



Behavioural Factors: The Fatal Five

13 hasten slowly: speed and road safety

Why is speed an important issue?

The *National Road Safety Action Plan 2003 and 2004* identifies speed as one of the most important issues in road safety – though certainly not the only issue requiring action.

Those refusing to comply with speed limits either don't believe in the influence of driving speed on impact speed or just don't care at all. Due to this 'rejection front' it must be proven in every country that the laws of Isaac Newton are true.

The rationale for speed management

Travel speed affects the severity of crashes, as well as the risk of involvement in a crash. There is evidence from an extensive body of research that even small reductions in vehicle speeds result in a marked reduction in the number of road fatalities and serious injuries.

Community attitude surveys show growing public understanding of speed risks, and majority support for quite strict approaches to speed management. However, this is still well short of the profound change in public attitudes to drink driving that developed over the last two decades.

There is still a widespread belief that it is only speeds well in excess of current limits (or prevailing speeds) that are risky – though this is now a minority view. Australian research has provided direct evidence that speeds just 5 km/h above average in urban (60 km/h) areas, and 10 km/h above average in rural areas are sufficient to double the risk of a casualty crash: roughly equivalent to the increase in risk associated with a Blood Alcohol Concentration of 0.05. The evidence also indicates that although ‘moderate’

speeding (within 10 or 15 km/h of the posted limit) is far less risky than more extreme speeds, it makes a comparable contribution to serious road crashes because it is so common.

Speed enforcement programs backed by extensive publicity were a major factor in the substantial reduction in road fatalities (37%) that occurred between 1989 and 1997. Compliance with speed limits is still far from perfect, and better compliance would cut road deaths significantly. The National Road Safety Strategy notes the need for enforcement and education initiatives to *promote the public perception that compliance ‘everywhere, all the time’ is the best way of avoiding penalties and improving safety.*

Further substantial road trauma reductions can be obtained by lowering speed limits. Australia has relatively high speed limits across most of its road network, compared with limits set by most other OECD countries on comparable roads. The only exception is freeway-standard inter-city roads, where our 110 km/h limits are mid-range, by international standards.

Why and how are speed limits set?

The main rationale for setting speed limits is to improve safety. Setting a limit on speed reduces both the incidence and severity of crashes and also reduces possible variations in speeds, which can increase the number of vehicle conflicts. In setting speed limits, an appropriate balance has to be struck between risk and travel time for a particular section of road. Speed limits may also be set at moderate levels for fuel conservation purposes, as they were in the US following the oil crisis in 1973, or to limit air pollution.

One commonly-cited method of setting speed limits is the 85th percentile method – the free speed at or below which 85 per cent of vehicles are driven. However, this method involves the dubious assumption that most drivers will make speed choices that produce good outcomes for society as a whole (see *Speed and driver experience: perception versus reality*, later in this chapter). There is also the question of why the 85th percentile speed, rather than the average or median speed, should be taken as representing the collective wisdom of drivers.

Australian jurisdictions generally use a combination of road characteristics, crash records and measured free speeds to set speed limits.

Criteria for setting speed limits are specified in *Australian Standard AS1742 Part 4: Speed Controls* but adherence to

the standard is voluntary. Most jurisdictions have their own version of the guidelines, with modifications on matters of detail.

Several jurisdictions use a computerised 'expert system' (LIMITS), developed by ARRB Transport Research, as a guide for setting speed limits. There are a number of versions of this system (for example, N-LIMITS in NSW, V-LIMITS in Victoria, Q-LIMITS in Queensland). Each LIMITS system incorporates all the rules and guidelines for setting speed limits in the relevant jurisdiction, and prompts the user to enter all the relevant data. Use of such a system promotes systematic and consistent application of speed limit guidelines within these states.

If conditions change frequently over the length of a road, then correspondingly frequent changes in the speed limit provide the most efficient balance between travel times and safety. However, authorities do make compromises between efficiency and simplicity, and generally set minimum link lengths for special speed zones.

Some jurisdictions use variable speed limits on specific roads depending on traffic and weather conditions during different times of day. The currently applicable and enforceable speed limits are displayed using variable message signs.

The *National Road Safety Action Plan for 2003 and 2004* proposes measures to improve compliance with speed limits, and selective reduction of limits on roads or sections with above-average crash rates.

There was a strong consensus among officials and experts involved in developing the Action Plan that improved speed management could make a substantial contribution to achieving the target of a 40 per cent reduction in the road death rate by 2010.

However, the focus on speed management remains controversial.

This chapter provides a summary of the results of research on speed risks, and related information. It includes a summary of results of new research on the negative and positive economic impacts of different travel speeds on rural roads in Australia, and the potential effects of variable speed limit systems on travel times and crash costs.

Why speed affects crash risk and severity

Speed affects both the risk of a crash, and the severity of any crash that occurs – including crashes caused by factors other than speed.

Research has shown that the average time taken by a driver to determine that a crash may occur, decide on avoiding action, and implement the action is about 1.5 seconds. The distance the vehicle travels during this time is directly proportional to the speed of the vehicle.

The braking distance, or distance needed to stop, is proportional to the square of the speed. If a crash occurs, the energy of the vehicle that must be dissipated is also proportional to the square of the vehicle's impact speed. These squared relationships mean that changes in vehicle travel speeds produce disproportionately large changes in emergency braking distances and in speed at the point of impact, if a crash occurs.

A small change in impact speed produces a larger change in impact energy, and the probability of death or severe injury in a crash increases very rapidly as impact energy increases.

Speed also increases the risk of losing control on curves, or when a driver brakes or swerves in an emergency.

*The minutes
Some folks
Save through speed
They never even
Live to need.*

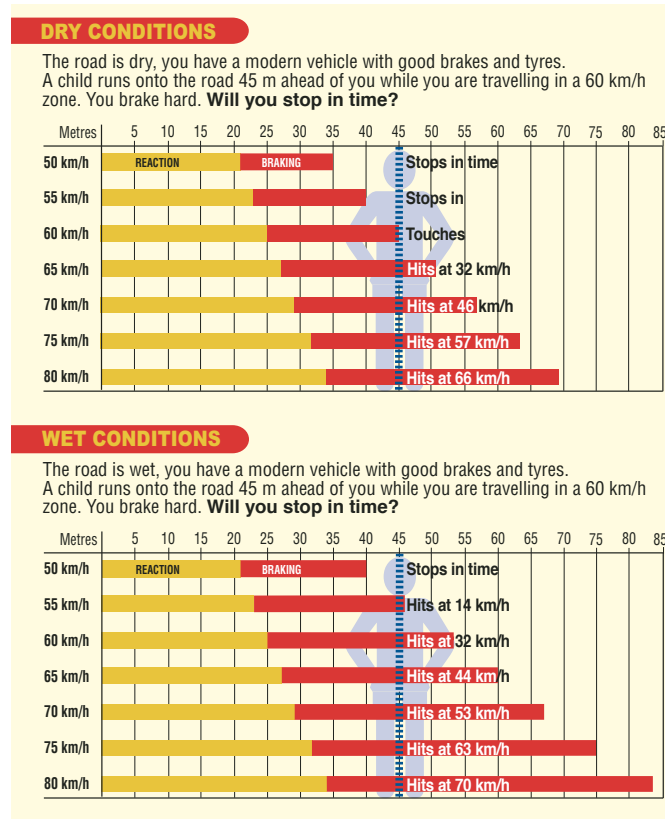
1940's BURMA SHAVE JINGLE IN US ROAD SIDE SIGN

The bottom line is that driving 10 km/h faster can make the difference between a near miss and a fatal crash.

For example:

- A 20 per cent increase in travel speed (e.g. from 50 km/h to 60 km/h) increases emergency braking distance by almost half (44 per cent).
- At the point where a driver braking from 60 km/h would stop completely, a driver braking from 70 km/h would still be travelling at about 46 km/h (figure 29) – a speed that could be fatal if the vehicle hits a pedestrian or the side of another vehicle.
- Most pedestrians struck by a car at 40 km/h survive; most pedestrians struck by a car at 60 km/h die (figure 30).
- All new cars sold in Australia must pass several occupant protection crash tests. In line with internationally agreed standards, these tests are conducted at impact speeds between 48 km/h

FIGURE 29:
Will you stop in time?



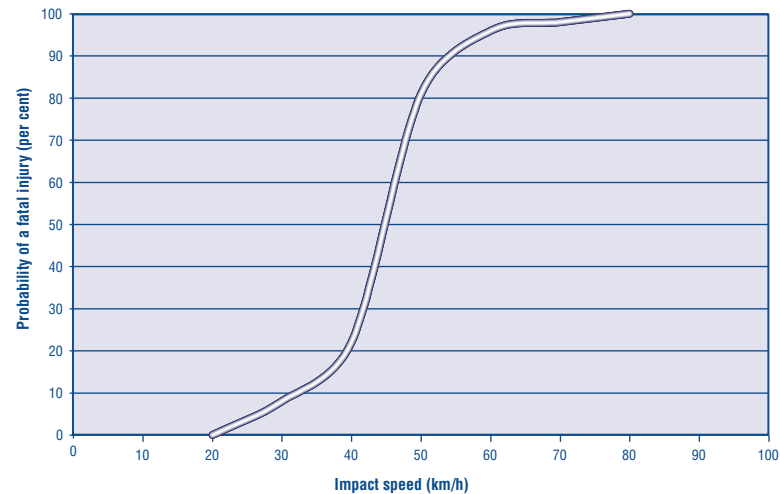
Source: Australian Transport Safety Bureau

*Person who drive like hell
bound to get there sooner.*

JOHN COLLIS, ATSB

and 56 km/h. Consumer information tests are conducted at speeds between 56 and 64 km/h. The higher speeds used in consumer tests involve roughly one-third more crash energy than the corresponding regulatory tests. Tests at 70 km/h would involve 56 per cent more energy than the standard regulatory offset frontal crash test and more than twice the energy of a standard full frontal crash test. But tests are rarely, if ever, conducted at these speeds. Designing vehicles to pass crash tests at such speeds would present major engineering challenges, and could compromise occupant protection at lower impact speeds, which are more typical of most injury crashes.

FIGURE 30:
Probability of fatal injury to a pedestrian, by impact speed



Source: Australian Transport Safety Bureau



- A few extra km/h can have the same effect on stopping distance as a few extra beers. Alcohol slows reaction times and increases effective stopping distances in an emergency. A driver 2–3 times over the maximum legal alcohol limit (0.05) has a decision reaction time about 50 per cent longer than a sober driver. At 60 km/h this additional reaction time increases total emergency stopping distance by about 28 per cent: this is roughly the same effect on total stopping distance as the difference between a sober driver travelling at 60 km/h, and a sober driver at 70 km/h.

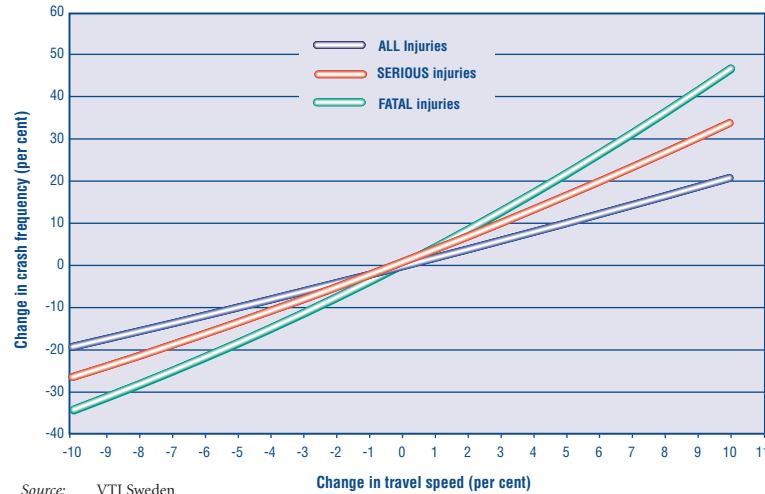
Speed and casualties: research evidence

There has been extensive research into the effects of travel speeds on safety. Several different research methods have provided consistent evidence that quite small changes in travel speeds result in very substantial changes in risk. Even a few kilometres per hour makes a difference.

The different research methods used to establish the results summarised here include:

- before-and-after studies of the effects of changes to speed limits, and of speed enforcement changes
- correlational studies of crash rates on similar roads with different speed distributions
- detailed investigation and computer reconstruction of crashes (allowing travel speeds of crashed vehicles to be compared with the measured speeds of other vehicles at the same locations; the likely outcomes for different initial travel speeds can also be calculated).

FIGURE 31:
Effect of changes in average travel speed on casualty crash frequency



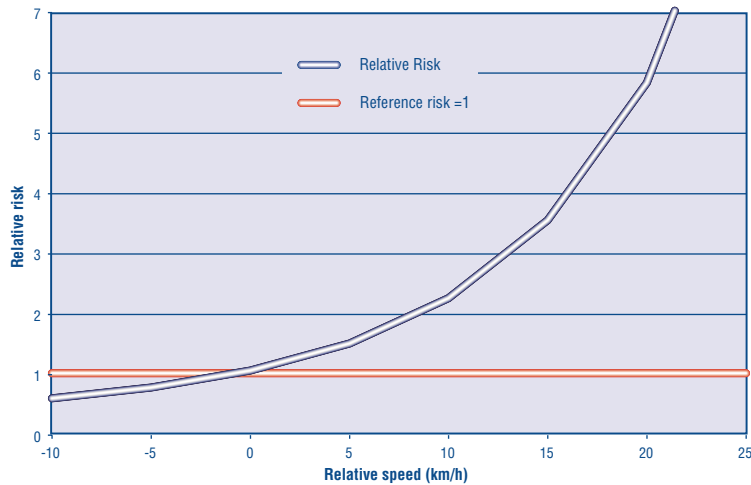
- A small percentage change in average travel speeds on a road typically results in a much larger percentage change in casualty crashes. This is the case even when initial travel speeds are substantially below the nominal 'design speed' of the road.

- Severe crashes (serious injuries and deaths) are more sensitive to speed changes than crashes in general (figure 31).
- For small speed changes, the typical result is approximately:

- a two-fold percentage change in minor injury crashes
- a three-fold percentage change in serious injury crashes
- a four-fold percentage change in fatal crashes.

- An increase in average vehicle speed from 100 km/h to 110 km/h on a rural road can be expected to increase serious injury crashes by about one-third, and fatal crashes by about 46 per cent.
- Small reductions in urban travel speeds can markedly reduce the number of fatal pedestrian crashes: for example, a detailed study of fatal pedestrian crashes in Adelaide found that 32 per cent of the pedestrians who died would probably have survived if the vehicle that hit them had been travelling 5 km/h slower before the emergency; one in ten would not have been hit at all (the driver would have been able to stop in time).

FIGURE 32:
Casualty crash risk and speed relative to other vehicles (rural roads)



Source: Australian Transport Safety Bureau

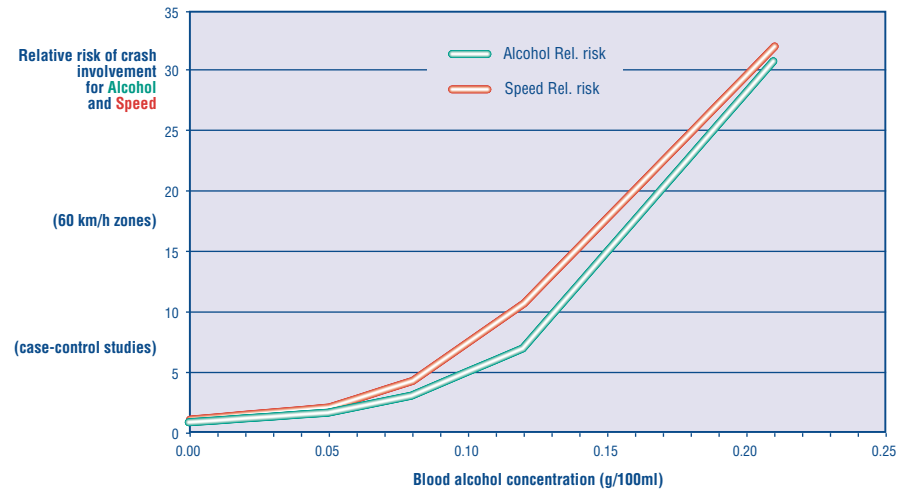
*His fuel was rich
His speed was high
He parked in a ditch
To let the curve go by.*

ANON

Risks increase very rapidly for individual vehicles travelling at above-average speeds.

- Speeds just 5 km/h above average in urban areas, and 10 km/h above average in rural areas, are sufficient to double the risk of a casualty crash (figures 32 and 33)
 - this is roughly equivalent to the increase in risk associated with a Blood Alcohol Concentration (BAC) of 0.05
 - at higher speeds, the risk increases exponentially: for example, vehicles travelling 20 km/h above the average on rural roads have about 6 times the casualty crash involvement of vehicles at the average speed
 - these risk increases reflect the combined effects of speed on crash risk and crash severity.

FIGURE 33:
Casualty crash risk and speed relative to other vehicles (urban 60 km/h zones)



Source: Australian Transport Safety Bureau

- Although 'moderate' speeding (within 10 or 15 km/h of the posted limit) is far less risky than more extreme speeds, it makes a comparable contribution to serious road crashes because it is so common.
- Coroners' records indicate that excessive speed is a causal factor in about 26 per cent of fatal crashes
 - this does not reflect the effects of speed on crash severity, and many cases of marginal speeding are probably unrecorded
 - 'excessive speed' includes speed that is not over the limit, but too fast for the location or conditions.
- Many people believe that they are safer at slightly higher speeds on rural roads because the speed keeps them more alert. However, Australian and overseas evidence clearly shows that this theory does not work in practice: higher speeds result in higher rates of fatal and casualty crashes. If speed does increase the alertness of some drivers, the effect is more than offset by the negative safety effects of higher speeds.

- For example, in 1973, the US set a national maximum speed limit of 55 mph (89 km/h), to reduce fuel consumption during the oil crisis. Average speeds on the rural interstate system dropped by about 9 km/h and deaths per distance travelled on these roads dropped by 34 per cent. In 1987 and 1988, 40 states raised limits to 65 mph (105 km/h). Evaluation studies showed road death increases of 11 per cent to 16 per cent. The average actual speed increase was around 3 per cent. In 1995, all federal controls on speed limits were abolished and limits of 70 or 75 mph (113–121 km/h) were introduced in many states. An early evaluation indicated a 9 per cent increase in deaths on affected roads. A more recent evaluation using a longer time

series found increases of 35 per cent and 38 per cent on 70 mph and 75 mph roads. The US rural interstate system is a series of high quality roads, covering long distances.

- Early research in the US appeared to show that vehicles travelling below the average speed on rural roads had a higher risk of involvement in a serious crash than vehicles at the average speed; this finding is still often quoted, despite a number of faults that have been identified in the early research designs. Recent well-designed research on Australian roads indicates that vehicles travelling at lower than average speeds have a lower risk of involvement in a casualty crash.





Speed and driver experience: perception versus reality

Personal experience is a poor guide to understanding the links between travel speed and risk.

Serious crashes are quite common events on our road system, but they are actually very rare in the experience of individual drivers. There is roughly one fatal crash per 100 million vehicle kilometres travelled. Injury and property damage crashes are more common, but it is still quite possible for an individual driver to engage in regular 'moderate' speeding for a long time without disastrous consequences.

If they do crash, they are unlikely to carry out detailed calculations to work out how the outcome might have changed if they had been travelling a few kilometres per hour slower, and it is often easy to find someone or something to blame for the crash.

Therefore, what a great many drivers erroneously learn from personal experience is that 'moderately' fast driving is 'safe'.

Balancing benefits and costs of different speeds

A recent research project conducted for the ATSB explores the potential economic costs and benefits of changes to speed limits on rural roads in Australia.

Higher travel speeds produce benefits through reduced travel times, but raise costs through higher vehicle operating costs (mainly fuel consumption), increased vehicle emissions, and more crashes.

Net costs and benefits were estimated over a range of travel speeds (80 to 130 km/h) for a number of road types, ranging from two-lane undivided roads to freeways. The economic 'optimum' was defined as the speed that minimises total social costs.

The study found that:

- Increasing truck travel speeds above 100 km/h would increase net costs on all road types, and

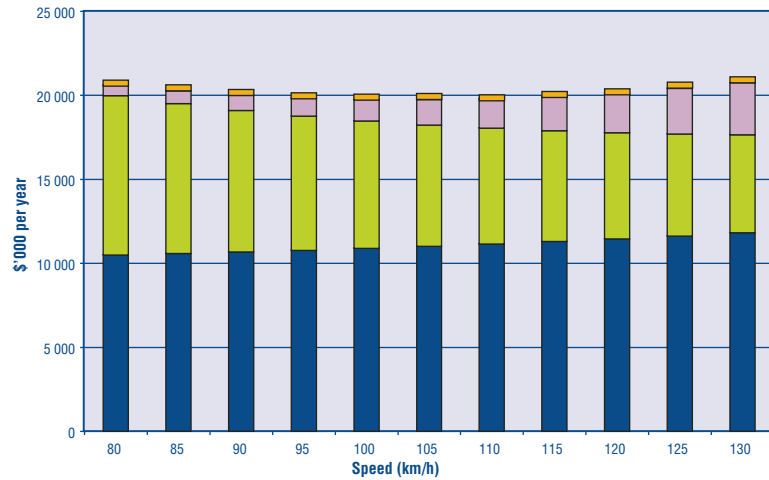
the optimum speed for trucks was below 100 km/h on lower standard roads.

- The economically optimum speed for cars and light commercial vehicles on freeways was between 115 and 125 km/h, depending on the method used to value travel time and crash costs.
- The economically optimum speed for cars and light commercial vehicles on undivided rural roads was up to 105 km/h for reasonably high standard roads (shoulder-sealed roads 8.5 m wide) but only if the road was straight and did not include intersections or towns
 - for undivided roads with curves and intersections, the optimum was 90 km/h for higher standard roads, and 85 km/h for sealed roads 7 m wide.

- A variable speed limit system on freeways, allowing speeds of 120 km/h for cars and light commercial vehicles during good conditions, but reduced to 100 km/h under adverse conditions including night driving, while limiting trucks to 100 km/h at all times, would keep total economic costs below current levels
 - however, all scenarios in which speed limits are increased for some vehicle types and circumstances would involve increasing road trauma to provide travel time saving benefits.

Figures 34 and 35 illustrate how the various cost components vary with travel speed on undivided rural roads. The results are combined cost estimates for light and heavy vehicles. 'Cruising speed' is the average speed of vehicles on parts of the road where speeds are not affected by curves or intersections.

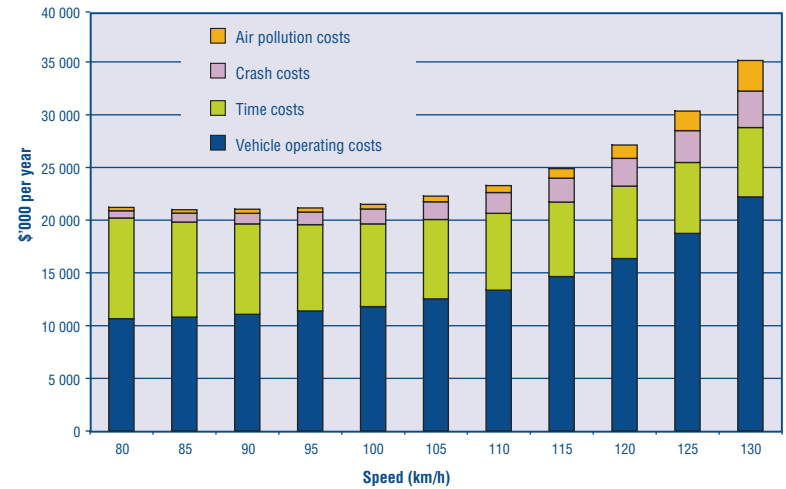
FIGURE 34:
Economic costs of different cruising speeds on rural roads (straight section)



Undivided 8.5 m shoulder-sealed road: straight, no intersections 100 km section, 1 000 vehicles/day, Austroads travel time and crash cost estimates, all vehicle classes (trucks and light vehicles combined)

Source: Australian Transport Safety Bureau

FIGURE 35:
Economic costs of different cruising speeds on rural roads (section with curves and intersections)



Undivided 8.5 m shoulder-sealed road with curves and intersections 100 km section, 1 000 vehicles/day, Austroads travel time and crash cost estimates, all vehicle classes (trucks and light vehicles combined)

Source: Australian Transport Safety Bureau

What do Australians think about speed?

In 2002, the ATSB commissioned a survey of Australian residents on a range of issues relating to speed. The survey was conducted with a sample of 2 543 people aged 15 years and over, residing in the mainland States of New South Wales, Victoria, South Australia, Queensland and Western Australia.

The main findings were:

- While most people say they normally drive within the speed limit, six in ten indicate that they sometimes drive at higher speeds.
- Many admit to exceeding posted limits by 10 km/h or more, in both urban 60 km/h zones (33 per cent of drivers) and rural 100 km/h zones (46 per cent of drivers).
- On average, one in five drivers has been booked for speeding in the past two years, though this varies between states: from a low in New South Wales (12%), to a high in Western Australia (30%).
- Three-quarters of the community assumes that speed limits are enforced with some degree of tolerance.
- Half the community believes the enforcement tolerance in 60 km/h urban speed zones is at least 5 km/h; and four in ten think the tolerance in 100 km/h rural zones is at least 10 km/h.
- New South Wales residents are more likely than others to assume the tolerance is 10 km/h or more, in both 60 km/h zones (20 per cent, compared with 9 per cent from other states) and 100 km/h zones (45 per cent, compared with 35 per cent from other states).
- Victorian residents tend to nominate lower permissible speeds than people who live elsewhere; many believe the enforcement tolerance is set at 3 km/h, particularly in urban 60 km/h zones.
- A majority of people in all jurisdictions think that speed limits should be enforced with a tolerance of 5 km/h or less; substantial minorities favour a zero tolerance approach, in both urban (29 per cent) and rural (24 per cent) speed zones.
- The community generally believes that enforcement intensities should either stay the same or increase; there is little support for any reduction in current enforcement levels, including the number of speed cameras and the severity of penalties.
- There is a strong view in the community that speed is given too much emphasis in television commercials for new cars.



belts, bags and headbands: the benefits of occupant protection measures

Occupant restraint systems, notably seat belts and airbags, have been proven to save lives and reduce injuries. This chapter surveys the benefits of these systems, including the potential benefits of a headband based on research commissioned by the ATSB.

The demand for seat belts is too low to justify seat belts being introduced as standard equipment and what demand there is could be satisfied by after market fitment.

AUSTRALIAN VEHICLE MANUFACTURER, 1967

Research shows that wearing a seat belt doubles your chances of surviving a serious crash.

Seat belts

The car seat belt evolved from the seat belts used to prevent ejection from aircraft during the early part of the 20th century. The potential benefits of seat belts for motor vehicles were realised during World War II and, by the late 1950s, seat belts were being provided in some new cars.

Australian Design Rules for seat belts and seat belt anchorages were introduced for new vehicles from 1 January 1969. This led to a steady increase in the proportion of motor vehicles fitted with belts. In Melbourne, the proportion of cars fitted with driver and front passenger seat belts rose from 50 per cent in 1969 to 76 per cent in 1971. Having a vehicle fleet in which the majority of vehicles were fitted with seat belts was an important factor in ensuring the success of seat belt wearing legislation.

In 1970, Victoria became the first jurisdiction in the world to introduce compulsory seat belt wearing. Seat belt wearing throughout Australia became compulsory in 1972. Seat belt usage rates increased markedly after the implementation of legislation. For example, in Melbourne, one month after the legislation was enacted, seat belt wearing rates increased from 25 per cent to 50 per cent. After a further one month of enforcement, wearing rates increased to 75 per cent. Recent studies have indicated that about 97 per cent of Victorian drivers wear seat belts.

It is widely accepted that the use of seat belts in motor vehicles substantially reduces the incidence of death and serious injury in crashes.

The US National Highway Traffic Safety Administration (NHTSA) has estimated that seat belts save 13 000 lives in the US each year and that

7 000 deaths would be avoided if the occupants had been wearing seat belts. NHTSA estimates that seat belts reduce the risk of death for front seat car occupants by around 50 per cent.

Australia has one of the highest seat belt wearing rates in the world – generally over 90 per cent. The wearing rate for front seat passengers is around 96 per cent, and slightly lower for rear seat passengers.

Given the weight of research evidence on the efficacy of seat belts, it makes good sense to wear a seat belt at all times while travelling in a motor vehicle. Yet, tragically, each year up to 33 per cent of fatally injured car occupants (about 300) and 19 per cent of those seriously injured are unbelted. These statistics reflect the effectiveness of seat belts, as well as the possibility that unbelted drivers tend to take higher risks.

Why are seat belts effective?

If a car travelling at 60 kilometres per hour hits a solid object like a large tree, the tree will bring the car to a sudden stop, but the speed of the occupants of the car will still be 60 kilometres per hour. In the absence of a seat belt, the occupants of the car will keep moving forward at that speed until they hit an object in front of them, such as the steering wheel or dashboard (or until they are ejected through the windscreen and hit the tree). This tendency of a moving object to keep moving, or of a stationary object to remain at rest, is called inertia.

A seat belt generally comprises a lap belt, which extends over the pelvis, and a shoulder belt, which straps across the chest. These two sections of the belt are fixed firmly to the chassis of the vehicle. If a crash occurs, the belt will apply most of the force to the shoulder, sternum and pelvis, which are relatively less vulnerable parts of the body. The webbing material used in seatbelts has some flexibility and reduces the sudden impact of the crash by allowing just a little stretching.

The force generated by the crash is also reduced by the vehicle's crumple zones, which are areas in the front and rear of the vehicle that are designed to collapse on impact, thereby reducing the energy transmitted to the occupant compartment. However, the protection afforded by crumple zones will only be fully effective if the occupants are securely fastened to the passenger compartment, so that they decelerate with the vehicle.

Seat belts in modern vehicles are designed to extend and retract, enabling occupants to lean forward. In a crash, the belt reel immediately locks, holding the occupant securely in place. There are various technologies being used to further improve the protection offered by seat belts, such as pre-tensioners that reduce slack in the belt and load limiters that reduce the forces exerted by the belt on the body.

Almost everyone in Australia wears a seat belt – except the people most likely to crash.

Seat belt use by truck drivers

In crashes involving trucks, about 16 per cent of those killed are truck occupants. A key factor in truck crash deaths is low seat belt wearing rates by truck drivers. Research has shown that seat belt wearing rates among truck drivers killed in crashes are as low as 10 per cent. Around 40 unbelted truck drivers are killed each year.

A study was undertaken by the New South Wales Roads and Traffic Authority (RTA) between 1995 and 1998 involving 225 drivers of prime movers with trailers, involved in crashes in New South Wales. The study showed that 205 drivers (91 per cent) were not wearing a seat belt. Of the 20 wearing a seat belt, none was killed or seriously injured and 30 per cent had minor injuries. Of those not wearing a seat belt, 45 per cent were killed or injured. It is estimated that 40–50 per cent of heavy vehicle driver deaths could be prevented if seat belt wearing rates of truck drivers were similar to wearing rates in cars.

Truck drivers are reportedly reluctant to wear seat belts because of discomfort, inconvenience and the mistaken belief that an unbelted driver will be able to avoid injury by jumping out before a crash. Another widespread misconception is that wearing a seat belt will increase the chances of being trapped in the vehicle; however, a study of the effects of seat belts in crashes into water found that the reverse occurs. Belted drivers were more likely to survive the initial crash impact and get out of the sinking vehicle, and in fact, more unbelted drivers ended up trapped.

The *National Heavy Vehicle Safety Action Plan 2003–2005* aims to improve belt wearing rates by a combination of initiatives: regulations for fitting integrated lap/sash seat belts in new and existing vehicles, education programmes for drivers, improved management practices by operators of fleets, and increased enforcement by police.

Seat belt reminder systems

A study conducted in 1990 by the then Federal Office of Road Safety (FORS) found that a seat belt warning system in vehicles would be warranted on the basis of economic analysis. In 1995, the then federal Department of Transport introduced a new Australian Design Rule 69 (ADR 69) which required manufacturers to meet specified crash performance criteria in a crash involving full frontal impact. The new rule also required the mandatory fitment of a seat belt reminder system, comprising a warning light that remained on for five seconds after the ignition was switched on. In most cars, this system is easy to ignore or deactivate.

Some manufacturers have introduced devices to remind vehicle occupants to fasten their belts. These devices usually involve a flashing light or audible warning or a combination of both. The effectiveness of these devices depends on how occupants respond to them. The target group for these devices comprise those who forget to wear their belts, rather than ‘hard core’ non-wearers (a minority of non-wearers).

*The airbag is not a substitute for the seat belt.
The airbag increases the benefit of a seat belt.
Australian tests have shown that an
airbag at least halves the chance of
a serious head injury.*

Recent research commissioned by the ATSB has examined more stringent seat belt warning devices than the system mandated by ADR 69. Three devices were evaluated: a simple flashing light and warning tone; the simple design with an increasing intensity with higher speeds; and a complex two-stage model where the hazard lights flash after a set period of non-compliance. The results of the economic analysis suggested that a regulation requiring manufacturers to provide a more aggressive seat belt reminder system than is currently provided by ADR 69 would be appropriate and beneficial.

As noted earlier, there are about 300 road deaths a year involving people who have a seat belt available but do not wear it. If they all wore belts, it is probable that about half would survive. Even if only 40 per cent of these non-wearers buckled up, there would be about 60 fewer road deaths each year.

Compared with their potential benefits, seat belt reminder systems are relatively inexpensive to install. The research sponsored by the ATSB indicated that the cost range for these systems would be from about \$10 to about \$150 for the more complex systems.

The *National Road Safety Strategy Action Plan 2003 and 2004* includes the action item: 'Introduce an ADR for intrusive audible seat belt warning devices.'

The Vehicle Safety Standards (VSS) branch of the Department of Transport and Regional Services is preparing a regulation impact statement to assess the need for an Australian Design Rule mandating

the introduction of audible seat belt reminders. However, it appears that manufacturers are voluntarily introducing these devices, and that they will increasingly appear in the Australian motor vehicle fleet over time.

The ATSB has also commissioned research on retrofitting existing vehicles up to ten years of age in the Australian passenger fleet with a more aggressive seat belt warning device. This research shows that it would be worthwhile to fit such a device in the driver's seat if the device produced a minimum 20 per cent improvement in seat belt wearing and cost no more than \$45, including installation. This cost criterion might be difficult to meet.



Airbags

Head injuries are a major cause of death and serious injury in crashes. Head injuries to car occupants account for nearly half of all injury costs associated with passenger car crashes in Australia, representing a total cost to the community of about \$3.7 billion per year.

The concept of a rapidly inflatable cushion to prevent crash-related injuries, including head injuries, was first developed in aviation. A patent for an inflatable device to enable the crash-landing of aircraft was filed in the US during World War II. The technology of airbags for use in vehicles was initially introduced into vehicles in the 1980s.

The airbag is a supplemental restraint system (SRS) and is not a substitute for a seat belt. Airbags are meant to be used in combination with seat belts.

If a crash occurs, the airbag is meant to reduce the vehicle occupants' speed to zero, while minimising injury. If a vehicle is airbag-equipped, the driver

airbag is located in the hub of the steering wheel, while the passenger airbag is usually in the dashboard above the glove compartment. Side airbags and side curtain airbags are being introduced in some vehicles. Side airbags are in the door panel or seat, and curtain side airbags are located above the side doors. The airbag operates under extreme space and time constraints, deploying in a fraction of a second in the space between the occupant and the steering wheel, dashboard or doors.

During impact, sensors in the vehicle detect sudden deceleration. If the crash is severe enough, there is a flow of electricity to the inflator, which ignites the gas generator. The crash severity for airbag deployment depends on the type of system used. Deployment also depends on the type of crash (frontal or near-frontal in the case of frontal airbag systems) and the object that is struck. Most airbags in the Australian market have a high deployment threshold, which reduces the risk of airbag-induced injuries in minor crashes. This threshold would typically be equivalent to a collision with a rigid object at 25 km/h or higher,

but in 'softer' collisions (such as rear-end crashes) these speeds may be considerably higher.

Typically the airbag is inflated by the combustion of a propellant material (such as nitro-cellulose, sodium azide or 'non-azide' compounds) which produce inert nitrogen gas. Some systems also use stored pressurised gas for inflation. Ignition of the inflator instantly fills the bag, causing it to burst out of its storage container at a speed of over 300 km/h. The deployment of an airbag takes a few milliseconds – faster than the eye can blink. The bag then deflates quickly by allowing the gas to escape through vent holes or through the weave of the fabric, absorbing the energy of the occupant while this occurs. A powder (talcum powder or corn starch) may be used to lubricate the bags during deployment.

Some later generation airbag systems use a two-stage inflator – which allows the control module to vary airbag inflation rate and pressure – tailoring the deployment to the severity of the crash. This helps improve the protection of occupants in a range of crash severities and reduces any risk from deployment in low-severity crashes.



Headbands for vehicle occupants: safety with fashion?

Research commissioned by the former Federal Office of Road Safety and the ATSB has demonstrated that headwear in the form of bicycle-style helmets or padded headbands would be almost as effective in reducing head and brain injuries as driver airbags, but at a fraction of the cost.

Protection of this type would be particularly beneficial for occupants of older vehicles that are not equipped with the latest safety devices, but would provide additional protection even for drivers of cars equipped with airbags.

The research has found that helmets would be substantially more effective than many vehicle design options, including improved interior padding, side-impact airbags and advanced restraint systems. As head injuries to car occupants

in Australia cost about \$3.7 billion per year, helmets could save the community as much as \$950 million, or about 25 per cent of annual head injury cost.

While full helmets would approach the ideal form of occupant head protection, an analysis of impact patterns among brain injury cases has shown that specially designed headbands could provide a practical alternative. To be effective, the headband would cover the front and sides of the head, where a large proportion of the impacts have been found to occur. The headband would have energy absorbing properties to provide the wearer with real protection, but would be lighter, cooler and less bulky than a conventional helmet. Protective headbands would offer about half the total benefits of a full helmet.

Prototype headbands have been tested using a variety of materials, including expanded polypropylene sandwiched between a styrene outer shell and a cloth liner.

The ATSB is of the view that the use of protective headwear for car occupants would be a voluntary market-driven safety option. Preliminary market research has found that the concept would have very limited acceptance across the wider community, at least in the short term. Similar consumer resistance was demonstrated in the early stages of the introduction of seat belts and helmets. However, the headband could be of considerable interest to certain groups such as young families. With some imaginative designing, the headband might well be developed as a fashion accessory.



Safety tips

- Always use seat belts and child restraints, even if your vehicle is equipped with air bags.
- Replace frayed and damaged seat belts promptly.
- The rear seat is the safest seating position for children.
- Read the owner's manual to understand the operation of the vehicle's air bag system.
- If the steering wheel can be tilted, position it so that the air bag will deploy towards the chest and not the head.
- Drivers should be positioned at least 30 centimetres (1 foot) from the airbag by adjusting the seat. Front passenger seat occupants should move the seat as far back as possible.

15 driving high: substance abuse and road trauma

Alcohol

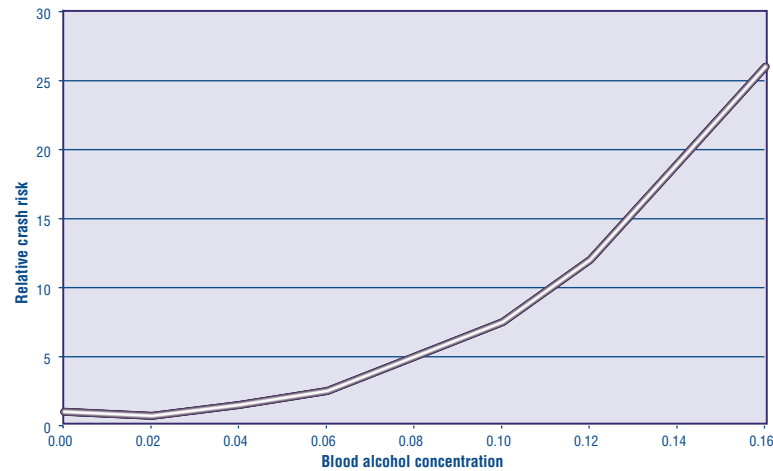
Research has consistently shown that driving skills are impaired at blood alcohol concentration (BAC) of around 0.05 gm/100 ml. Performance impairment has been shown in the laboratory for alcohol on tasks such as concentration, divided attention and reaction time. Similar results have been shown in driving simulator studies, with alcohol leading to a dose-related increase in risk-taking behaviour, number of simulated crashes, and an increase in the number of speedometer, accelerator, brake and indicator errors. On-road tests at a level of

0.05 gm/100 ml have also shown a significant impairment in city driving, with impairment of vehicle handling and manoeuvring in traffic.

Research on crash involvement has shown that at 0.05 BAC, a driver has double the risk of a serious crash than at zero, and at 0.08 the risk is double that at 0.05, as indicated in figure 36.

At a blood alcohol concentration of 0.05, a driver has double the risk of a serious crash than at zero. At 0.08 the risk is double that at 0.05.

FIGURE 36:
Crash risk at different blood alcohol concentrations



Source: Australian Transport Safety Bureau

In Australia, alcohol remains one of the biggest single causes of road deaths and injuries, although significant reductions in drink driving have been achieved over the past decade. In 1999, 28 per cent of driver and motorcycle rider fatalities had a BAC

over the legal limit (0.05gm/100ml). Alcohol involvement for this group had been as high as 44 per cent in 1981.

The reduction in drink driving in Australia has resulted from the application of an integrated package of measures which combine to produce, in most drivers, the perception that driving above the legal blood alcohol limit has a high probability of detection, and of swift, certain and severe consequences.

The integral elements of the package include: the use of legislated, defined low blood alcohol limits; intensive and highly visible enforcement of these limits supported by a reasonably high level of publicity; and a graduated series of penalties of increasing severity dealing with progressively higher detected BACs or with repeated offences. Each measure depends on perceptions of consequences and each component of the package reinforces the others.

Alcohol limits

Victoria introduced the first statutory BAC in Australia of 0.05 gm/100 ml in 1966.

Alcohol is the drug which makes the single biggest causal contribution to road crashes, and priority should continue to be given to a comprehensive approach to preventing alcohol-related road trauma and to the provision of resources to combat drink driving.

Cannabis and other drugs present less of a problem than alcohol, but this does not mean that they are no problem.

AUSTROADS DRUGS AND DRIVING WORKING GROUP, 2000

All Australian states and territories now enforce a general BAC limit of 0.05, with a lower limit of zero or 0.02 for young novice drivers, and for drivers of heavy vehicles and public passenger vehicles drivers. These special lower limits reflect the high crash risk of young drivers, the potential severity of heavy vehicle crashes, and the standards of responsibility expected of all professional drivers. Some jurisdictions apply a small enforcement tolerance on a nominal 'zero' limit for these groups. This acknowledges the difficulties in definitively enforcing a zero BAC.

Random breath testing

Random breath testing (RBT) enables police to administer a screening breath test to drivers without their having reason to suspect the driver has been drinking. RBT is essentially a general deterrence program aimed at discouraging potential drink drivers from committing the offence through their fear of detection and consequences. This differs from specific deterrence, which relates to ways of deterring convicted offenders from re-offending by

imposing sanctions. The use of the word 'random' in RBT is intended to convey the notion that it is possible for any driver to be picked for testing, even if the driver has not been involved in a crash and has done nothing to attract the attention of the police.

RBT was first introduced in Victoria in July 1976, where it enjoyed only limited success in deterring drink driving due to the style in which it was implemented. This was initially at rather low levels of enforcement interspersed with periods of high intensity ('blitzes'). Evaluations tended to show that although night-time serious crashes (a surrogate measure for alcohol-related crashes) fell, this effect was not lasting.

It was the 1982 introduction of RBT in New South Wales at high enforcement levels that saw real, sustained and significant gains.

After considerable public discussion, RBT was introduced in New South Wales initially for a trial period of three years. During that period, police carried out more than 3 million breath tests. Evaluations of road crash statistics for that time

indicated that RBT was a very cost-effective measure.

Research carried out for the then Federal Office of Road Safety concluded that the long term deterrent effect of RBT depends mainly on maintaining a high level of continual, visible police enforcement; also integral to this is the support of suitable penalties and publicity about the existence of RBT.

RBT is now carried out in all Australian jurisdictions, and enjoys an extremely high level of public support (97 per cent approval nationwide). It is interesting to note that public support for this measure has increased dramatically since its introduction, a phenomenon that has also been observed for other road safety measures.

RBT has not been carried out in a uniform manner nationally, a fact which is reflected in the varying degrees of success of the programmes at particular points in time. For example, some jurisdictions did not always maintain a high level of continual police enforcement, particularly in the 1980s.

Through various forums over the past fifteen years, target rates of RBT have been set as a way of improving results nationally. In 1989, the Prime Minister's Road Safety Initiative stipulated that RBT enforcement be increased to ensure that at least 1 in 4 drivers were tested each year. Subsequent national initiatives have encouraged higher testing rates.

All jurisdictions are now testing at very high rates, and in Victoria, New South Wales, Western Australia and Tasmania the rate is more than five tests per ten licensed drivers per year. The most recent evaluation of RBT confirmed the effectiveness of this measure when carried out in a highly visible manner at very intensive levels, and recommended increasing testing rates to a level equivalent to one test per licence holder per year.

One well-known and long established approach to RBT is designed to maximise its visibility and the number of people tested. It involves several police officers with a 'booze bus' (a special bus or mini-

van containing evidentiary breath analysis equipment) with highway patrol or other vehicles for pursuit and general transport duties.

In more recent times other methods of implementing RBT have also been employed to counter any possible waning of its effects. For example, in response to perceptions that some drivers were evading RBT by using back streets, a more mobile form of RBT (whereby police patrolling in cars can stop any driver and administer a breath test) was introduced in New South Wales, and subsequently other jurisdictions. Often, booze buses and mobile patrols are used in combination.

Penalties

Although research indicates that the certainty of appropriately severe penalties is integral to the functioning of RBT, determining what these should be is not simple. The whole question of deterrence and effectiveness of penalties is very complex, with the evidence of specific deterrent effects also remaining largely unclear.

Licence withdrawals have been found to have a uniformly positive effect in reducing collisions and traffic offences. Among the other penalties imposed on convicted drink drivers, the use of imprisonment has consistently been shown to be

*The driver is safer when the roads are dry;
the roads are safer when the driver is dry.*

ANON

*It's best for
One who hits
The bottle
To let another
Use the throttle.*

1940s BURMA SHAVE JINGLE IN US ROADSIDE SIGN

of marginal value and in some studies the results support a view that longer periods of imprisonment increase, rather than decrease, the probability of re-conviction for drinking and driving.

However, it is believed that the value of jail terms and fines lies in their role in general deterrence, and some research suggests that the advertising of such penalties has greater overall impact than the punishment.

In addition, there is some evidence to suggest that required drink driving rehabilitation treatments as a supplement to licence suspensions may have a positive effect on recidivism.

In Australia, the level and extent of penalties for drink driving offences varies among jurisdictions.

Most jurisdictions have set different and escalating penalties according to the perceived seriousness of the drink driving offence. For example, in New South Wales different penalties apply if the offender's BAC is in the 0.02 to 0.05 range, 0.05 to 0.08 range, 0.08 to 0.15 range and over 0.15. Most jurisdictions have stricter penalties for a second or subsequent offence.

Some jurisdictions apply licence suspensions automatically and immediately for offenders whose blood alcohol level is deemed to be 'high', that is, usually over 0.15 gm/100ml, and in some jurisdictions any drink driving offence attracts an immediate 24-hour suspension.

A number of jurisdictions also require disqualified drivers to undergo an assessment or undertake a treatment or rehabilitation programme as a

condition of re-licensing, and in some cases as a condition of sentencing.

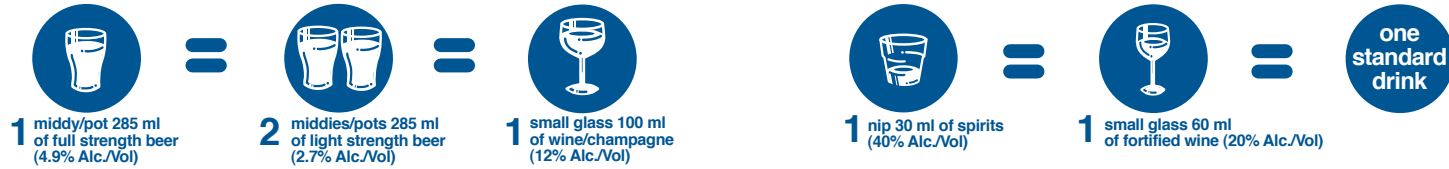
There have been a number of moves in recent years to improve the extent to which penalties for drink driving reflect the seriousness of the road safety risk, and to achieve greater uniformity between jurisdictions. The 1997 National Road Safety Package called for jurisdictions to introduce provisions to allow for licence suspension for a minimum period of at least three months for driving with a BAC of 0.05 or higher.

Where not already in place, jurisdictions were encouraged to introduce provisions for licence suspension and for a minimum period of at least six months for driving with a BAC of 0.15 or higher. Jurisdictions were also asked to review their enforcement and penalty regimes taking into account national best practice. There has been movement towards these requirements, with jurisdictions in general setting and reviewing penalties with an aim of achieving a level of penalty consistent with a strong deterrent effect.



Any drink containing 10 grams of alcohol is a standard drink

These are **standard** drinks



Source: Australian Transport Safety Bureau

Public education campaigns

Considerable efforts are made to inform the driving public of their responsibilities and the consequences of drink driving. In New South Wales, advertising campaigns supporting and reinforcing RBT have been conducted regularly since its introduction in 1982. In Victoria, the Transport Accident Commission (TAC) has provided funding for very intensive campaigns. Evaluations have determined that this kind of publicity has been important in maintaining the perceived level of risk of detection.

Other related public education activity provides information about how to stay below the legal BAC limit. Some years ago, the then Federal Office of Road Safety ran a campaign titled 'Rethink your

second/third drink'. This campaign provided simple 'rule of thumb' guides for male and female drivers. It warned men that more than two standard drinks in one hour can put them over the 0.05 limit, and for women, more than one standard drink can do the same.

As part of this campaign a credit-card sized memory jogger was developed containing this basic information on one side, with 'standard drink' information on the reverse. This card is used by numerous organisations Australia-wide in a variety of public education activities aimed at preventing drink driving. There are many other examples of drink driving publicity campaigns.

Future directions

Continuation of RBT: The application of RBT and its associated components has had considerable success in reducing the incidence of drink driving in Australia. RBT remains important, and there is still scope for further enhancement of RBT efficiency and effectiveness.

Rural drink driving: There is some evidence that RBT has been less effective in rural than in urban areas. The *National Road Safety Action Plan 2003 and 2004* calls for development of specially adapted programmes to reduce drink driving in rural areas.

Alcohol Ignition Interlocks: There is increasing focus on those drivers who remain undeterred by current measures. Many of them drive with very

high BACs, even after being detected and punished. They are a small proportion of the total population, but are a significant proportion of drivers involved in serious crashes.

One countermeasure targeted at recidivist drink drivers which has some potential is the compulsory installation of alcohol ignition interlocks into the vehicles of drivers found guilty of multiple and high BAC category offences. Such schemes have been evaluated in a number of jurisdictions in the US and Canada.

There is some evidence from studies in these countries that interlocks on their own may only delay recidivism, and do little to directly address the personal factors contributing to repeat drink driving. However, there is some promise offered by the Canadian experience to support the use of interlocks with rehabilitation.

South Australia introduced Australia's first alcohol ignition interlock programme in 2001. Under this legislation, motorists with licences suspended for

drink-driving offences can return to the road early, provided they have alcohol interlocks on their vehicles. The driver pays for installation and monthly rental of the ignition device. Courts may give people who have received the minimum licence disqualification of six months the option to join the interlock scheme after three months. They have to keep the interlock devices on their vehicles for double the remaining period of suspension (six months). Participants receive a conditional licence (which includes displaying 'P' plates), and are required to attend an alcohol awareness counselling session at their own cost.

Two other Australian jurisdictions (New South Wales and Victoria) have now introduced interlock programmes, and Queensland is conducting a large scale trial in conjunction with an already quite successful rehabilitation programme.

Server Intervention: Another approach with the potential to contribute to reducing alcohol-related road trauma involves server intervention or responsible service programmes. These

programmes are intended to educate those who sell and serve alcohol of their responsibilities towards their patrons, in order to help ensure their safety. Ideally, elements of such programmes should include an understanding of the server's legal rights and obligations, knowing how to control alcohol consumption and how to manage intoxicated patrons. Education programmes of this kind may assist in dealing with the drink driving problem, as well as other situations, including reducing the numbers of alcohol-affected pedestrians involved in road crashes.

However, it may be overly optimistic to expect that server intervention programmes alone could prevent a patron from exceeding the legal limit of 0.05 (in the case of a driver) or being endangered as a drunken pedestrian. A more strategic approach to serving alcohol would involve not just training staff in responsible serving practices and identifying 'at risk' patrons, but also include a range of activities and initiatives. These could include installation of public breath testing machines, ensuring venues are well served with



access to taxis or public transport, discouraging 'happy hours', provision of meals or complimentary bar snacks, and marketing low-alcohol or non-alcohol beverages.

Low-alcohol beer: Since the introduction of lower legal blood alcohol limits and intensive anti-drink driving enforcement strategies, the market share of low-alcohol beers has increased to around a quarter of all beer sold. There is some anecdotal evidence suggesting that the mid-range low-alcohol beer (2.5 per cent) appeals to people who would otherwise be drinking regular strength beer.

There is evidence that the price of alcoholic beverages, and the price differentials between low-alcohol and high-alcohol beverages, both have effects on alcohol consumption, which impacts on

road safety. Addressing pricing issues may therefore be a useful strategy to consider in the context of server intervention programmes.

Other initiatives

The following measures have been implemented in some, but not all, jurisdictions.

Compulsory blood testing of all road crash victims taken to hospital, and testing of all crash-involved drivers and those who commit serious traffic offences.

Alcohol assessment and/or rehabilitation programmes for repeat offenders: a number of jurisdictions also require disqualified drivers to undergo an assessment or undertake a treatment

or rehabilitation programme as a condition of re-licensing, and in some cases as a condition of sentencing. There is some evidence to suggest that such treatments as a supplement to licence suspensions may have a positive effect on recidivism.

Alcohol is a bigger problem than all other drugs combined. It has been estimated that there would be a 24 per cent reduction in fatal crashes if no drivers used alcohol, and a 13 per cent reduction if no drivers used other drugs.

Other drugs

There are a number of drugs (both legal and illegal) that have the potential to increase the risk of road crashes. The list includes cannabis, benzodiazapines, hallucinogens, antihistamines, amphetamines and opiates.

Many of these drugs have been shown to impair performance on driving-related tasks in laboratory tests, driving simulators, 'off road' and 'on road' studies. There are also concerns that some drugs, including amphetamines, can be associated with aggressive driving, and (when used to combat extreme fatigue) with the risk of quite sudden onset of sleep.

In Australian studies, drugs other than alcohol have been detected in a substantial proportion of crash-involved drivers.

However, available evidence suggests that alcohol is a bigger road safety problem than all other drugs combined.

Figures quoted for detection of drugs in crash-involved drivers often include:

- drivers using alcohol as well as other drugs (in recently published Australian data for drivers and riders killed in crashes, about 4 in 10 of the drug-positive drivers also had a BAC over 0.05)
- drivers who have traces of other drugs in their blood, but were not necessarily drug-impaired at the time of the crash (for example, traces of cannabis can often be detected some days after use)
- drivers using drugs that increase crash risk, but to a lesser extent than alcohol.

An Austroads report published in 2000 provided estimates of the contribution of alcohol and other drugs to road crashes. These estimates took into account available evidence on the level of crash risk associated with different drug groups, as well as the proportion of crashes in which alcohol and other drugs (both licit and illicit) are detected.

The report estimated that:

- If no drivers used alcohol, the number of fatal crashes would be reduced by about 25 per cent, and the number of serious injury crashes by 9 per cent.
- If use of all other drugs by drivers could be eliminated, the number of fatal crashes would be reduced by up to 11 per cent, and the number of serious injury crashes by about 1 per cent.
- The potential crash reductions associated with drivers who had used drugs but not alcohol were estimated at about 8 per cent of fatal crashes, compared to 20 per cent for drivers who had used alcohol but no other drugs.

The estimates of potential crash reductions presented by Austroads are lower than the total proportion of crash-involved drivers in whom alcohol or other drugs are detected. Data on the association between drug presence and culpability in crashes were used in deriving the crash

reduction estimates. In essence, if a substance is strongly linked to culpability (as is the case with alcohol) the estimated crash reductions will be higher than if the link to culpability is weak. The results are based on research published by a group headed by the Victorian Institute of Forensic Medicine at Monash University.

The research used to estimate drug involvement in non-fatal crashes tested for a more limited range of drugs than the data on fatal crashes. However, the Austroads report indicated that involvement of drugs in non-fatal crashes is probably significantly less than in fatal crashes. This is consistent with research findings for alcohol.

More recent data on drug involvement and culpability among fatally injured Australian drivers

have been published since the Austroads report was prepared. Application of the Austroads analysis to this more recent data gives an estimated 24 per cent fatal crash reduction if no drivers used alcohol, and 13 per cent if no drivers used other drugs (compared with the original Austroads estimates of 25 per cent and 11 per cent).

Cannabis is the drug most commonly detected in fatally injured drivers and riders in Australia. Testing in recent years identifies the active ingredient of cannabis (THC), separately from inactive forms that can persist in the body for some days after use. THC has been detected in 8.5 per cent of drivers and riders tested, including 4.1 per cent who had used cannabis without alcohol or other drugs. For the THC-only group, the odds of involvement as the culpable driver in a

fatal crash were 2.7 times those of drug and alcohol free drivers. This odds ratio rose to 6.6 for drivers and riders with a THC concentration over 5 mg/ml (3 per cent of those tested). This compares with a culpability odds ratio of 6.0 for drivers and riders with a BAC over 0.05 (29 per cent of those tested, with 20 per cent testing positive to alcohol only).

Stimulants, benzodiazapines and opiates (without other drugs or alcohol) were each detected in between 1 and 2 per cent of drivers and riders tested.

Heavy vehicle drivers

On available evidence, use of stimulants by truck drivers to combat fatigue is fairly common.

Surveys and roadside tests indicate that about one in five drivers use stimulants on at least some trips. There is some evidence that usage rates have declined since the early 1990s. Stimulants used include both over-the-counter or prescription medications and illegal stimulants, particularly methamphetamine.

Use of other psychoactive drugs by Australian truck drivers in conjunction with driving is quite rare, and their drink-driving involvement is substantially lower than other drivers.

In contrast to most other forms of drug use by drivers, truck drivers take stimulants with the specific intention of improving their alertness and driving performance, and avoiding crashes (or, from another perspective, attempting to cope with extremely demanding work schedules). There are,

however, concerns about sudden loss of alertness as stimulant effects wear off in a fatigued driver, and about long term health effects of sustained or excessive use.

Australian research published in 2003 found that 32 of 139 truck drivers killed in road crashes (23 per cent) had used some form of stimulant; 22 (16 per cent) had used only stimulants, without alcohol or other drugs, and these drivers were more likely to be responsible for their crash than alcohol and drug free drivers.

The main focus of current effort is on measures to reduce driver fatigue, rather than measures aimed directly at detecting and deterring the use of stimulants or other drugs. However, new Victorian legislation will make it possible to detect and penalise drivers who have used any quantity of methamphetamine.

Enforcement

All Australian states and territories have legislation that prohibits driving while under the influence of drugs, but the provisions and enforcement practices vary.

Generally, these laws require evidence of observable driver impairment, as well as evidence of the presence of a drug, before a driver can be penalised. This avoids the difficulties involved in relying solely on a test for the presence or concentration of a drug in the driver's body to establish that a driver was actually impaired by the drug.

RBT for alcohol is based on a quick, reasonably unobtrusive roadside test that can reliably distinguish between drivers likely to be impaired and those who have no alcohol in their system, or a trivial amount, which is unlikely to have significant consequences for road safety.

In the case of other drugs, the situation is more difficult. There are a large number of drugs that can affect driving performance. Reliable research on the relationship between dosage levels and degree of impairment is not available for most drugs. Many legal therapeutic drugs can make drivers safer if used in appropriate doses to treat their illness, but can increase risk when abused. Highly sensitive laboratory tests can detect most drugs in blood or other body fluid samples, but these tests can produce positive results when a drug is present in minute quantities that have no effect on crash risk. These tests are also expensive. Roadside drug tests that are currently available detect only a limited number of drugs, and are less accurate than the laboratory drug tests. They are cheaper than laboratory tests, but much more expensive than roadside breath tests for alcohol.

An impairment-based approach to drug enforcement removes many of these difficulties. A common approach is to test first for alcohol (the most common source of impairment) then, if that

test is negative but there are still suspicions that the driver might be impaired, to make a systematic assessment of observable impairment, and then take a sample for laboratory analysis. Drivers are then prosecuted on the basis of the combined evidence of impairment and presence of a relevant drug.

New legislation that will come into effect in Victoria in July 2004 will enable drivers to be prosecuted on the basis of a positive test for an illicit drug, without direct evidence of impairment and regardless of the amount detected. This will apply to THC and methamphetamine. This new enforcement model will operate in parallel with existing impairment-based enforcement.

16 fatigue – the hidden killer

The perils of fatigue

Driver fatigue or tiredness contributes to hundreds of deaths and injuries on our roads each year. Driver fatigue can be just as deadly as drink driving or excessive speed. Some estimates suggest that driver fatigue is a factor in up to 30 per cent of fatal crashes and up to 15 per cent of serious injuries requiring hospitalisation. However, the extent of the effects of fatigue involvement in crashes is difficult to quantify because, unlike alcohol and drugs, post-mortem examinations cannot identify fatigue as a causal factor.

Fatigue is usually associated with long distance driving, particularly by commercial truck drivers. However, any driver can be affected by fatigue.

Fatigue may be the cause of many crashes described as ‘cause unknown’. They are generally characterised as crashes where a vehicle ran off the road and/or collided with another vehicle or object, witnesses reported lane drifting before the crash, or there are no brake or skid marks. Other circumstances surrounding fatigue-related crashes include crashes that:

- occur late at night, early morning or mid-afternoon

- result in high levels of severity
- involve a vehicle leaving the roadway
- occur on a high speed road
- involve the driver not attempting to avoid the crash or the driver being the sole occupant in the vehicle.

The problem with fatigue is that it often develops slowly, and drivers may not realise that they are too tired to drive safely. But it is possible to learn to remain alert for the warning signs and take a break before it is too late.

What is fatigue and how is it caused?

There is no universally accepted definition of fatigue. Fatigue generally refers to a combination of symptoms such as impaired performance and subjective feelings of drowsiness. The term can also refer to contributory factors such as prolonged activity, inadequate sleep and disruption of circadian rhythms (see below).

Fatigue involvement in a road crash can therefore be due to a range of factors including drowsiness, falling asleep at the wheel and inattention to the driving task. It is important to note that fatigue can cause cognitive impairment, including a lack of perception and inattention, without accompanying feelings of drowsiness.

Although there are a range of factors that can cause fatigue, the three main causes are: lack of sleep; time of day or circadian factors; and time performing a task.

Lack of sleep

Adequate sleep is vital for the proper functioning of the human body. The amount of sleep an individual needs generally varies between seven and nine hours per day, with eight hours being fairly common. Research has shown that, when the body is deprived of sleep, it builds up a 'sleep debt' much like a monetary debt which has to be paid back. Sleep debt is the difference between the

minimum amount of sleep required to maintain alertness and the actual amount of sleep obtained. Accumulated sleep debt of even small amounts such as two hours can have serious effects on alertness and reaction time.

A study by the Centre for Sleep Research in South Australia has found that a person who drives after being awake for 17 hours has a risk of crashing equivalent to being at the 0.05 blood alcohol level.

When I die, I want to die like my grandmother, who died peacefully in her sleep. Not screaming like all the passengers in her car.

ANON

Driving after 24 hours without sleep increases the risk to a level equivalent to a blood alcohol concentration of 0.10.

Broken sleep or too little sleep at night and sleep disorders can contribute to fatigue. Sleep apnoea is a medical condition involving brief interruptions in breathing during sleep and often affects people who are overweight. Untreated sleep apnoea can result in dozing off during the day and increases the risk of falling asleep at the wheel. A US study of 6 000 patients with sleep apnoea found that 15.6 per cent had been involved in at least one car crash compared with 6.7 per cent for drivers in the non-apnoea control group. This means that people with sleep apnoea could be twice as likely to be involved in a car crash in the course of their lifetime as people without apnoea.

Narcolepsy is a sleep disorder characterised by extreme daytime sleepiness and sudden, brief attacks of muscle weakness. Insomnia – a symptom rather than a disease – is some sort of sleeping difficulty. Any of these conditions can increase the risk of crash involvement

considerably, particularly if they are undiagnosed and untreated and can result in a driver being tired even before getting into a car.

Time of day

The neurobiological sleep-wake cycle in human beings is called a circadian rhythm or body clock. During the 24-hour circadian cycle, there are two periods when the level of sleepiness increases: night and early morning and afternoon. During these periods, many functions such as subjective mood, performance and alertness are reduced.

Research has shown that fatigue-related road crashes tend to correspond to the effects of circadian rhythms. Such crashes tend to peak in the night and mid-afternoon.

Time on task

Extended periods of physical activity without adequate rest results in muscular fatigue. Prolonged mental effort produces similar effects on mental alertness. Research shows that as time spent on a task increases, the level of fatigue also increases.

*Sleep in a chair
Nothing to lose
But a nap at the wheel
Is a permanent snooze.*

1940s BURMA SHAVE JINGLE IN US ROAD SIDE SIGN

Once you notice the warning signs, take the safe option and rest up sooner rather than later.

Other factors

General health, age, alcohol, drugs, illness, medicines, stress, demanding physical or mental work, shift work, caring for children and the demands of daily living can all contribute to fatigue, drowsiness or inattention while driving.

A comfortable or monotonous driving environment can also induce fatigue. The high interior comfort level of modern cars, cruise control and good road engineering can lead to reduced vigilance. Dull scenery and repetitive patterns such as headlights, trees, utility poles and highway markings can contribute to ‘highway hypnosis’ – a trance-like condition that dulls the senses, affects judgement and reduces reaction time.

Fatigue warning signs

When you do not get enough sleep, the cerebral cortex, which governs what you think and say, begins to shut down. Several easy-to-recognise

warning signs show when you are becoming fatigued. They include any combination of the following:

- you keep yawning
- you have difficulty keeping your head up or your eyes open
- your eyes feel sore or heavy
- your vision starts to blur or dim
- you start ‘seeing things’
- you find you are daydreaming, thinking of everything else but your driving
- you have difficulty in maintaining a conversation
- you become impatient and make rash decisions
- you feel hungry or thirsty
- your hands feel sweaty
- your reactions seem slow
- you feel stiff or cramped
- your driving speed creeps up or down
- you start making poor gear changes
- you wander over the centre-line, or into another lane or onto the road edge
- you hear a droning or humming in your ears
- you do not notice a vehicle until it suddenly overtakes you
- you miss exits or turns
- you do not remember driving the last few kilometres.

ATSB fatigue research

The ATSB commissioned research on fatigue-related crashes in Australia and published the results in 2002. The study used an operational definition of fatigue which:

- includes single vehicle crashes that occurred during 'critical times' (midnight–6 am and 2 pm–4 pm)
- includes head-on collisions where neither vehicle was overtaking at the time
- excludes crashes that occurred on roads with speed limits under 80 kilometres per hour and crashes that involved pedestrians, unlicensed drivers and drivers with high levels of alcohol (over 0.05 g/100ml).

The operational definition, while useful, has some limitations. It will inevitably fail to identify some fatigue-related crashes and include some crashes caused by other factors.

Using this definition, the study found that 16.6 per cent of fatal crashes in 1998 involved driver fatigue. Between 1990 and 1998, the proportion of fatal crashes involving driver fatigue increased from 14.9 per cent in 1990 to 18.0 per cent in 1994, after which there was a decline to 16.6 per cent in 1998.

More single-vehicle crashes occurred in the early morning (midnight–6am) than afternoon (2pm–4pm). However, the incidence of head-on

crashes was highest between midday and 6 pm and lowest between midnight and 6am. This finding may be related to traffic densities: higher traffic densities during the day would increase the likelihood of fatigue-related crashes involving multiple vehicles in head-on collisions and lower traffic density during the early morning would increase the likelihood of fatigue-related crashes involving single vehicles.

After all the research I've done on sleep problems over the past four decades, my most significant finding is that ignorance is the worst sleep disorder of them all.

DR WILLIAM C. DEMENT, SLEEP RESEARCHER, 1999

Most early morning fatigued drivers and riders were under 29 years of age. Fatigued drivers and riders over 50 years of age were involved in more afternoon crashes than in early morning crashes.

The proportion of fatal articulated truck crashes (29.9 per cent) involving driver fatigue in 1998 was almost twice the proportion of all fatal crashes involving fatigue (16.6 per cent). However, when only speed zones of 80 km/h or over were considered the difference was smaller: 34.5 per cent of fatal articulated truck crashes involved fatigue, while 24.9 per cent of all fatal crashes involved fatigue. Although fatigue is more highly represented in articulated truck crashes, this does not necessarily imply that the truck driver was always the fatigued driver in a crash involving more than one vehicle. In head-on fatigue-related crashes involving an articulated truck, truck drivers were estimated to be the fatigued driver in only 16.8 per cent of crashes, while passenger car drivers were fatigued in 66 per cent of crashes.

Myths and facts

There are many myths about driver fatigue:

Myth: I will be safer if I make the trip overnight because I will avoid the daytime traffic.

Fact: Your body has a normal 24-hour rhythm pattern built into it. If you are driving when you would normally be sleeping, you will be fighting yourself to stay awake. The chances of falling asleep at the wheel after your normal bedtime, especially in the early hours of the morning, are very high.

Myth: It is a good idea to start the trip after work.

Fact: This is the worst time to begin your trip. You have been using your mental and physical energies all day and you will be tired already, even though you do not realise it. The safest thing to do is to get a good night's sleep (about 7 to 8 hours of undisturbed sleep) and start your journey the next morning.

Myth: Loud music will keep me awake.

Fact: This might help for a while but it will not help for long. Loud music might also distract you from the driving task or even send you to sleep!

Myth: A flask of coffee or a caffeine drink will keep me awake.

Fact: Caffeine is only a short-term solution and will have less and less effect the more often you use it. It might make you feel more alert, but it will not keep you going for long. The long-term solution is to get some sleep.

Myth: Plenty of fresh air through the window will keep me awake.

Fact: This might give you a boost and help for a while, as might turning the air-conditioning on to cold. But if you are tired, sleep is the only solution.

Reducing fatigue-related crashes

Road design changes that can help in mitigating fatigue-related crashes include shoulder sealing, audio-tactile edge-lining (rumble strips), provision of adequate rest areas and facilities, using medians or barriers to divide highways and removing roadside hazards such as utility poles and trees.

There are many in-vehicle technological aids purported to combat driver fatigue, but there are concerns about the reliability of these devices. Excessive reliance on these devices could be dangerous, as they may not work as intended. The use of these devices may also encourage drivers to rely on them to provide warnings when situations become quite dangerous, whereas drivers should get adequate sleep before driving and plan their journeys to include rest breaks.

Research has shown that the only measures that have some effect in reducing drowsiness while driving are taking a ‘powernap’ of about 15 minutes or consuming at least 150 mg of caffeine.

But these measures cannot fully substitute for adequate sleep. Only taking proper precautions against fatigue (see facing page) will foil the hidden killer.

...most people claim that they can drive sleepy and handle it. Their attitude is akin to someone being happy to sit on a time bomb every day, complacent because it hasn't gone off yet.

DR WILLIAM C DEMENT, SLEEP RESEARCHER, 1999



Tips for avoiding fatigue

Once fatigue sets in, there is little you can do except to stop and take a break. A safer solution is to avoid becoming tired in the first place. Here are some strategies for staying fresh and alert on a long trip:

- Be sure to have 7 to 8 hours of uninterrupted sleep before your trip. The worst time to begin your trip is after work. You have been using your mental and physical energies all day and you will be tired already, even though you do not realise it.
- Aim not to travel for more than 8 to 10 hours each day.
- Take regular 15-minute breaks at least every two hours. With each break, get out of the car, take some deep breaths and get some exercise.
- If possible, share the driving. Listen to your passengers if they tell you that you look tired or that you are showing signs of tiredness.
- Eat well-balanced meals at your usual meal times. This will also ensure that you take proper breaks. Avoid fatty foods, which can make you feel sluggish.
- Avoid all alcohol before driving or during rest breaks. Similarly, avoid taking any prescription medicines that can affect your alertness or cause drowsiness. Check with your doctor or pharmacist to see if you can safely do without them during your trip.
- Arrange overnight accommodation in advance so you can avoid driving into the night. Your chances of crashing are much higher at night, and especially in the early morning hours. If you drive when you would normally be sleeping, you will find it harder to stay awake.

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driven to distraction: the dangers of inattention

Driving is a complex task and requires the use and coordination of various skills including those in the physical, cognitive and sensory areas. However, despite the obvious need for high levels of concentration and attention while driving, drivers engage in various activities while driving, including smoking, conversing with passengers, adjusting the controls of audio equipment, using mobile phones, shaving, applying cosmetics, reading and writing.

The BBC reported, on 5 December 2003, that US police stopped a driver who was breastfeeding her child while travelling at 110 km/h. Before pulling up, she also managed to phone her husband for advice while taking notes on the steering wheel.

Driving in London's my pleasure

I prize it above any other

One hand on the wheel

The fingers like steel

And the A–Z clenched in the other.

PAM AYRES, A–Z: THOUGHTS OF A LATE-NIGHT KNITTER, 1978



Even a fly can kill

The Courier-Mail of 3 October 2002 reported a crash involving a four-wheel drive vehicle on the Condamine Highway 200 kilometres west of Toowoomba. The vehicle had left the highway and rolled several times before coming to rest in a paddock over 100 metres away.

The driver, a 20-year old university student, survived the crash, but her four friends who were travelling in the vehicle were killed.

The driver had lost control of the vehicle when she attempted to swat away a fly.

Driver distraction is part of the broader issue of driver inattention. Distraction occurs when a driver experiences a delay in recognising information that is required for safe driving because of the influence of something (such as a person, event or activity) that occurs inside or outside the vehicle. The occurrence of an event or activity differentiates distraction from the more general issue of inattention.

This chapter focuses mainly on sources of distraction inside the vehicle (as opposed to outside the vehicle) and surveys some Australian and international research on distraction.

The National Highway Traffic Safety Administration (NHTSA) has identified four types of driver distraction: visual (things you see), auditory (things you hear), biomechanical or physical (things you do with your hands) and cognitive (things you think about).

Visual distraction can occur in different ways. It may involve focusing on a roadside object or

object in the vehicle for too long. Another form of distraction is a lack of visual attention, where the driver looks at something but does not really see it for what it is.

Auditory distraction occurs when drivers focus attention on sounds instead of the road environment. Common forms of auditory distraction are conversing with passengers, listening to the radio, tapes or CDs and using mobile phones.

Biomechanical or physical distraction refers to the removal of one or both hands from the steering wheel to perform tasks such as tuning the radio, eating or drinking.

Cognitive distraction involves thoughts that occupy the mind of the driver to the extent that they interfere with concentration on the driving task. Having a conversation using a mobile phone is an example of cognitive distraction.

Some activities can involve more than one form of distraction. For example, using a mobile phone can involve all four types of distraction.

As opposed to the four types of distraction, sources of distraction can be classified into two broad groups: technology-based (such as mobile phones, in-vehicle navigation systems, audio and video equipment) and non-technology based distractions (such as smoking, conversation, eating and drinking).

*Sign at a cemetery along a busy road:
Drive carefully – we can wait.*

Ergonomic design of the human-machine interface is the most effective means of reducing in-vehicle distraction.

In the case of young drivers, research has found that the presence of passengers increases crash risk, particularly because of distraction (verbal and physical interaction) and peer pressure.

An issue in assessing driver distraction is the frequency of events that cause distraction. An activity that is less distracting but occurs more frequently (such as conversation with passengers) has to be weighed against an activity that is more distracting but is performed occasionally (such as shaving). The extra exposure to the more frequent

The use of hand-held mobile phones is banned in all Australian states and territories and penalties apply for non-compliance. Hands-free mobile phones can be as distracting as hand-held phones.

*Beneath this slab
John Brown is stowed.
He watched the ads
and not the road.*

OGDEN NASH, AMERICAN HUMORIST, 1942

activity can increase crash risk relative to the less common activity.

Given the increasing availability of in-vehicle information, communication and entertainment systems, driver distraction is likely to become an increasingly important road safety issue in the future.

Technology-based distractions

Mobile phones

Irrespective of whether the phone used is hand-held or hands-free, drivers have to focus some of their attention on the call, and will often take their eyes off the road to make a connection by dialling a number or answering a call. Hand-held phones involve additional physical distraction by requiring the driver to use only one hand in steering the vehicle. Auditory distraction can occur due to the driver being startled by the initial ringing of the phone as well as by the conversation.

Conversing with a passenger is generally less distracting than using a mobile phone because passengers, being aware of the road environment, can control the conversation by lapsing into silence and allowing the driver to concentrate on the driving task when facing a hazardous situation. Conversations using mobile phones while driving could tend to be more distracting if the driver is talking to certain people (such as clients or

superiors) or if the conversation is particularly stressful, thereby not allowing the driver to refocus on the driving task when facing a hazardous situation.

A 2002 British study conducted by the Transport Research Laboratory using an advanced driving simulator compared the use of a hand-held and hands-free mobile phone while driving with driving over the United Kingdom legal alcohol limit (80 mg per 100 ml or 0.08). The study found that reaction times to hazards were on average 30 per cent slower when conversing on a hand-held phone than when driving under the influence of alcohol and 50 per cent slower than under normal driving conditions. The study also found that there was reduced control of speed while a mobile phone was being used. The conclusion of the study was that the use of a hand-held mobile phone while driving significantly impairs driving performance.

A Canadian study conducted in Toronto found that the risk of involvement in a crash while using a mobile phone was four times greater than the risk among the same drivers when they were not using a phone. The study also found that there were no safety benefits of using a hands-free phone compared with a hand-held phone while driving. Several other studies have also found that using a hands-free phone while driving is no safer than using a hand-held phone.

Mobile phone use usually involves other tasks such as checking diaries or writing down information that further increases distraction.

A survey conducted in the United Kingdom showed that drivers considered sending a text message to be the most distracting activity and this was ranked more distracting than reading a map, using a hand-held or hands-free phone, eating fast food or changing a tape. An Australian survey conducted by the University of Sydney found that

30 per cent of people surveyed had sent text messages while driving. Another Australian survey, conducted by Telstra, found that one in six drivers regularly sent text messages while driving. These findings are a cause for concern as text messaging involves more distraction than talking on a mobile phone.

A US simulation study found that talking on a mobile phone is more distracting than holding a conversation with a passenger, but no more distracting than eating a cheeseburger.

Route guidance systems

The most distracting task in using route guidance systems is entering destination information. Using voice input technology reduces the distraction in using these systems. Systems that provide navigation instructions audibly are less distracting than those that use visual display of information. The most useful and least distracting systems are those that provide turn by turn instructions.





Entertainment systems

Listening to the radio is one of the commonest in-vehicle activities. Tuning a station is likely to involve physical and visual distraction due to the need to look away from the road, while listening to the radio would involve cognitive and auditory distraction.

Studies have shown that mere listening to radio programmes while driving can impair driving performance (as measured by deviation from the driving lane), but tuning the radio is less distracting than dialling, talking on a mobile phone or operating route guidance systems. Adjusting audio equipment while driving can also adversely affect driving performance. Operating a CD player while driving has been found to be more distracting than dialling a mobile phone or eating.

Non-technology distractions

A US study has shown that a greater proportion of drivers involved in crashes are distracted by eating or drinking (1.7 per cent) than by talking on a mobile phone (1.5 per cent). Another US study has found that eating a cheeseburger was as distracting as using a voice activated dialling system, but less distracting than continuously operating a CD player.

There is evidence from several studies that smoking while driving increases the risk of being involved in a crash. Smokers remove their hands from the steering wheel to light a cigarette, hold it in their hands for a few minutes and put it out. Research shows that there are three factors that could influence the increased crash risk of smokers: distraction caused by smoking, behavioural differences between smokers and non-smokers, and the toxic effects of carbon monoxide.

*Radio tuning or CD player operation
can be more distracting while driving than
using a hands-free mobile phone.*

The Australian NRMA/MUARC study

A study commissioned by NRMA and undertaken in a driving simulator by the Monash University Accident Research Centre (MUARC) investigated the effects of different types of distraction on driver behaviour.

The study examined the driving performance of 30 drivers across three age groups. Distraction within the vehicle and visual clutter in the road environment were examined in 60–80 km/h speed zones. The distractors used were:

- operating the car audio system (adjusting volume, loading cassettes)
- conducting a simulated hands-free mobile phone conversation
- driving in a complex road environment with many advertising billboards, signs and traffic.

The study employed a hazard perception task, which assessed the effects of distraction in terms of drivers' reactions to pedestrians and other hazards in the roadway.

The study found that the negative effects of distraction were more pronounced for the audio system tasks than for the mobile phone tasks:

- When people were distracted by the audio system, they slowed between 9 and 11 km/h less when there was a pedestrian crossing the road or standing in the roadway than when they encountered the same hazards without being distracted.
- When they were distracted by the mobile phone conversation, they slowed between 5 and 7 km/h less than when there was no distraction.

- When distracted by the audio system, drivers' vehicle position on the road deviated up to 0.8 metres more than when they were not distracted. This means they wandered over the road more when they were distracted by the audio system than when they were not.
- Drivers were told to maintain a constant speed. When they were distracted by the audio system, their speed varied from the target speed by 1.5–1.7 km/h more than when they were not distracted. This means they were less able to concentrate on maintaining a constant speed while operating the audio system.
- Overall, the results found that the distractors reduced overall driving performance (poorer speed control and lane-keeping); reduced drivers' ability to detect and respond safely to unexpected hazards; and increased drivers' feelings that they were under pressure. The results were relatively consistent across different age groups and environmental complexities.
- The negative effects of distraction were observed in both simple and complex highway environments – light traffic with fewer distractions as well as situations with heavier traffic and more environmental distractions such as pedestrians and signage.
- An important finding was that the audio system distractor had the greatest negative impact on performance, suggesting that common activities such as radio tuning or CD player operation can be more distracting while driving than using a hands-free mobile phone.

