomechanics to the analysis of mass crash records to understanding younger and older drivers, CASR's breadth and depth of knowledge make it a sought after resource for research and information.

Energy and Infrastructure on matters arising from the investigations that are relevant to the safety of particular locations and to the safety of the road and traffic system generally.

Our at-scene, in-depth approach yields a wide range of detailed information that can be gathered in no other way. Two studies by the Centre on travelling speed and the risk of crash involvement were feasible because we could collect the data needed to calculate speeds at the scene of the crash. We can obtain a much clearer understanding of road crashes than is possible from the very limited information in routine police reports.

## Impact laboratory testing

CASR studies the influence of vehicle design on pedestrian injury in a collision. The Streeter Impact Laboratory is a central component of our pedestrian safety research, which considers both accident prevention and injury mitigation through vehicle design.

It is the only laboratory in Australia able to conduct pedestrian "sub-system" impact tests on vehicles. It is equipped to assess the danger posed by the front of a vehicle to a pedestrian. Our study does not use crash test dummies, as is done with studies on occupant protection, but "sub-systems" that represent, separately, the head, upper leg, and lower leg of a pedestrian. These sub-system impactors

are launched at the stationary vehicle. The laboratory's main client is the Australasian New Car Assessment Program, who regularly publishes the results of the pedestrian sub-system tests (see "Pedestrian testing for the Australian New Car Assessment Program").

Quantifying and studying the impacts between a pedestrian and a vehicle in a crash can lead to a better standard of pedestrian protection. We have used the laboratory extensively in the reconstruction of actual pedestrian crashes to relate injuries to the head to the forces that produced the injury. Our expertise in the laboratory complements the unique data on real-world pedestrian injury we have compiled, in building a knowledge bank that will help ensure greater protection of pedestrians in the future.

## Computer modelling and reconstruction of pedestrian crashes

CASR continues to devise simulation tools to study how pedestrians are injured in collisions with vehicles. The simulation represents the pedestrian as a 'multi-body' model of segments connected by kinematic joints. The properties of the model are based on the properties of the human body as measured in human volunteer tests, and validated against published data from tests on human cadavers.



The modelling provides information on head impact speeds typically encountered in pedestrian crashes. This in turn is used to develop test methods to assess the pedestrian safety of vehicles. Our current interest extends to developing methods of modelling crashes that account for any uncertainties in the reconstruction of the crash.

Honda R&D Co.Ltd. has created a crash test dummy, POLAR II, for simulating a collision between a car and pedestrian. CASR has conducted three reconstructions of actual accidents to see how the dummy simulation compares with computer modelling, sub-system tests and the actual

accident. Much of this work took place at the Japan Automobile Research Institute and at Honda R&D Co. Ltd. in Japan.

More recently, we have embarked on a major study of pedestrian injury mechanisms with Mitsubishi Motors Corporation, Japan. (Read more about this in the following Projects Section.) We are devising improved methods of characterising the interaction of the pedestrian and the vehicle, to improve numerical simulations of the vehicle-pedestrian collision. We are using these methods to reconstruct, via simulations, the forces placed on the human body in ten collisions we investigated at the scene.

## Analysis of mass data

There are several types of data that are useful to our research and which are collected and collated routinely. The most important is the information about road crashes that is recorded by the police. This has some biases and errors in it, but is nevertheless invaluable for tackling many research questions. Mortality and hospital inpatient statistics often give better information about injury. Other databases or datasets are useful for converting crash numbers to crash rates, such as datasets on how much travel people do, driving licences, and vehicle registrations.

CASR is often tasked with answering questions that can involve the interrogation of any of these datasets. This is achieved through complex queries and, sometimes, data-matching different sets of data. For example, the licence records of thousands of novice drivers were matched with crash records to study the relationship between how, where, and when licences are obtained and the likelihood of crashing in the months following licensure.

Other recent examples of CASR projects that have used such techniques include examining trends in crash numbers in South Australia and analysing the effect of reducing the default urban speed limit from 60 km/h to 50 km/h.

CASR is also developing a web-based interface to mass accident data. The interface, known as WebTARS (Web interface to the Traffic Accident Reporting System), allows simple statistics to be compiled, such as the annual road toll over a period, to more complex reports on site-specific, crash type-specific crash numbers and cross tabulations between different variables. This is providing a powerful tool to both CASR staff and personnel at DTEI and MAC for studying and exploring the nature of crashes within South Australia.

## Pedestrian testing for the Australian new car assessment program

One of our most significant clients is the Australasian New Car Assessment Program (ANCAP). ANCAP is a consortium of Australian and New Zealand motoring clubs, State government departments, and motor injury insurance authorities. It provides vehicle buyers with information on the crash performance of vehicles, including side impact tests, offset-frontal tests and pedestrian tests. Since 1999 we have been contracted to perform the pedestrian tests, and since 2000 we have tested 57 vehicles for the program.

The tests are designed to measure the risk of injury to pedestrians in a collision with the front of the vehicle. Many kinds of crash test use instrumented dummies to measure injury risk but for pedestrian safety tests, 'sub-system' impactors representing different regions of the body are used. The different impactors represent the head of an adult pedestrian, the head of child pedestrian, the upper leg of an adult pedestrian and the knee/lower leg of the pedestrian.

The headform tests are conducted on the bonnet and at the base of the windscreen at a speed of 40 km/h (the windscreen itself is considered to be 'safe' and unlikely to cause serious injury on its own). Twelve different locations are tested, and manufacturers can nominate extra tests and locations to modify the test score. The results of the headform tests contribute most strongly to the overall assessment of the vehicle. The headform measures impact deceleration, and this is used to rate the severity of the impact.

The upper legform tests are conducted along the leading edge of the vehicle, around the forward-most area of a passenger vehicle's bonnet. The impactor measures the severity of the impact and the risk of fracture to an adult pedestrian's femur and pelvis.

The full legform tests are conducted along the front bumper of the vehicle, and it measures the risk of ligament damage to the knee and the risk of fracturing the tibia and fibula. Knee injury is assessed by examining the kinematics of the 'knee joint' in the legform and tibia/fibula fracture risk by the impact deceleration of that part of the legform.

Individual test scores are summarised by a star rating between 0 and 4. Generally, the testing has shown a range of results, with some vehicles clearly designed to ensure some level of protection for pedestrians, while other vehicles have performed poorly. The test scores generally lie in the range of one to three stars.

**For more information on the program, please visit <http://www.ancap.com.au>**

# Library



CASR holds the largest and most comprehensive collection of road accident material in Australia.

The highly specialised library provides support for the research staff of the Centre by way of literature reviews, current awareness services and inter-library loans, and also provides limited reference support to affiliated organisations and other libraries.

The library holds a comprehensive collection of primary and secondary materials including the latest research reports, conference proceedings, journals and books from both Australia and overseas.

The collection focuses on the areas of road accidents, road safety, head and brain injury, spinal injury, neck injury, biomechanics of

injury, vehicle occupant protection, injury prevention, road accident statistics and epidemiology.

The Centre's website (<http://casr.adelaide.edu.au>) allows for the dissemination of this information and includes a link to the library catalogue as well as electronic copies of current awareness bulletins listing items recently added to the library collection.

The CASR Library produces a weekly email news-alert service, which informs those involved in road safety research or policy of the latest Australian and international developments.





# Teaching

CASR has an established research role within the University. It is now expanding to train the future researchers and engineers who will have to apply and extend current knowledge about road and vehicle safety.

In 2006 CASR undertook three major teaching initiatives; The provision of a semester subject on vehicle safety for final-year Automotive Engineering students, the provision of a short course on crash investigation for a team of engineers from Thailand (See box, "In-depth crash investigation training for Thai road safety project"), and the establishment of a postgraduate research program within the Centre.

The undergraduate course taught students about the principles of passive and active safety in automotive design, and the role of safe vehicles within a broader context of road safety. The course was coordinated and substantively delivered by CASR staff, but also involved guest lectures from Ford Australia, Autoliv Australia (who design and manufacture restraint systems) and Bosch Australia (who develop Electronic Stability Control Systems). The course was also supported by Advea Engineering who donated the software tool MADYMO. This meant that the students were trained in the use of the software and could use it to study the theory of energy management as applied to the design of seat belts.

CASR's postgraduate program allows students to enrol in the Centre itself; previously postgraduate students involved in the Centre's projects were enrolled elsewhere in the University. The new arrangements allow us to actively promote positions and recruit students who may be interested in pursuing a research career in road and vehicle safety.

## In-depth crash investigation training for Thai road safety project

In March 2006, CASR presented a course on "Establishing an in-depth crash investigation study" to 18 visitors from Thailand. Professor Jack McLean, the Director of CASR, was a pioneer many years ago in the in-depth at-scene investigation of road crashes, and CASR has continued this work to the present. Previously (March 2005), the Centre had organised a seminar on road safety held in Bangkok (generously supported by Takata Corporation), and the idea for the course came out of that meeting.

The World Health Organization dedicated World Health Day 2004 to road safety. The very good reason for this is the enormous increase in road deaths and injuries occurring as motorisation takes places in the developing world. The aim of the CASR course was to help in the transfer of knowledge from the developed countries to those in the process of motorisation. Much of the motorising world is where the developed countries were 70 years ago, with death rates 10 or 20 times higher than now.

In-depth crash investigations involve the investigators visiting the scene of the crash, talking to those involved and witnesses, examining the vehicles, later finding out from medical sources what injuries were sustained, possibly having access to blood analyses, and possibly having access to police files. It is common to aim to reach the scene of the crash before the vehicles are moved and while witnesses are still there, but some research teams do not do this. A detailed site plan is prepared, there is an attempt to understand why the crash happened, and to determine the movements of the vehicles during the crash. There may or may not be an attempt to understand the exact mechanism of injury.

There were six main themes or types of activity during the course. Description of the procedures of crash investigation. Presentation of cases. Equipment. Practical exercise: Putting together a crash investigation report. Library. Supplementary issues.

Among the most important reasons for doing in-depth studies are the following. 1. For greater understanding of what happens in crashes, and the ways in which safety equipment can fail to operate in the ways intended. Quite small details about road and vehicle design may be important, and even today any country may discover something about their own roads and vehicles that differ from other countries. 2. To say something about a specific site. Discoveries could in principle be made via the investigation of non-crashes; that is, some sort of road safety audit or traffic conflicts study. Perhaps more should be done along those lines. But it is more convincing to do an in-depth study and report that a particular type of crash did occur, rather than could occur. 3. Educating and increasing the expertise of the people doing the investigation. Many discoveries may come by other routes, such as statistical analysis of mass accident data, crash testing in a laboratory, computer programming of crash events, or economic analysis of which policy measures are worthwhile and which are not. However, this understanding is deepened by careful study of individual cases. 4. Sophisticated uses of the data collected: for example, as a basis for case-control studies, or to compare real events with what computer simulations predict.

The detailed study of individual crashes certainly brings home to the investigator the multiplicity of factors that are involved. But it is only part of the total picture of road safety research: particularly, reliable briefer information collected by the police or hospitals is vital to many decisions made by local and national government. However, a group conducting in-depth crash investigations needs also to be involved with a variety of other research approaches, to make its full contribution to road safety. At CASR, the more important of these are:

- Crash injury biomechanics: both the vehicle and the human body, both impact testing and computer simulation.
- Analysis of routinely-collected datasets on crashes.
- Experiments on human performance.
- Consideration of traffic and transport systems.
- Evaluation of policy proposals and policy changes.
- Literature reviews.



# Project summaries

## Further evaluation of the South Australian default 50 km/h speed limit

On 1 March 2003 the default urban speed limit in South Australia was reduced from 60 km/h to 50 km/h. On-road speeds prior to the introduction of the default limit were compared with speeds one and three years later. The numbers of casualty crashes and casualties in the three years prior to the introduction of the default limit were compared with the corresponding numbers in the three years after the default limit came into effect. On roads where the speed limit was reduced from 60 km/h to 50 km/h, average vehicle speeds decreased by 3.8 km/h after three years and casualty crashes fell by 23 per cent. On roads where the speed limit remained at 60 km/h, average vehicle speeds decreased by 2.1 km/h after three years and casualty crashes fell by 16 per cent.

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## In-depth crash investigation

In 2006, CASR was active in its program of in-depth investigation of South Australian road crashes. The activity was focussed on preparation of the major end of project report for the Metropolitan In-Depth Crash Investigation Study, and on the planning and initiation of the Rural In-Depth Crash Investigation Study.

In the Metropolitan Study, CASR investigated a total of 298 crashes that matched the selection criteria. One of the major tasks for 2006 was to collate all of this information for a final report. This final report includes an overall statistical summary of the sample, plus detailed descriptions of each of the 298 crashes. These detailed descriptions include basic information such as crash type, crash injury severity, types of vehicles involved, day of week, time of day, weather conditions, lighting conditions, road characteristics, road surface conditions, and speed

zones. There is also a detailed narrative description of the events of the crash, and photographs of the crash site and the vehicles involved.

A surveyed map of the crash site is also included, showing all relevant site characteristics, and the movements and final positions of all crash-involved vehicles (or pedestrians). Finally, details are provided of the vehicles involved in the crash, the positions of the crash participants within those vehicles, the types of restraints available to vehicle occupants and whether they wore them (or safety equipment used, in the case of cyclists or motorcyclists), and the injuries of all crash participants.

The Rural In-Depth Crash Study began in the second half of the year, with significant planning and training being conducted prior to the commencement of data collection.

This study is investigating crashes outside the metropolitan area and up to 100 km from Adelaide.

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## The crash and offence experience of drivers eligible for the South Australian Driver Intervention Program

This report compared the crash and driving offence experience of two groups of offending drivers: those attending the Driver Intervention Program (DIP, a small-group workshop for disqualified L- or P-plate drivers), and those who could have attended the DIP but chose not to and paid an expiation fee instead; both before and after they became eligible for the



DIP. Concerning crashes, the DIP group did not have a statistically significantly different rate from the Expiation group. Concerning moving offences (such as speeding), the DIP group had a statistically significantly lower rate than the Expiation group. Concerning administrative offences (such as driving without a licence), the DIP group had a statistically significantly and much lower rate than the Expiation group. The fact that drivers themselves chose whether to attend the DIP or pay an expiation fee means that any differences found could not be ascribed solely to the DIP: pre-existing differences in the sex, age and offending rates were found. No comment could be made on the effect of the DIP on offences. It does seem unlikely that the DIP results in a large reduction in crash rate among its attendees. However, given that the DIP is a cheap measure and that the current study could not show that it is not having an effect large enough to justify this small cost, there is no reason in this study for its discontinuation. In the Discussion a true randomised experiment is described that would, if conducted, be expected to detect if the DIP program has a substantial impact.

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### A survey of drivers' child restraint choice and knowledge in South Australia

This study investigated the frequency of child restraint choices in a sample of 357 drivers in the Adelaide metropolitan area, who were transporting to school 586 children aged up to 10 years. The main survey result was that the rate of appropriate restraint use was between 64% and 72% on such trips, (according to weight criteria in the Australian and New Zealand Standard on child restraints for motor vehicles). Only 1% were completely unrestrained. Most of those who were not restrained appropriately had prematurely progressed to an adult seatbelt.

Appropriate child restraint use was lowest for children in the age range 5 - <7. Inappropriate restraint choice is strongly related to the child's age, their seating location (children seated in the rear being more likely to be restrained appropriately), and possibly the child's entry into primary school.

Female drivers were more likely than male drivers to know what restraints were suitable for children in their carriage. However, it did not appear to be the case that good knowledge of child restraints is predictive of appropriate restraint use.

Drivers told us that the child's safety was an important concern. But many believed that the child's safe travel could be achieved with the use of an adult seat belt. Drivers may not feel compelled to provide a forward facing child restraint or a booster seat for the children they are transporting, as state law does not mandate their use. Official guidelines are reasonably clear, but may be difficult to remember and

confusing to implement: most drivers did not cite the guidelines when asked about appropriate transition between restraints.

Barriers to booster seat use included the child's attitudes to using a booster seat. Anecdotally, children are concerned that booster seats are for babies, and see the adult belt as more "grown up". This effect may be lessened if the child's age could be used to guide restraint selection, as peer cues (for child and parent) would be more consistent. Drivers almost never mentioned cost as a barrier to child restraint use. Encouraging parents to become better informed may also help, but recommendations should be reviewed. Further development of the Australian and New Zealand Standard for child restraints may enable age to be used as the criteria for transition, thus simplifying advice to parents.

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## TARS web interface

CASR is developing a web interface to the crash data that is collected by the South Australian Police and further processed by DTEI. Currently, this interface is only available to members of CASR and DTEI and selected people from other organisations. In 2007, CASR will explore allowing a wider range of people access to this system. During 2006, the ability to plot crashes on interactive maps was added.

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## Rating bull bars for pedestrian safety

A bull bar is likely to increase the danger of a vehicle to other road users in a collision and yet, for many car owners, a bull bar rarely performs its ostensible purpose – protecting the vehicle from an animal strike.

The aim of this project was to work toward providing consumers with information on the risks to vulnerable road users associated with bull bars, so that they can make a more informed choice about whether to install a bull bar or, if they do decide to purchase a bull bar, incorporate information on pedestrian safety into their purchasing decision.

Thirteen bull bars were assessed using impact tests, as well as the front of each of the five models of vehicle to which the bull bars are designed to be fitted. The bull bars were chosen to represent the range of designs and materials used to construct the most common types of bull bar. The materials represented were steel, aluminium/alloy and polymer.

Three tests were used in the assessment: two tests using an impactor representing the upper leg of an adult pedestrian, and a test with an impactor representing the head of a child. The headform impact and one of the upper legform impacts were

with the top rail of the bull bar, and the second upper legform impact was with the bumper section of the bull bar. Equivalent locations on the vehicle, that the bull bars were attached to, were also tested. The tests were conducted at 30 km/h.

Overall, the steel bull bars tested were significantly more hazardous to a pedestrian than the front of the vehicle. This was also the case with aluminium/alloy bull bars, but to a lesser extent than the steel bull bars. The polymer bull bars of the type tested here were, in some tests, less hazardous for a pedestrian than the front of the vehicle that they are designed to protect.

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## A comprehensive review of Whiplash Associated Disorders

There is a large body of scientific and medical literature devoted to the study of whiplash and a significant proportion of this is in the form of discussion, opinion, editorials and correspondence. A search of the science citation index yields over 1,100 articles published since 1980 on the topic of whiplash, covering vehicle factors, the biomechanics, pathophysiology, psycho-sociology, treatment, rehabilitation and compensation of whiplash associated disorders.

Much of this literature reveals sharp divisions in opinion over certain aspects of whiplash, specifically related to the importance of psychosocial factors and the effects of compensation on the prognosis of acute pain due to whiplash, in the absence of overt pathological signs. Compounding this are further divisions in the literature along 'professional' lines; for example the engineering literature on vehicle factors and biomechanics does not always acknowledge or incorporate findings from epidemiological and clinical studies of whiplash. The reverse is also true.

In the midst of all of this, it is often difficult to get an overview that encompasses all aspects of whiplash research. In this report our aim was to present overviews of the whiplash phenomenon from different perspectives: epidemiological, engineering, biomechanical, biopsychosocial, and treatment. Each chapter was written by a specialist in their field. Finally we presented the results of two recent studies in South Australia that examine factors that affect the outcome of whiplash injury.

A consistent theme throughout the report is the complexity of whiplash-associated disorders. There is little direct evidence for the lesion or lesions that cause whiplash (despite some promising indicators), except at the higher grades of injury. Because of this, and the apparent sensitivity of the incidence and prognosis of whiplash to non-clinical factors, explanations have been sought that lie outside the biomedical model (in which pain can be attributed to the presence of a lesion) and instead whiplash phenomena is being increasingly viewed from a biopsychosocial perspective. This perspective seeks to explain the aetiology and prognosis of whiplash by encompassing biomechanical, biomedical, social and psychological factors.

A biopsychosocial approach does not discount the importance of seeking a mechanism of whiplash injury in biomedical terms, and it is likely that biomechanics will explain much about the incidence of whiplash injury, although the exact mechanisms are yet to be fully elucidated. Nevertheless, interventions, such as specially designed 'active' headrests, designed to minimise extreme neck motions during rear impact are showing some success in reducing the incidence of the acute injury.

For those who sustain whiplash injury, the prognosis is generally good, with a high rate of recovery. However, a small proportion of cases do go on to have

chronic complaints. It is the characteristics of these chronic complaints and their origins that seem to generate the most debate.

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### Key performance indicators of enforced driver behaviours

The Centre for Automotive Safety Research is commissioned by the Department for Transport, Energy and Infrastructure to produce an annual report quantifying performance indicators for selected enforced behaviours (drink driving, speeding and restraint use) in South Australia. These annual reports are then tabled in State Parliament.

The drink driving section includes data concerning the number of random breath tests conducted, the percentage of licensed drivers tested, the number of drink drivers detected, the number of drivers detected using random breath testing, blood alcohol levels of seriously and fatally injured drivers and riders, roadside drink driving surveys, and expenditure on anti-drink driving publicity. The speeding section provides data concerning the number of hours of speed detection, the number of drivers detected speeding, speeding detection rates, the extent of excessive speed as the apparent error in serious and fatal crashes, on-road speed surveys, and expenditure on anti-speeding publicity. The restraint use section provides data concerning levels of restraint use enforcement, restraint non-use offences, restraint use by vehicle occupants in serious and fatal crashes, on-road observational restraint use surveys, and expenditure on restraint use publicity.

For some categories of information, comparisons are made with jurisdictions interstate.

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### Characteristics of pedestrian crashes in South Australia

This study characterised pedestrian crashes in South Australia. Trends in the age profile of pedestrian crashes were examined in SA since 1981. The rate of pedestrian casualties has approximately halved over the period, driven largely by reductions in casualties under the age of 20 years. The rate of pedestrian casualty crashes has declined faster than most other categories of crash.

Serious casualty crashes occurred largely on arterial roads in the metropolitan area. Many crashes occur in the CBD, but only a small proportion lead to serious injury.

In March 2003, the default urban speed limit was reduced from 60 km/h to 50 km/h. A study of the effect of the change on the number of pedestrian crashes was examined using logistic regression. A significant and large change in the number of crashes, corresponding with the change in limit was observed.

Depending on the region examined, the change in limit corresponded with a 26 to 35 percent reduction of casualty crashes on those roads.

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### Investigation and reconstruction of pedestrian crashes

The reconstruction of actual pedestrian crashes serves two important purposes. Firstly, it provides information on how and under what forces pedestrians are injured in crashes. This information can be used to determine safe limits for impact forces in impact tests. Secondly, the way that the pedestrian is thrown on to the vehicle may be studied as this determines, for example, the speed at which the head of the pedestrian will strike the vehicle. Again, this information is useful when specifying test speeds when evaluating the relative safety of vehicle designs.





We are developing improved methods of being able to model a person colliding with a vehicle. Computer models are being used to determine testing procedures for regulation and consumer testing programs, and so the accuracy of these models is important. Under a contract from the Department of Transport and Regional Services, we conducted an audit of one of the most widely adopted computer models of pedestrian impact. This audit has documented and compared the properties of the model against measured properties of the human body that can be found in the scientific literature. This audit will provide a basis for an international collaboration to revise and improve the model through 2007 and 2008.

In 2006, we completed a study for Mitsubishi Motors Japan on the reconstruction of actual pedestrian crashes. We began by investigating around 80 pedestrian crashes in Adelaide. In ten of these cases, we created computer simulations of the collision and the resulting motion of the pedestrian. These simulations were used to set up physical tests on vehicles of the same make and model as those involved in the collision. The physical tests allowed us to determine empirically the stiffness of the part of the vehicle that was struck and this was fed back into the computer simulation. From this, we could estimate various parameters related to the impact with the head and these could be compared with the severity of any head injuries that were sustained in the crash.

**For more information please contact  
Robert Anderson:**  
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### Sensitivity analysis of comparison of benefits and costs of an alcohol ignition interlock scheme

An alcohol ignition interlock aims to prevent the motor vehicle in which it is fitted being driven by someone with alcohol in their breath. In South

Australia, a scheme operates whereby some drivers who previously committed a drink-driving offence are permitted to drive for a period only with an alcohol ignition interlock fitted in their vehicle. Work is being done on estimating the effectiveness of interlocks and of licence disqualification, and their effects on the balance between the benefits and costs of interlocks. There is also consideration of the possibility that drink drivers and their families may be excessively punished through loss of employment following disqualification of driving licence, as this is potentially avoidable with interlocks. Rather than making interlock conditions on a driving licence compulsory for some period of time, it may be better to adjust the severity of drink-driving penalties via the length of licence disqualification. But interlock conditions are appropriately an option, as in the present South Australian scheme. Most of the evidence for the effectiveness of interlocks refers to reduction in offences rather than crashes. Numerically, interlocks in their present form are unlikely to have much effect on crashes.

**For more information please contact  
Paul Hutchinson:**  
[paul@casr.adelaide.edu.au](mailto:paul@casr.adelaide.edu.au)

### Patterns of bicycle crashes in South Australia

Characteristics of pedal cycle crashes (as reported by the police) in South Australia, and how they have changed over the period 1981-2004, are examined. In 1981, pedal cyclist casualties were mostly children and teenagers. In 2004, pedal cyclist casualties were mostly spread across the age range from 16 to 49. Child pedal cyclist casualties reached a maximum in 1982-1987, and have fallen sharply since. Adult pedal cyclist casualties reached a maximum in 1987-1990, and then fell. The three main Sections of the report tabulate data for pedal cyclist casualties aged 5-15 for the period 2001-

2004, data for pedal cyclist casualties aged 16 years and over for 2001-2004, and trends over the period 1981-2004.

**For more information please contact  
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### Best practice review of SA drink drive enforcement

Drink driving continues to be a major causal factor in fatal and injury crashes. Although Random Breath Testing (RBT) has been used as an effective tool over the past couple of decades in South Australia, new legislation permitting Mobile RBT has given the Police enhanced enforcement capabilities. What is not apparent, however, is the mix of strategies that would lead to optimal drink drive enforcement in SA. This leads to many issues that could be examined:

- The resources allocated to drink driving enforcement operations
- The possibility of dedicated RBT units
- Effects of regionalisation of policing
- Times at which operations are conducted
- The effectiveness of the 'cordon bleu'
- The appropriate balance between 'overt' and 'covert' operations
- The appropriate balance between stationary and mobile RBT
- The appropriate type and level of accompanying road safety television advertising
- Equipment used, and possible applications of data-logging

The Alcohol and Drugs Taskforce of the Road Safety Advisory Council requested a project to determine what was considered best practice in terms of drink drive enforcement in the South Australian context. The aim of the project was to examine ways in which police drink driving enforcement could be optimised. The project reviewed enforcement practices that had the greatest potential to reduce the incidence of drink driving and ultimately the number of drink drive crashes in SA.

This involved a review of international literature, comparison with interstate enforcement practices, a review of SA enforcement practices and discussions with managerial and operational officers of the SA Police.

The report is being used in cooperation with the SA Police and the Drugs and Alcohol Task Force to explore ways in which drink drive enforcement can be enhanced in South Australia.

For more information please contact  
Jeremy Woolley:  
[jeremy@casr.adelaide.edu.au](mailto:jeremy@casr.adelaide.edu.au)

### Obtaining and understanding travel exposure measures

One of the challenges constantly facing road safety researchers is the estimation of travel exposure in relation to vehicle usage. Measures such as numbers of registered vehicles, licensed drivers or vehicle kilometres travelled provide some insight into macro trends but are coarse and do not reflect the subtleties that may exist on different parts of the road network.

A project was initiated to determine if a tool for travel exposure measures for road safety research could be readily created based on travel surveys conducted by DTEI. The most noted of these surveys is the Metropolitan Adelaide Household Travel Survey conducted in 1999 (MAHTS99). This survey is based on a face to face interview of a random sample of approximately 9000 households in the Adelaide Statistical Division. The objective of the survey was to collect details on the travel behaviour over a consecutive two day period of all members in a household.

Two spreadsheets were developed based on information supplied from DTEI. Variables that were useful for road safety exposure considerations were tabulated including: population demographics, trip origins and destinations, trip times and time of travel, transport modes and trip purpose were tabulated.

The project demonstrated the feasibility of using the MAHTS99 data for road safety related research. Although some limitations existed in relation to the interpretation of the data, the report documents what is potentially available in terms of exposure measures when planning future road safety research projects.

For more information please contact  
Jeremy Woolley:  
[jeremy@casr.adelaide.edu.au](mailto:jeremy@casr.adelaide.edu.au)

### ARC traffic microsimulation of the Adelaide CBD

Dr Jeremy Woolley has been leading an Australian Research Council Linkage Grant project to construct a traffic model of the Adelaide Central Business District (CBD) and its surrounding road network. The three year project finishing in 2006 was a major undertaking in cooperation with the Adelaide City Council and the Transport Systems Centre at the University of South Australia.

The project had two principal objectives:

1. To create a microsimulation traffic model of the Adelaide City Road Network

2. To explore the advantages and disadvantages of using Intelligent Transport Systems (ITS) technologies in an Australian CBD environment

The completed model allows the Adelaide City Council to explore traffic management and planning scenarios including roadworks and major community events. To date the model is already experiencing intense usage with the current tram extension and North Terrace upgrade projects. It is envisaged that applications will be made to fund the use of the model on road safety oriented projects such as the impact of adopting fully controlled right turn signal phases throughout the city or the impact of enhanced pedestrian infrastructure on traffic movements.

An agreement has been signed with the University of SA, which entitles CASR to Intellectual Property rights stemming from the project.

For more information please contact  
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[jeremy@casr.adelaide.edu.au](mailto:jeremy@casr.adelaide.edu.au)



Project reports are available online at:  
[casr.adelaide.edu.au/reports](http://casr.adelaide.edu.au/reports)



# Staff profiles



## Jack McLean, Director and Professorial Research Fellow in Road Safety

**Qualifications:** Doctor of Science in the fields of Epidemiology and Biostatistics (Harvard) 1972; Master of Science in Hygiene in the field of Environmental Health (Harvard) 1968; Master of Engineering (Adelaide) 1968; Bachelor of Engineering, Mechanical (Adelaide) 1961

**Specialised areas:** Crash injury biomechanics, with emphasis on brain injury; Vehicle, road and traffic factors in crash and injury causation; Human factors in crash causation

**Awards:** Centenary Medal, Commonwealth of Australia 2003; Basil Hetzel Leadership on Public Health Award 2002; Widmark Award of the International Council on Alcohol, Drugs and Traffic Safety 2002; SA Great Award - Health 2001; Vulcan award for best scientific paper, Australasian Road Safety Researchers Conference 1998; Medal of the International Association of Accident and Traffic Medicine 1995; Graeme Grove Medal of the Royal Australasian College of Surgeons 1989; Volvo International Traffic Safety Award 1988

**Professional affiliations:** Australian Academy of Technological Sciences and Engineering; South Australian Road Safety Advisory Council; International Harmonised Research Activities, Pedestrian Safety Expert Group, Australian representative; International Research Council on the Biomechanics of Impact (IRCOBI); International Council on Alcohol, Drugs and Traffic Safety; Standards Australia: Committee ME/83: Vehicle Frontal Protection Systems; Australian Institute of Traffic Planning and Management; Society of Automotive Engineers (USA)



## Robert Anderson, Deputy Director

**Qualifications:** B.E. (Hons), University of Adelaide (1991); Ph.D. (Mech Eng), University of Adelaide (2000)

**Specialised areas:** Brain injury biomechanics; Pedestrian injury; Simulation and modelling of pedestrians and occupants in crashes; Road safety evaluations; Sub-system impact testing to simulate pedestrian impact severity; Statistical methods; Psychology

**Awards:** Elizabeth Penfold Simpson Prize 2003 awarded by the Brain Foundation (SA); Peter Vulcan Award 2002 awarded by the Austroads Conference Committee

**Professional affiliations:** Engineers Australia Injury Biomechanics Panel; SA Road Safety Advisory Council Vehicle Restraint Use Task Force; CS-076, Standards Australia Committee for Protective Helmets for Vehicle Users; CS-085, Standards Australia Committee for Child Restraints For Use In Motor Vehicles

**Current research:** Multi-body models for stochastic modelling of pedestrian collisions; Design-for-age specifications for child restraints; Finite element modelling of mechanisms of brain injury; Estimating future benefits of vehicle Electronic Stability Control in Australia



## Paul Hutchinson, Senior Research Fellow

**Qualifications:** MA, Ph.D.

**Specialised areas:** Statistical methods; Psychology

**Professional affiliations:** Chartered Institute of Transport and Logistics; Institution of Highways and Transportation; British Psychological Society; Safety and Reliability Society; Royal Statistical Society

**Current research:** Analysis of routinely-collected crash data



## Jeremy Woolley, Senior Research Fellow

**Qualifications:** B.E. (Hons) University of South Australia; Ph.D. University of South Australia

**Specialised areas:** Traffic Management; Road Design and Infrastructure; Road Safety Audit and Risk Management; Road Safety Evaluation; Road Safety in Developing Countries; In-depth Crash Investigation; Enforcement practices; Traffic Modelling

**Awards:** Outstanding paper award (co-author), 5th Eastern Asia Society of Transportation Studies (EASTS) Conference, Fukuoka, Japan (2003); Associate Supervisor of the Year, UniSA Student's Association (2003);

**Professional affiliations:** President, Australian Institute of Traffic Planning and Management (AITPM), SA branch; Committee Member, Australasian College of Road Safety, (ACRS), SA branch; International Scientific Committee, Eastern Asia Society for Transport Studies (EASTS); Member, Speed Management Task Force (on behalf of ACRS), SA Road Safety Advisory Council; Member, Fitness to Drive Task Force, SA Road Safety Advisory Council

**Current research:** In-depth crash investigation; Road design and safety; Road Safety Audits; Traffic management and safety; Enforcement practices and road safety; Heavy Vehicle Safety; Traffic Modelling



### Matthew Baldock, Research Fellow

**Qualifications:** BA (Hons) University of Adelaide; PhD, University of Adelaide

**Specialised areas:** Older drivers; In-depth crash investigation; Fitness to drive; Alcohol/drugs and driving

**Awards:** 1995 Australian Psychological Society Prize; 2005 Frank Dalziel Memorial Prize

**Professional affiliations:** Member of ICADTS (International Council for Alcohol, Drugs and Traffic Safety)

**Current research:** In-depth investigation of rural road crashes; Longitudinal study of the driving behaviour of older drivers; Performance indicators of enforced driver behaviours (drink driving, speeding, restraint use)



### Craig Kloeden, Research Fellow IT

**Qualifications:** B.A. Adelaide

**Specialised areas:** Large data set analysis; Crash reconstruction; Speed and crash risk; Young drivers

**Professional affiliations:** Member and Webmaster of the International Council on Alcohol, Drugs and Traffic Safety

**Current research:** Developing a web interface to South Australian crash data; Tracking the crash offence experience of a cohort of young drivers over time



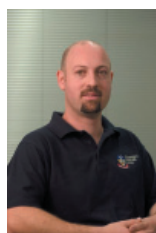
### Lisa Wundersitz, Research Associate

**Qualifications:** B.A. (Hons) University of Adelaide; Ph.D. candidate University of Adelaide

**Specialised areas:** Young driver research; Driver attitudes and behaviour; In-depth crash investigation; Intervention evaluation; Alcohol and driving

**Professional affiliations:** Driver Intervention Program

**Current research:** Personality characteristics and attitudes of young drivers; In-depth investigation of rural road crashes; Drink driving enforcement; Travel exposure measures; Performance indicators of enforced driver behaviours (drink driving, speeding, restraint use)



### Guilio Ponte, Research Engineer

**Qualifications:** B.Eng (Mechanical), University of Adelaide

**Specialised areas:** Crash Investigation; Computer Aided Reconstruction; Pedestrian Sub-system Testing; Vehicle Safety Testing and Assessment

**Awards:** Vulcan award for best scientific paper, Australasian Road Safety Researchers Conference 1998

**Current research:** Rural Crash Investigation; ANCAP Pedestrian Testing



### Alex Long, Research Engineer

**Qualifications:** B.E. (Hons); BA University of Adelaide

**Specialised areas:** MADYMO modelling of the pedestrian to vehicle interaction; At-scene crash investigation

**Professional affiliations:** The Institute of Engineers Australia (Graduate member)

**Current research:** Collaborative research into pedestrian accidents with the Institut National de Recherche sur les Transports et leur Sécurité (INRETS), France; Evaluation of speed limit reductions.





### Andrew van den Berg, Impact Lab Manager

**Qualifications:** B.E. (Hons) University of Adelaide

**Specialised areas:** Pedestrian sub-system testing; Instrumentation and signal processing; Vehicle safety testing

**Professional affiliations:** The Institute of Engineers Australia

**Current research:** ANCAP pedestrian impact testing; Pedestrian impact reconstruction; VFPS performance testing



### Daniel Searson, Lab Research Officer

**Qualifications:** B.E. (Hons), University of Adelaide

**Specialised areas:** Pedestrian subsystem testing; Instrumentation and signal processing

**Current research:** ANCAP pedestrian testing; Pedestrian impact reconstruction; Vehicle design for pedestrian safety



### Tori Lindsay, Research Officer

**Qualifications:** RN RM Dip App Sc BN Ed

**Specialised areas:** Medical conditions and health outcomes; Abbreviated injury scoring; At scene crash investigation

**Professional affiliations:** International Traffic Medicine Association (member)

**Current research:** Medical conditions as contributing factors in crash causation; In-depth crash investigation

## PHD STUDENTS



### Jeff Dutschke, PhD student

**Qualifications:** B.E Mech (Hons) University of Adelaide; BSC (Ma & Comp sc.) University of Adelaide

**Current research:** Modeling the Biomechanics of Intracranial Trauma



### Jamie Mackenzie, PhD student

**Qualifications:** B.E. (Hons) University of Adelaide

**Specialised areas:** Pedestrian subsystem testing; Instrumentation and signal processing

**Current research:** Currently researching the potential benefits of Electronic Stability Control for Australian rural roads

## ADMINISTRATIVE STAFF



### Leonie Witter, Business manager



### Jaime Royals, Information Manager

**Qualifications:** B.A. (Library and Information Management) University of South Australia



# Publications

## Conference papers

Anderson RWG, Edwards SE, Hutchinson TP (2006) *'Results and implications of a survey of child restraint use in South Australia'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd

Anderson RWG, Thomas H, Somers RL (2006) *'South Australian primary schools bicycle helmet usage survey'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd.

Anderson RWG, van den Berg AL, Ponte G, Streeter LD, McLean AJ (2006) *'Testing the pedestrian safety of bullbars - methods and results'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd.

Long AD, Kloeden CN, Hutchinson TP, McLean AJ (2006) *'Reduction of speed limit from 110km/h to 100km/h on certain roads in South Australia - a preliminary evaluation'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd.

McLean AJ, Kloeden CN, Ponte G (2006) *'Characteristics of rollover crashes'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd.

Woolley J, Kloeden CN, Lindsay T, Ponte G, McLean AJ (2006) *'The Adelaide metropolitan indepth crash investigation study 2002-2005'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd.

Wundersitz LN, Burns N (2006) *'Personality characteristics and attitudes of young traffic offenders'* in Proceedings of 2006 Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Australia, 25-27 October 2006. Gold Coast: Able Video and Multimedia Pty Ltd.

Hutchinson TP (2006) *'The trade off between the probabilities of the two types of prediction error: how to linearise the graph'* in Ho CD (ed) Proceedings of the Second International Conference of the Australasian Business and Behavioural Sciences Association. Adelaide: School of Commerce, University of Adelaide

## CASR report series

Reports available online at: <http://casr.adelaide.edu.au/reports.html>

Anderson RWG ed. (2006) *'Whiplash associated disorders: a comprehensive review.'* Adelaide: Centre for Automotive Safety Research

Anderson RWG, van den Berg AL, Ponte G, Streeter LD, McLean AJ (2006) *'Performance of bull bars in pedestrian impact tests.'* Adelaide: Centre for Automotive Safety Research

Edwards SA, Anderson RWG, Hutchinson TP (2006) *'A survey of drivers' child restraint choice and knowledge in South Australia.'* Adelaide: Centre for Automotive Safety Research

## CASR report series cont.

Kloeden CN, Woolley JE, McLean AJ (2006) *'Further evaluation of the South Australian default 50km/h speed limit.'* Adelaide: Centre for Automotive Safety Research

Kloeden CN, Hutchinson TP (2006) *'The crash and offence experience of drivers eligible for the South Australian Driver Intervention Program.'* Adelaide: Centre for Automotive Safety Research

Long AD, Kloeden CN, Hutchinson TP, McLean AJ (2006) *'Reduction of speed limit from 110 km/h to 100 km/h on certain roads in South Australia: a preliminary evaluation.'* Adelaide: Centre for Automotive Safety Research

Woolley JE, McLean AJ (2006) *'Edge delineations.'* Adelaide: Centre for Automotive Safety Research

Wundersitz LN, Hutchinson TP (2006) *'South Australia's Driver Intervention Program: Participant characteristics, best practice discussion and literature review.'* Adelaide: Centre for Automotive Safety Research

## Journal articles

Anderson R, Kloeden C, Hutchinson TP, McLean AJ (2006) *'Choice of licensing method and crashes of young drivers.'* Journal of the Australasian College of Road Safety; 17(3): 28-33

Baldock MRJ, Mathias JL, McLean AJ, Berndt A (2006) *'Self-regulation of driving and its relationship to driving ability among older adults.'* Accident Analysis and Prevention; 38(5): 1038-1045

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Hutchinson TP (2006) *'ROC analysis in credit scoring and credit judgment.'* Journal of Database Marketing and Customer Strategy Management; 13(3); 182-185

Lawrence DW, Guard A, Meier A, Laflamme L (2006) *'Developing the injury prevention and safety promotion thesaurus, international English edition: an interdisciplinary tool for indexing and searching for research literature.'* Progress report 1. Safety Science; 44(4): 279-296



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